24th INTERNATIONAL CONGRESS ON SOUND AND VIBRATION
23–27 July 2017, London

ICSV24
23-27JULY 2017
LONDON CALLING

MANAGEMENT OF ENVIRONMENTAL SUSTAINABILITY OF PORTS - FOCUS ON NOISE MITIGATION

Walid Kamali

AL Manar University of Tripoli, Faculty of Engineering & Maritime Studies, Tripoli, Lebanon
email: Walid.kamali@gmail.com

Ports and are characterized by several complex operations, especially if compared with other logistic nodes. In these scenarios, noise pollution analysis is complicated due to the presence in the same area of several types of sound sources with different characteristics. Noise from port areas comes not only from ferries, ships and trade but also from industrial and shipyards activities as well as auxiliary services. In this way, noise pollution can produce negative effects both to the natural eco-system and to the urban population. The work performed within the last four years of activities in the ENPI CBC MED project, "Managing the Environmental Sustainability of Ports for a durable development (MESP)" addressed the pollution reduction from port activities through the implementation of a multidisciplinary approach in air, noise and water sectors. It encompassing technological, regulatory and administrative solutions to ensure natural and urban sustainability and high level of life quality in surrounding territories. To prevent a heterogeneous development, the "status quo" of ports in Northern and Southern Shores of the Mediterranean Sea was analyzed and a guideline on methodologies, good practices and measurement assessment, adaptable and transferable in different port contexts was elaborated. To assess the procedures, validation tests have been carried out to different real cases. In noise sector pilot projects in the ports of Patras, Greece, and Tripoli, Lebanon, have been implemented. Due to the dissimilar scenarios, in terms of orography, facilities and activities, different noise mitigation actions and interventions were consequently attained.

Keywords: Environmental Noise, Testing Campaign, Modelling, Port Area, Vehicle Noise

1. Introduction

The European Union Sustainable Development Strategy (EU SDS) was developed in order to ensure a better quality of life for its citizens and its neighborhood. In this regard short- and long-term objectives have been put in action through a wide range of common recommendations, key factors and visions regarding local and global actions on social, economic and environmental issues. The degradation eco-systems, crucial for guaranteeing a high quality of life, by strengthening the efforts for environmental protection [1–3]. Concerning maritime issues, at the regional level, attention has been paid to the so-called "Barcelona system" consisting of the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its various protocols, respectively, dealing with dumping, pollution from ships, land-based pollution, specially protected areas and biodiversity, offshore activities and hazardous waste and, notably, integrated coastal zone management. The promotion of environmental sustainability at the Mediterranean basin level is one of the main priorities of the Operational Program ENPI CBC MED (European Neighborhood and Partnership Instrument multilateral Cross-Border Cooperation "Mediterranean Sea Basin") [4]. Among the various granted ENPI CBC MED projects, "MESP" (Managing the Environmental Sustainability of Ports for a durable development) [9] will be hereinafter analyzed, as a good example of EU sustainable project management. MESP project aims to decrease pollution levels concerning air, noise and water deriving from port activities and give back to citizen, tourist and workers a healthier and

usable environment [6]. The MESP project target goals are the identification of best practice and procedures and the realization of pilot projects in different port in order to firstly assess the validation of the selected methodologies. In this way, these actions can help management authorities and port areas and infrastructures users in reaching a higher level of sustainability and in decreasing the pollution levels. In this paper a specific focus on the noise sector developed within MESP project activities is shown and illustrated.

2. Mediterranean Ports Protection

The majority of ports in the Mediterranean basin are often are an integral part of the old city. Ports are complex nodes where often various activities take place. Such activities do vary in nature and are hard to be isolated from each other's. Commercial, industrial and construction and leisure activities coexist on same coastal area. This creates negative effects both to the sea eco system and to the urban population.

The European Sea Port Organization (ESPO) represents the port authorities, associations and administrations of the seaports of the Member States of the European Union and Norway with the aim to make the European port sector more efficient and environmentally sustainable. In 2016, ESPO produced the "ESPO Port Performance Review 2013" whose outcomes contributed to the second edition of the Port Performance Dashboard [7, 8]. As can be seen in Figure 1, noise impact reaches and maintains high ranking in 2016.

Figure 1: 2016, Top – 10 Environmental priorities of European Ports

Noise pollution and mitigation has remained high on its priorities for many years and will remain for many more years to go.

It is well known that port areas contain several noise sources in various sectors with different characteristics from each other, such as ferries, ships and trade operations, industrial and shipyards as well auxiliary services [5, 11, 12]. Such activities strongly impact the environment of the surrounding area and, as a consequence, local population, port workers and tourists as well as both terrestrial and marine ecosystems.

3. Two Ports Two approaches

Concerning noise sector the two context represented from Patras, Greece and Tripoli, Lebanon showed two different context and two consequentially different approaches and interventions. [10]

The Patras Port, playing an important role in the economic life of Patras, Western Greece and Greece in general, besides the necessary facilities of a Commercial Port currently not utilized, is mainly a passenger port handling an important part of the total passengers' sea traffic as the West Gate of Greece towards Italy and the rest of European Union. From 2011 the Old Port close to the downtown of Patras, was extended towards south, along the urban area, with the new port, aimed mainly to serve the ferry route Patras-Italy. Figure. 2.

Figure 2: The South Port or else known as New Port

Patras pilot project aimed to reduce the impact on the receivers. Considering that the limited budget at disposal did not allow realizing a significant intervention, useful to evaluate the goodness of the intervention, the undertaken action in Patras foresaw the application of sound proof windows on the pilot building of ADEP S.A., directly exposed to the traffic noise in Eleftheriou Venizelou Street.

The Port of Tripoli, the Second major port in Lebanon, is located on the boundaries of both cities Al-Mina and Tripoli. It covers an approximate area of 3 million m^2 with a water area of 1.5 million m^2. The Port of Tripoli currently has two basins where commercial and maintenance activities mostly take place. Large development projects, especially the construction of the new berth (1200 m long) with an accompanied land area of 550000 m^2 are ongoing, elevating the status of the Port of Tripoli to International. In this way the sustainability of the port area is a current concern for Port of Tripoli Authority and it includes dealing with problems that may seriously affect the environment in harbor. The Figures 3.a and 3.b below show the construction progress over the last six years.

Figure 3: Arial view of the Port of Tripoli in 2010 3a (left) and 2016 3b (right)

After an overview on the general approach to pollution reduction a specific key element is the review of the two pilot projects methodologies.

3.1 Patras Results

Noise testing in Patras pilot project consisted of testing Noise in one building facing the port that is the building of ADEP S.A. Noise levels are affected by the port in an indirect way. More specifically: the port has two Exit Gates from which all vehicles can exit the port area. One of these 2 gates (the north exit) leads to the Street of Eleftheriou Venizelou next to which ADEP S.A. building is located (El. Venizelou 38). This street leads to the highway that takes the vehicles to the directions of Athens and Pyrgos the 2 main directions away from Patras. This means that vehicles, especially trucks that exit the ferry and have a destination outside of Patras will most likely use Venizelou Street creating increased noise levels that will also affect ADEP S.A. building. The results are summarized in the Figure 4

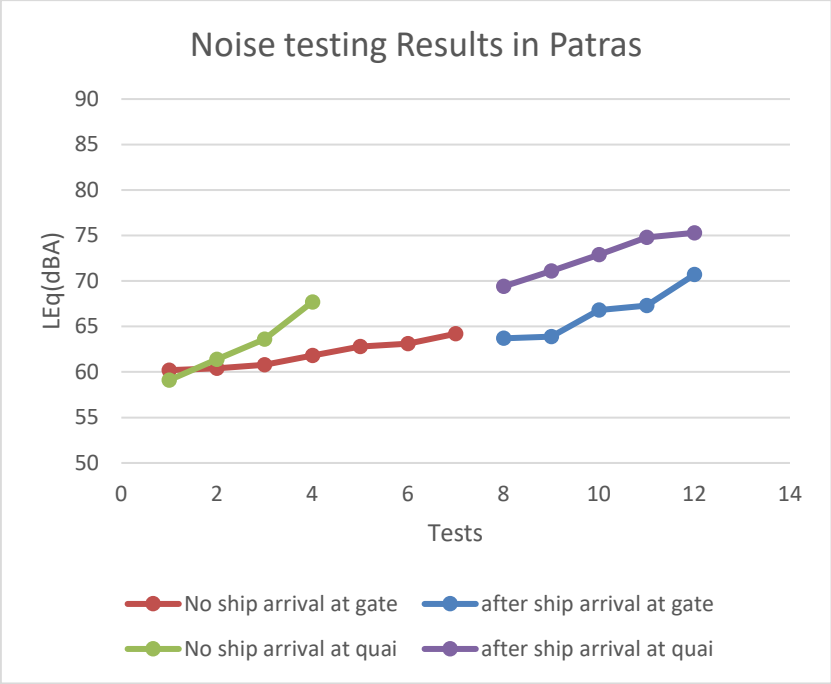

Figure 4: Noise Testing Results in Patras

3.1.1 Observations

The following observations have been issued in Patras Pilot Project. Noise reaches high levels at inner Exit gate after the arrival of ships, especially caused by the vehicles that exit the ferry and the port. Noise increases significantly at docks after the arrival of ships due to the vehicles that exit the ferry and the port. Noise levels are quite lower than at Inner Exit Gate. Normal noise levels are registered at Old Port as a result of the low port activity. Finally Traffic created by the exit of vehicles from the port after the arrivals of ferries, increases the noise levels by the ADEP S.A. Building

3.1.2 Conclusions

The point with the most significant noise issue is the Inner Exit Gate due to the fact that is used by many different vehicles and the pattern of use concentrates the high noise levels in certain periods of time. The people mostly affected by that this are the workers of the Maritime Force. Interventions to improve the noise insulation of their offices should be made in order to reduce the nuisance.

The traffic created after the arrival of ferries causes increased noise levels in the main streets that lead to the port. Traffic outside the city of Patras affecting buildings and people on the way. Better noise insulation to buildings is to be implemented

3.2 Tripoli Results

The pilot project in the Port of Tripoli went through several steps such as Surveying, Testing, Assessment, Mapping and Interventions. [13-24]

3.2.1 Noise Survey

The survey remains an instrumental tool to raise the awareness and to lay the ground for possible intervention measure. Figure 5shows an example of the survey results where Port users were questioned.

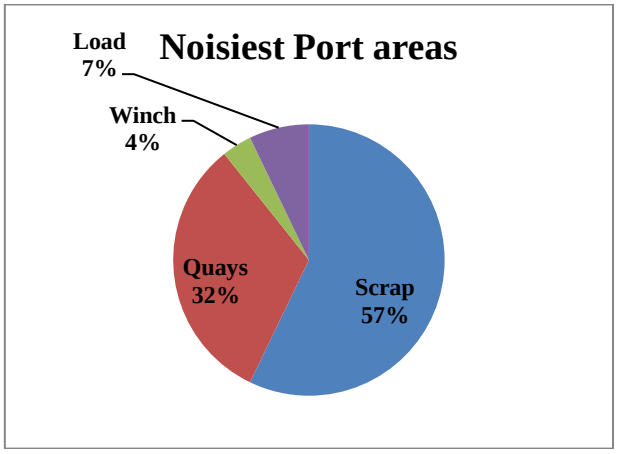

Figure 5: Survey Results, Cause of Noise

Concerning the cause of noise, 40% believed that the type of equipment used and the vehicles (mainly trucks and winches) as the primary sources of noise.

3.2.2 Targeted Noise Testing

Various testing have been performed. The Vehicle mobility proved to be of the highest impact on Port users. Figure 6 shows the results of Noise testing due to Vehicle Mobility

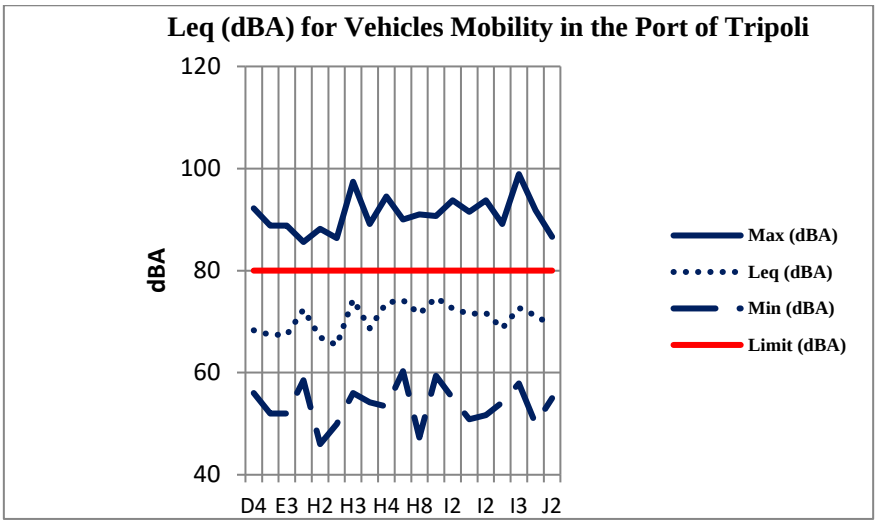

Figure 6: Targeted Noise Testing with focus on Vehicle Mobility

3.2.3 Noise Mapping

It was then decided that speed reduction of vehicles moving within and around the Port area would result in a significant reduction of Noise. The assumption was validated using a Noise mapping simulation software MITHRA SIG from CADCORP. The different simulations included activities such as Vehicles Mobility + Berthing of Ships, Vehicles Mobility + Loading of Cargo, Vehicles Mobility + Loading of Metal Scrap, Vehicles Mobility + Loading of Cargo + Berthing of Ships and all activities included. The information on Noise sources such as Vehicle mobility and other point sources was entered in the model and demonstrated certain level of agreement between the measurement and the model. The following step consisted of a new simulation using a reduced speed model. Speed reduction has been planned through awareness campaign, Road signs as well as speed bumps.

3.2.4 Interventions

Figure 7: Speed Reduction Interventions

During the second monitoring campaign in September 2015, following the installation of road signs for speed limitation, controlled noise testing was also performed. The reduction of speed limit to 20 km/h and the result of the "no honking" campaign contributed in the decrease of maximum of Sound pressure levels. The recorded results showed average L_{Eq}, and L_{Max} of 70dBA and 88dBA respectively.

4. Conclusion

Noise Analysis in port areas requires a specific methodology approach which is observation, monitoring, measurement and identification.

To validate the selected approach pilot projects were implemented in the Port of Patras and in Port of Tripoli. It resulted in the adoption of specific approaches and different mitigation measures. Both methods proved to be valid in reducing noise level exposures in port areas.

One of the targets of MESP project which was financed under ENPI CBC MED Programme 2007-2013 is to disseminate the project outcome and to capitalize the experience concerning the topic addressed, in view of identifying good practices and common valuable approaches.

Consequently, the creation of a strong cooperation network and long-lasting collaborations among subjects of different nature such as harbor cities, port authorities and scientific skills.is essential to allow valuing and increasing the sustainability of ports through to the creation of homogeneous best practices.

Acknowledgments

The author acknowledges the contributions of the team members of the MESP project in particular the Working Group for Noise from UNIGE, ADEP and the Port of Tripoli. The data collection has been produced with the financial assistance of the European Union under the European Neighborhood and Partnership Instrument Cross-Border Cooperation Mediterranean Sea Basin Program (ENPI CBC MED). The contents of this document are the sole responsibility of the authors and can under no circumstances be regarded as reflecting the position of the European Union or of the Program's management structures. The project MESP total budget is 1388695.72 € and it is financed, for an amount of 1249826.15 € (90 %), by the European Union.

REFERENCES

1 Commission of the European Communities. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Mainstreaming Sustainable Development into EU Policies: 2009 Review of the European Union Strategy for Sustainable Development. COM (2009) 400 Final; Commission of the European Communities: Brussel, Belgium, 2009. 2.

2 Eurostat. Sustainable Development in the European Union. 2015 Monitoring Report of the EU Sustainable Development Strategy; Publications Office of the European Union: Luxembourg, 2015. 3.

3 Pavasovic, A. The Mediterranean Action Plan Phase II and the revised Barcelona Convention: New prospective for integrated coastal management in the Mediterranean region. Ocean Coast Manag. 1996, 31, 133–182.

4 Schenone, C., *Numerical Modeling of Environmental Noise*, 2nd International Conference on Advances in Computational Tools for Engineering Applications, pp. 114-119, Dec. 2012

5 Schenone, C., Pittaluga, I., Repetto, S., Borelli, D. Noise pollution management in ports: A brief review and the EU MESP project experience. *Proceedings of the 21st International Congress on Sound and Vibration*, Beijing, China, 13-17 July, (2014) , pp. 1364-1371

6 Good Practice Guide on Port Area Noise Mapping and Management NoMEPorts

7 European Environmental Bureau, *Noise*, (2011) [Online] available: http://www.eeb.org/index.cfm/activities/industry-health/noise/

8 Tourist facilities in ports, the environment factor *Commissioned by: European Commission Directorate-General for Maritime Affairs and Fisheries*. August (2009)

9 MESP project website, *www.mesp.org*

10 Roadmap on Sustainability Criteria, Guidelines for Port Environmental Management available on MESP Project website (2015) [Online] available: www.mesp.org

11 Environmental impacts of Noise from ships and boats, (2001) [online] available on *The UK Marine SACs Project website*: http://www.ukmarinesac.org.uk/activities/ports/ph3_2_3.htm

12 Harbouring Pollution, *Strategies to clean up U.S. Ports*, Aug 2004

13 State and Trends of the Lebanese Environment 2010, Ecodit

14 Cost of Coastal Zone Environmental Degradation in Northern Lebanon, METAP Report, March 2009)

15 Fooladi, M. *Involuntary and Persistent Environmental Noise Influences Health and Hearing in Beirut, Lebanon* Journal of Environmental and Public Health Volume 2012(2012), Article ID235618, 7 pages, doi:10.1155/2012/235618

16 Annex 10 of the decision 1/52 of the Lebanese Ministry of Environment: www.moe.gov.lb, section Laws and Regulations, link: http://www.moe.gov.lb/The-Ministry/Laws-Regulations.aspx (1996)

17 Standards and Specifications to reduce air, water and soil pollution, Decision 1/52 of the Lebanese MoE (1996)

18 Abdul Wahab, A., El Moghrabi Y. & Kamali W., Managing the Environmental Sustainability of Ports for a Durable Development (MESP), Noise -Water – Air - Paper 1 - Laws and Regulations, *OEANL SC Magazine*, **8**, 1 - July (2013)

19 Kamali, W., Abdul Wahab, A., El Moghrabi, Y., Kabbara, H., Hajar, A., Mecsaci, R., Merhaby, D., Survey on Environmental noise in the port of Tripoli, *Proceedings of the 21st International Congress on Sound and Vibration*, Beijing, China, 13-17 July, (2014)

20 Kamali, W., El Moghrabi, Y., Wahab, A.A., Noise mitigation measures of noise intense activities in harbour area and surrounding, *Proceedings of the 22nd International Congress on Sound and Vibration*, Florence, Italy, 12-16 July, (2015)

21 Schenone C., Pittaluga, I., Borelli, D., Kamali, W., El Moghrabi, Y., The impact of environmental noise generated from ports: outcome of MESP project, *De GRUYTER Open Access Research Article Noise Mapping*, **3**, 26-36, February (2016)

22 Kamali, W. and El Moghrabi, Y., Effects of Noise Generated by Port Activities into the Surrounding area of Tripoli Port, Lebanon, *Proceedings of the 23rd International Congress on Sound and Vibration*, Athens, Greece, 10-16 July, (2016)

23 Schenone, C & al. *Managing European Cross Border Cooperation Projects on Sustainability: A Focus on MESP Project*, http://www.mdpi.com/journal/sustainability, pp. 2-18, September (2016)

24 Badino, A, Borelli, D., Gaggero, T., Rizzuto, E. and Schenone, C., Criteria for noise annoyance evaluation on board ships, Proceedings of the 14th International Maritime Association of the Mediterranean, Genova, Italy. Vol. 2, 971-980 (2012)