

NOISE POLLUTION IN THE CITY OF MALAGA BY EXPLORING AFFORDABLE TECHNOLOGIES FOR THE POPULATION. CONTRIBUTION FROM GEOGRAPHY TO THE SDGs.

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WHAT IS THE CONTRIBUTION OF GEOGRAPHY, AS A GENERAL CONTEXT, TO THE ACHIEVEMENT OF THE SUSTAINABLE DEVELOPMENT GOALS (SDGs)?

All of the Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda provide us with the challenge of responding to their challenges and goals through our work as Geography professionals. When the SDGs are explored and questioned we discover that, in the essence of each one of them, in their principles, Geography beats, with systematised knowledge and methodological procedures in the different areas of knowledge that characterise its expertise.

This invites us to carry out an exercise of responsibility and frank balance between the application and transmission of our knowledge, the ideas that govern our thinking and conduct, coherence and commitment to action.

The SDGs, from a holistic position, urge us to also consider other disciplines, so that, together with the participation of citizens and social agents of public and private entities, taking into account territorial realities and the use of geographic information, we can prioritise needs, set goals, and join efforts to achieve the commitments made and achieve them within the established timeframe.

Geographic data information, located on a map, makes it possible to construct the indicators needed for subsequent implementation and monitoring. It is the responsibility of working together, in a participatory and participative, comprehensive and universal way, to achieve, with the sum of our efforts, progress towards the systemic and environmental dimension of sustainable development, cohesion and social equity, following the SDGs' reference compass.

HOW DOES OUR RESEARCH CONTRIBUTE TO THE SDGs?

This study was carried out for the city of Malaga, understanding as such the urban framework that presents a clear solution of continuity. It focused on the urban fabric of the Perchel Sur neighborhood, which is next to the east-west axis of the city, and very close to the Guadalmedina riverbed.

The 17 proposed goals and targets represent a great challenge and effort to achieve them jointly on a global scale, because of their extensive and ambitious content and because they call for citizen involvement. The expression "think global, act local" is a strategy for tackling them. For this reason, there is a consensus on the need to prioritise objectives and to define goals that are close to home, measurable with indicators that can be achieved within the proposed timeframe. In this process, learning takes on enormous value as a key element for creating knowledge, raising awareness and generating awareness for action on global objectives.

In this sense, taking into account the environmental dimension of the Sustainable Development Goals, I have been offering during successive academic years for the final project of the Degree in Geography and Land Management at the University of Malaga, several general thematic lines on "Aspects related to the environment and society" and "Aspects related to the activities of people" where students can focus their motivation by choosing between different topics.

The contribution we present is entitled "Noise pollution in the city of Malaga when exploring affordable technologies for the population. Contribution from Geography to the SDGs" is born in this context, creating a learning culture and raising awareness about the global sustainable goals; providing tools that can be used for environmental education in the achievement of SDG 11 (sustainable cities and communities).

It has worked cooperatively between students, teachers and other agents involved in the project, such as the Head of the Environmental Qualifications and Noise Control Section of the Environment and Sustainability Area of the Malaga City Council, the interlocutor teacher of the Applied Physics Department at the School of Telecommunications Engineering, who provided the loan of the professional sound level meter for the measurements, and the student J.M. Romero, who carried out the measurements with the sound level meter and presented the results as a final project of studies

The research focuses on **SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable**. Because any human society, whether hunter-gatherer, or the most technologically advanced modern society, can only survive and evolve if it finds in its environment a safe, inclusive settlement, with the necessary sources of resources and that these are not depleted by their use and transformation.

With so many challenges facing cities, these are in turn aligned with other SDGs, so that of the 169 targets identified in the SDGs, at least a third of them are relevant to urban life. At the same time, there are challenges such as noise pollution, which the World Health Organization (WHO) considers to be the second leading environmental cause of health problems after air pollution, with most of the world's cities affected.

By working on the challenge of noise pollution in cities in our research, we indirectly promote the achievement of other goals such as:

SDG 1. Contributing to the well-being of older people.

SDG 3. Health and well-being, improving acoustic quality, considering noise sources caused by human activities.

SDG 4. Ensuring education for sustainable development.

SDG 9. Optimising the environmental performance of human and economic activities and their compliance with legal noise requirements.

SDG 15. Protecting and restoring terrestrial ecosystems, nature's biodiversity in the city.

SDG 16. Promoting peaceful and inclusive societies for sustainable development, fostering environments of coexistence and dialogue in the face of conflicts of interest caused by noise.

Noise is one of the environmental factors that causes conflicts of interest and affects the quality of life, not only of people, but also of other living beings such as birds, yet it is not identified and its mitigation is not motivated in the SDG targets, even though planning instruments and legislation have been developed at the local level in Malaga, such as noise maps in the city, Noise Action Plans, and procedures for the identification of saturated areas.



WHAT IS THE HYPOTHESIS AND THE MAIN OBJECTIVE OF OUR RESEARCH?

The growing environmental awareness of citizens and their need to know immediately the value of the disturbance, is causing an amateur use of mobile applications as opposed to professional monitoring.

The hypothesis was based on refuting or validating whether in the 21st century the applications made by mobile phone devices analysed are suitable for monitoring environmental noise.

The main objective was to explore whether two mobile applications show results similar to those of professional instruments for measuring noise, contrasting the results obtained with a sound level meter to study the evolution of noise over three days in three different areas of the Perchel neighbourhood in the tourist city of Malaga.

WHAT WERE THE MAIN SOURCES OF DIRECT INFORMATION?

Field work with the collection of data on decibel measurements and observation in the study area. And as an oral source, an interview with a technician from Malaga City Council specialised in noise management.

WHAT METHODOLOGY WAS USED?

Two types of methodology were used: qualitative and quantitative, the latter being the most important in the development of the work.

The aim of the qualitative methodology was to find out the perception of the social agents involved and to define the areas in which to collect the data. The technique used for the collection of information was an in-depth interview lasting two hours with the Head of the Environmental Assessments and Noise Control Section of the Environment and Sustainability Department of Malaga City Council.

The quantitative methodology used was hypothetical-deductive. A Type I sound level meter was used as a measuring instrument, as it was ideal for carrying out the fieldwork as accurately as possible, while the digital sound level meters were downloaded to the mobile phone via the Play Store, a service provided by Google, and the best evaluation given by users was used as a criterion.

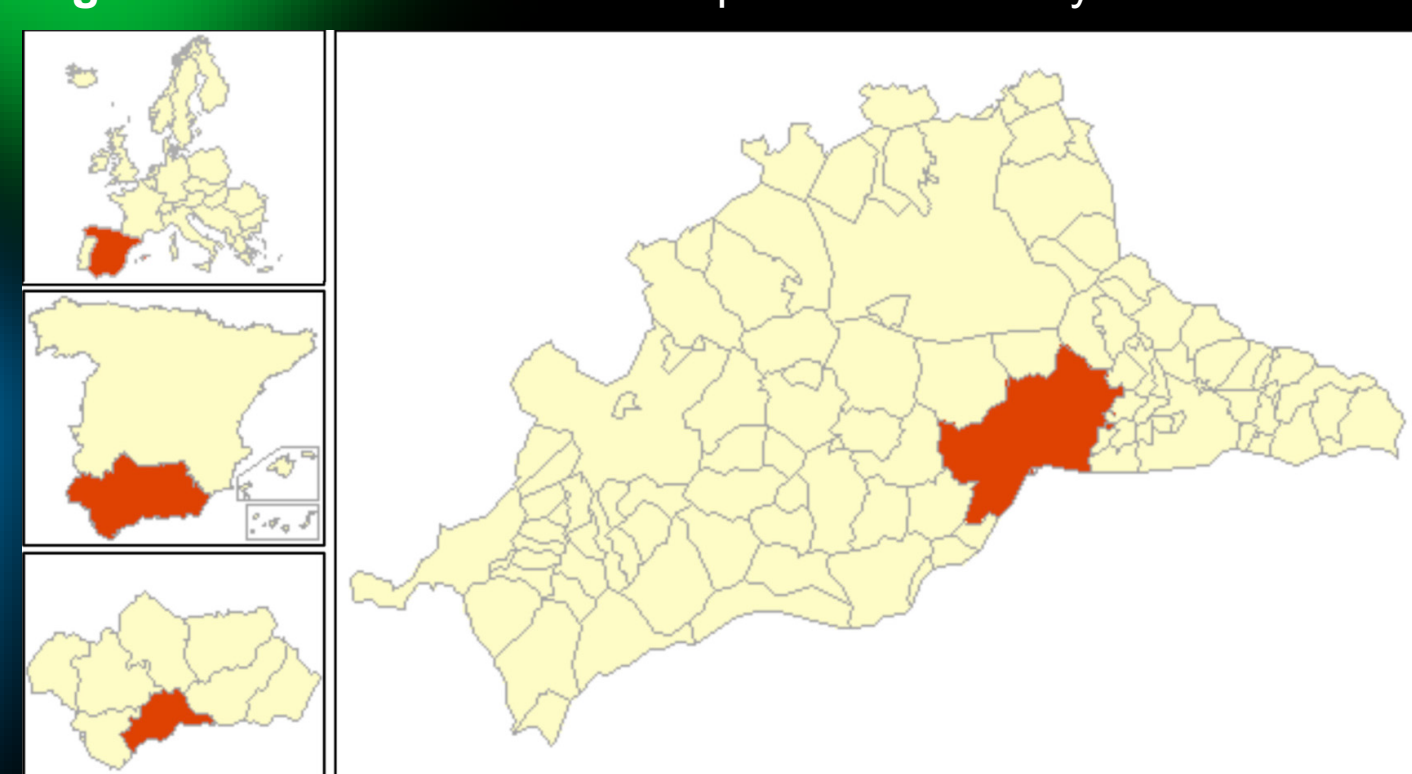
In the Perchel neighbourhood the three study areas were chosen, in each of them, eight locations as sampling points to observe the evolution of the noise dynamics during the three periods of the day studied, being for one hour in each study area to collect the evolution of the noise, being the periods: Morning (beginning at 9:00), Noon (beginning at 13:00) and Afternoon-Night (beginning at 19:00).

To evaluate the measurements, the indices established by the legislation in the Junta de Andalucía's Noise Pollution Guide were followed to comply with the noise quality objectives. Once the data had been taken in unison with the sound level meter and the mobile phone (taking a screenshot), and with both instruments at the same height, a photo was taken to show the results obtained by both instruments.

For the statistical treatment of the data, an Amateur Measurement Reliability Index (AMFI) was developed and applied to each of the eight established locations. The further away the resulting percentage figure is from 0, the more difference there is at a certain location when measuring with the sound level meter and the mobile phone.

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Where pm (sampling point); S (sound level meter); mov (mobile); m (morning); md (noon); tn (evening-night).

Figure 1: Situation and location plans of the study area.



Source: Institute of Statistics and Cartography. Junta de Andalucía.



Image 1: Measurement equipment used in measurements. Above is a Samsung Galaxy brand mobile, equipped with the Sound Detector and Sound Meter apps. Below, a type 1 sound level meter, CESVA brand.



Image 2: Comparison of values recorded with the sound level meter and mobile phone at location 6 of Cristo de Mena School.

WHAT WERE THE MAIN RESULTS OF THE RESEARCH?

The most reliable results are shown by a sound level meter because it is capable of specifying the decibels (dB) when there are a large number of emitting sources, highlighting that it is an instrument that requires prior revisions in special laboratories to calibrate them, while the mobile phone was not capable of being as accurate, at certain times giving absurd values, not marking anything or the application crashing. Developers should improve these digital services. The type of mobile phone being used also plays a role, especially the quality of the loudspeaker.

Discrepancy is almost always present when obtaining the results between a Type I sound level meter and the two mobile applications, so that professional and amateur measurements are not comparable.

The hypothesis put forward at the beginning of the study is confirmed, but only partially, because it could be stated that digital sound level meter applications are not very useful for citizens, except when the noise levels are very low, are not produced by many emitting sources and the use of the applications is not very prolonged, highlighting that an appropriate use could be to raise awareness among young people when explaining the effects of noise pollution in schools.

WHAT WERE THE MAIN CONCLUSIONS ABOUT NOISE IN THE STUDY AREA?

We confirmed that the city of Malaga and the Perchel Sur neighbourhood are very noisy. One of the main causes of noise pollution in the study areas, as in the rest of the city, is caused by vehicular traffic. The locations near bus stops are the most affected by engine noise, as well as the waiting times for vehicles at traffic lights that favour the concentration of traffic in the area and the noise generated by the horn, or the braking of the wheels, which raises the decibels.

The noise produced as people pass through the public roads near the leisure centre and railway station is relevant. As more people walk together, they generate more noise, sometimes even being considered annoying. Young people and tourists are the noisiest pedestrians due to the rubbing of the wheels of suitcases on the pavements. In the streets where bars are located for leisure and catering activities, the agglomeration of customers on the terraces of these establishments are the cause of noise in the area.

Also, a source of noise which can only be found in the vicinity of the school is the music band of the parish of San Pedro which, although its presence was not very noticeable except on the third day, it is estimated, on the basis of neighbourhood complaints made to the Town Hall, that it is one of the most representative sources of noise in the area, in addition to traffic noise. At the school it was found that, at different times of the day, school entrance and exit and break time, they became another source of noise emission.

The affordable use of mobile phones to measure noise, the research verifies that they are inaccurate for professional use. In schools they could be an alternative tool for workshops on noise measurement and mitigation; contributing to environmental education on noise pollution in cities and strengthening the achievement of SDG 11.

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