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Portuguese Real Estate Taxation, Land Use and Noise

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ABSTRACT

The goal of this study is the analysis of noise influence on real estate values as Portuguese Noise Code enforces building restrictions on municipal urban areas exceeding established noise limits. At present, municipalities are defining noise classification maps (mixed/sensitive areas) and, with noise maps, will determine "conflict areas". On these areas, and until mitigation measures enable noise reduction, private contractors will have their building permits refused on an excessive noise basis.

In 2003, the Portuguese government issued the decree-law 287/2003, concerning Real Estate Taxation. Nominal valuation of urban property was considered outdated and in need for reassessment with a new evaluation system based on objective parameters (construction cost, built area, site location, construction quality and building purpose).

As municipalities will have to communicate the inadequacy of vacant land for building construction, the following steps will be the reduction of nominal real estate value (based on building construction potential) and the taxes income.

The relationship "noise/real estate taxes" is based on GIS analysis performed on Portuguese cities, grouping land use, noise maps, noise classification areas and location coefficients. The combination "noise maps/noise classification maps" provides conflict areas and then, together with land use constraints, was possible to determine vacant land building potential. This construction potential will not be effective as those properties have excessive noise levels. Then, considering location coefficient (delineated by national authorities) is possible to evaluate new nominal values and potential loss regarding municipal taxes income. This will be an important incentive for municipalities to implement their ongoing noise reduction plans.

1 INTRODUCTION

The purpose of the present study is the analysis of noise interference on the building construction potential and, subsequently on real estate taxes income for the Portuguese municipalities. An important and peculiar "side-effect" of the current Noise and Real Estate Taxation Codes.

Until the moment, no Portuguese Municipality faced any negative economical effect derived from noise. But, as Portuguese population will become more aware and knowledge of their rights, municipal taxes income from urban properties will be likely to decrease.

This 3rd Noise Code enforces building restrictions on municipal urban areas exceeding established noise limits. At present, municipalities are still defining noise classification zones (mixed/sensitive areas) and, with noise mapping, will determine "noise conflict areas". On these conflict areas, and until mitigation measures enable noise reduction, private contractors

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will have their building permits refused on an excessive noise basis. This is the connection between these three factors: *noise*, *territorial management* and *real estate taxation*.

The 2003 Real Estate Taxation Code defined the concept of "***Urban Property***" and divided it in four classes: *housing*; *commerce*, *services* and *industry*; *land for construction* and *other properties*. The patrimonial value object of taxation is estimated according to the effective or potential construction aptitude mentioned on the municipal director plan. As the 3rd Noise Code is stringent in prohibiting new constructions on noise conflict areas, all the urban properties classified as *land for construction* will have a new classification as *other properties* since the municipalities will have to forbid any land division operation or construction.

2 NOISE

Until 1987, when the first Portuguese Noise Code and the Environmental Act were approved, the Portuguese Constitution was the only statutory document where environment and well-fare were mentioned. In fact, general concepts of well-fare, quality of life, environmental rights, nature and environmental protection and natural resources protection were stated on articles 9, 66 and 81 and referred as National Authorities responsibilities.

In 1987, the ***Portuguese Environmental Act*** (Law n. º 11/87, 7th April 1987) and the first ***Portuguese Noise Code*** – Decree-Law n. º 251/87, 24th June 1987 were approved. The scope of application of this later decree concerns housing, industry, commerce and services; equipments; entertainment and recreational activities; noise signals; traffic; and noise generating activities. This decree established some territorial planning constraints for buildings location, urban areas were classified as extremely noisy, noisy and low noise zones based on a statistical level parameter – L_{A50} – over a daytime (DT: 7 h – 22 h) or nighttime (NT: 22 h – 7 h) period with the limits indicated on Table 1 and considered suitable for buildings construction under the stated circumstances:

Table 1: Maximum ***Noise limits*** and ***building restrictions*** for Noise Classification (1st Noise Code 1987).

Noise Classification	Daytime period (7 h – 22 h)	Nighttime period (22 h – 7 h)	Building restrictions
Low Noise Zone (LNZ)	$L_{A50} \leq 65$ dB	$L_{Aeq} \leq 55$ dB	no restrictions
Noisy Zone (NZ)	$65 < L_{A50} \leq 75$ dB	$55 < L_{Aeq} \leq 65$ dB	noise reduction solutions: *- on noise source* *- on building* *- on building surroundings*
Extremely Noisy Zone (ENZ)	$L_{A50} > 75$ dB	$L_{Aeq} > 65$ dB	

Concerning road and rail infrastructures, their Authorities must have the purpose of preventing traffic noise, in order not to restrict existing or foreseen uses on surrounding areas and, if necessary, to promote noise mitigation measures.

In 1990, the European Directive n.º 85/337/CEE, 27th June 1985 was transposed into the Portuguese legal frame through the Decree-Law n.º 186/90, and Regulatory-Decree n.º 38/90. These pieces of legislation refer "*human environmental factors*" such as landscape, natural or built heritage and pollution (noise, chemical composites, effluents and residues and radioactive substances). About noise it is defined the obligation to establish noise limits, noise reduction on source, noise propagation reduction and adequate land-use policy.

The ***second Noise Code***, Decree-Law n. º 292/2000, 14th November 2000 (named RLPS) had the same scope of application of the previous one but changed the main acoustical parameter from L_{A50} to $\mathbf{L_{Aeq}}$. As fundamental principles, it stated the importance of an interaction between noise reduction strategy, territorial planning, economic, and social development policies to guarantee the appropriate environmental noise conditions on urban areas devoted to housing, educational or healthcare facilities or even on resting spaces. Namely, affirmed the need for an appropriate land-use planning, especially with housing,

employment and leisure activities, through the introduction on the municipal Map of Constrains (for all Municipal Directory Plans (PDM) revised after the approval of this Decree) of a new restriction – Noise Zoning: Mixed and Sensitive Zone, referred to the form of occupancy within a certain area, whose urban use and noise limits (reduced by 10 dB, regarding the "old" L_{A50} limits) are indicated on Table 2.

Table 2: Maximum ***Noise limits*** and ***Form of occupancy*** for Mixed and Sensitive zones (2nd Noise Code 2000)

Noise Zoning / Form of Occupancy		Daytime period (7 h – 22 h)	Nighttime period (22 h – 7 h)
Mixed Zone	coexistence of housing occupancy with other uses	L_{Aeq} = 65 dB	L_{Aeq} = 55 dB
Sensitive Zone	include hospitals, schools, housing (exclusively), religious buildings and public facilities	L_{Aeq} = 55 dB	L_{Aeq} = 45 dB

For prevention purposes, the RLPS imposed some circumstances for land subdivision schemes, previous information request, building permits and authorization for use. On each of those phases, petitioners were required to join a noise map section (when it does not exist, an acoustical data report), then an acoustical study and finally a certificate that guarantee the full accomplishment of RLPS and all the related legal documents. As mentioned before, whenever noise limits are exceeded, RLPS required municipal noise reduction plans (MNRP) whose implementation might be phased, considering the exceeding level (zones where the exceeding environmental noise level is greater than 5 dB(A) should be the first priority).

Municipalities were also advised to produce Municipal Noise Maps (MNM) before the definition of Noise Classification Maps, as they would be able to acknowledge the present situation in terms of environmental noise. In that context they decided to generate their own MNM and use them as a planning tool on its Municipal Director Plan under revision. In those circumstances, joining the Municipal Noise Map with the territorial management plan, it is possible to define the location of Mixed and Sensitive Zones and then the need for a Municipal Noise Reduction Plan.

In 2006, the Decree-Law n. º 146/2006 was approved, introducing the European Directive 2002/49/CE, 25th June into the Portuguese legal frame. This decree introduces several changes, as a new acoustical parameter (**L_{den}**) ***three reference periods*** (day (7 h – 20 h), evening (20 h – 23 h) and night (23 h – 7 h), **strategic noise mapping**, ***action plans*** and finally, the obligation for ***public information*** and ***participation***.

As for most of the European Union countries, the existent Portuguese noise legislation did not fulfill all these new requirements and so, in January 2007, the ***third Noise Code*** was approved (RGR – Decree-Law n. º 9/2007, 17th January 2007), harmonizing acoustical parameters, reference periods and noise limits as indicated on Table 3.

Table 3: Maximum ***Noise limits*** and ***Form of occupancy*** for Mixed and Sensitive zones (3rd Noise Code 2007)

Form of Occupancy	Full day period (0 h – 24 h)	Nighttime period (23 h – 7 h)
Mixed Zone	L_{den} = 65 dB(A)	L_n = 55 dB(A)
Sensitive Zone	L_{den} = 55 dB(A)	L_n = 45 dB(A)
Sensitive Zone close to an existent major transportation infra-structure	L_{den} = 65 dB(A)	L_n = 55 dB(A)
Sensitive Zone close to a major transportation infra-structure during design stage (not valid for airports)	L_{den} = 60 dB(A)	L_n = 50 dB(A)
Sensitive Zone close to a major airport infra-structure during design stage	L_{den} = 65 dB(A)	L_n = 55 dB(A)
Non classified zones	L_{den} = 63 dB(A)	L_n = 53 dB(A)

Following the indications of the previous Noise Code (RLPS), municipalities are once more advised to produce noise maps (L_{den} and L_n, at 4 m height) as a supportive planning tool for the elaboration, alteration and revision of municipal director plans.

In this Noise Code the most important connections between Territorial Management and Noise are enlightened. In fact, it is stated that municipal director plans (PDM) should guarantee environmental noise quality, promoting reasonable distribution of activities and noise sources as well as establishing noise classification areas (sensitive and mixed zones) even if it implies an amendment to the present PDM. As most municipalities are revising their municipal director plans they are incorporating the new noise demands, avoiding future conflict areas by preventing sensitive zones close to existing or planned transportation infra-structures.

Even though, it is not possible to guarantee the accomplishment of noise limits in the total extent of the municipality. Previous decisions on territorial planning and noise classification zones led to the recognition of noise conflict areas, where the reduction of environmental noise levels is enforced.

This municipal noise reduction plan (MNRP) ought to be executed in a two years period with reference to this Code approval. It is supposed to contemplate an array of noise reduction measures, which should be implemented regarding a defined priority order (sensitive and mixed zones with environmental noise exceeding more than 5 dB(A) the imposed limits).

According to the 3rd Noise Code, ***the licensing or the authorization of new housing buildings is forbidden, as well as of new schools, hospitals or similar social equipments and leisure spaces, while the breaking of settled environmental noise limits persists***.

The only exceptions are new housing buildings, in "*consolidated urban areas*"[3], with an approved municipal reduction noise plan or do not exceed more than 5 dB(A) the environmental noise limits and the Building Acoustics Study consider the reinforcement of the façade sound insulation by 3 dB(A).

2.1 Real Estate Taxation

The first forms of public taxation in Portugal were levied in the 17th century when a comprehensive income tax was introduced. The purpose of this taxation system was to finance the war against Spain.

In 1913, the principle of progressive tax rates was introduced, at first only for income, but later also for other direct taxes to guarantee the tax system coherence. Since 1957 this system was continuously reformed. In 1966, was introduced a sales tax – the Turnover Tax, which was levied on the total amount of transactions, on produced or imported goods and on certain services. In 1986, the Value Added Tax – VAT (IVA) was introduced in Portugal. In 1989 the taxation system was remodeled for its present form which has a strong resemblance to the system of the 17th century, creating a system of Company Income Tax (IRC) and Personal Income Tax (IRS).

In January 1999, the General Tax Law (LGT) came into force, clarifying the principles regarding the tax system, the taxpayers' guarantees and the tax administration powers, as well as the Tax Audit Procedures Regulation which regulates tax audit. In 2000, the Tax Proceedings and Procedures Law (CPPT) was approved in order to guarantee simplicity and efficiency in judicial tax procedures and fiscal executions law, later complemented, in 2001, with the General Tax Infractions Regulations.

In 2003 began the reform of immovable property taxation with two new Codes: *Municipal Tax on Charged Transmissions of Immovable Property* (IMT) and *Municipal Tax*

[3] (sensitive or mixed zone with steady urban occupation)

on Immovable Property (IMI).

Until then, the IMI evaluation system was created for a society based on agricultural economy. Therefore, the legal regimen of urban property evaluation was deeply misadjusted for the present financial system. The increasing urban property valuation, especially for housing, offices or commercial purposes and for construction, due to the inflating processes and economic growth acceleration, showed inadequacy regarding the structure and coherence of the taxation system, which was implicit on the over taxation of new buildings and the under taxation of the old ones.

This new Immovable Property Taxation Code (IMI Code) is based on objective parameters (like *mean construction cost*, *total construction area* and adjacent land, *land value, location, quality and comfort, age* and characteristics of the *surrounding area*), easy to understand and apply, reducing the subjectivity of the previous evaluation system.

The taxable value of urban property is calculated according to correcting coefficients such as average construction price, area and type of construction and quality standards, age and building location. The taxable value of rural property is 20 times it agrarian income, which is calculated according to specific factors established in the IMI Code.

While all urban properties aren't valued according to IMI procedures, those registered before November 30, 2003 and not alienated thereafter, will have their taxable value calculated with a transitional valuation scheme, under which the registered value is increased by an indexation coefficient for the cadastre year.

The applicable IMI tax rates are the following:

- 0.8% for rural property;
- 0.4% to 0.8% for urban property subject to the transitional valuation scheme;
- 0.2% to 0,5% for urban property registered and/or owned by December 1st, 2003;
- 5% for urban or rural property held by any resident of a listed low-tax jurisdiction.

The IMI is calculated over the taxable Patrimonial Value of rural and urban properties. In this Taxation Code there are some important concepts to mention, relevant to the purpose of this study:

*"**Property**" is a part of the territory, enclosing water, plantations, buildings and other types of construction, belonging to an individual or a company, with economical value; it also includes autonomous parts of the construction resultant from the horizontal property regimen.*

*"**Urban Property**" all the properties not considered as rural, which can be divided in housing; offices, commercial or industrial buildings; land for construction; and other properties.*

*"**Land for construction**" are properties to which has been granted license or authorization for land division operation or construction, and still those declared as so by the owner, except areas where the competent entities forbid any of those operations, in accordance with the territorial management plans.*

*"**Other properties**" are the ones located in agglomerations, not defined as "land for construction" nor as "rural property" or where competent entities forbid any land division operation or construction.*

According to this Code, the assessment of ***Patrimonial Value*** (V_t - Urban Property Value) depends on the present and/or future activity and involves the consideration of several parameters as designated on equation (1):

$$V_t = V_c \times A \times C_a \times C_l \times C_q \times C_v \quad (1)$$

where:

V_t	Patrimonial value
V_c	Construction value/m^2
A	Equivalent area (m^2)
C_a	Area function coefficient
C_l	Location coefficient
C_q	Quality and comfort coefficient
C_v	Age coefficient

The ***equivalent area*** *(A)* is a new factor in urban property valuation which aggregates building construction area and the exceeding area resulting from constructions implantation. The relation between this two area categories is accomplished by equation (2):

$$\boldsymbol{A} = (\boldsymbol{A_a} + 0.3\,\boldsymbol{A_b}) \times \boldsymbol{C_{aj}} + \text{‰}\ \boldsymbol{fr} \times (0.025\,\boldsymbol{A_c} + 0.005\,\boldsymbol{A_d}) \tag{2}$$

where:

A_a	*Private area* (area referring to the principal function of the autonomous fraction)
A_b	*Dependent area* (parking space, laundry, animal facility, attic, basement floor , …)
C_{aj}	*Area adjustment coefficient*
%fr	*Area function coefficient*
A_c	*Proximity area* (vacant land area: limited to two times the constructions implantation area)
A_d	*Distant area* (vacant land area: the exceeding area of two times the constructions implantation area)

In the case of urban properties classified as "***land for construction***" the calculation formulas for the *Patrimonial Value* ("sum" of building implantation area with the remaining adjacent land) and the *Equivalent Area* have some simplifications:

$$\boldsymbol{V_t} = \boldsymbol{V_c} \times \boldsymbol{A} \times \boldsymbol{C_a} \times \boldsymbol{C_l} \times \boldsymbol{C_q} \tag{3}$$

and

$$\boldsymbol{A} = (\boldsymbol{A_a} + 0.3\,\boldsymbol{A_b}) \times \%\,\boldsymbol{T} + (0.025\,\boldsymbol{A_c} + 0.005\,\boldsymbol{A_d}) \tag{4}$$

where:

%T	*Land Value* (Location coefficient for land percentage value regarding total construction cost)

When the urban property is nominated as "***other property***"[4] and the valuation object is a land allotment, its *Patrimonial Value* results from the product of construction value/m^2 for the location coefficient, the property area and an adjustment coefficient equal to 0.005, as expressed on equation (5):

$$\boldsymbol{V_t} = \boldsymbol{V_c} \times \boldsymbol{A_T} \times \boldsymbol{C_l} \times 0.005 \tag{5}$$

where:

A_T	Property area (m^2)

After the definition of Patrimonial Value and Equivalent Area for several situations, now it is the moment to explain the influence of the diverse applied coefficients, namely, the area function, location and quality and comfort coefficients.

[4] (property located on an urban agglomeration for which the competent entities forbid any license or authorization of land division operation or construction; or the existing buildings and constructions has a different destination than housing, Commerce, Industry or Services)

The ***Area Function coefficient*** (C_a) depends on the type of activity developed on that building or autonomous fraction or on the future purpose of the yet to build construction (in the case of "land for construction"), in accordance with Table 4:

Table 4: ***Area function Coefficients*** for IMI calculation (adapted from Taxation Code 2003).

Area function	Ca
Commerce	1,20
Office building	1,10
Dwelling	1,00
Controlled cost dwelling	0,70
Industry and warehouse	0,60
Commerce and offices in warehouse buildings	0,80
Covered and enclosed parking lots	0,40
Covered and opened parking lots	0,15
Opened parking lots	0,08
Buildings without construction permit	0,45
Storage facilities	0,35

The ***Location coefficient*** (C_l) depends on the type of activity developed (*housing*, *commerce*, *industry* or *services*) and on the kind of urban property (*construction* or *land for construction*) subject to this valuation procedure. The range of values for this coefficient varies between 0.35 and 3.00, whether is a dispersed building in rural area or in a raised real estate market value zone. The factors influencing this coefficient are *accessibility* (quality and variety), proximity to *public equipments* (schools, hospital, commerce, etc.), *public transportation* systems and *real estate market value*.

An example of these location coefficients (*housing* and *land for construction*) for the municipality of Maia is illustrated on Figure 1:

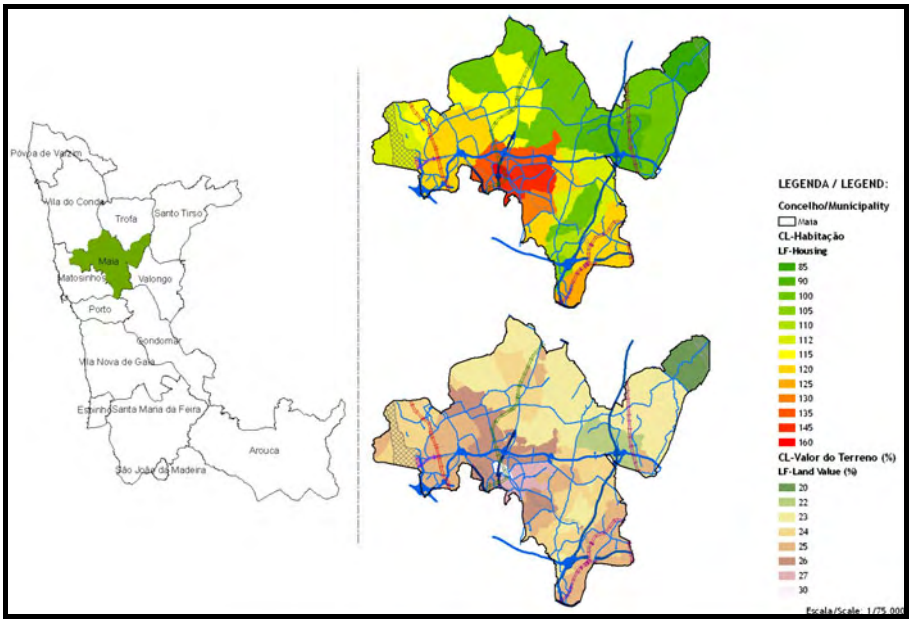

Figure 1: Example of Maia ***Location Coefficients*** for "housing" and "land for construction"(in percentage)

2.2 Territorial Management

Since 1999, the Portuguese territorial planning system is founded on the territorial

management system defined on the **Decree-Law n.º 380/99**, 22nd September with the amendment introduced by **Decree-Law n.º 310/2003**, 10th December. This legal framework of the Portuguese territorial management system involves the coordination of planning instruments at three levels: National, Regional and Local:

- The ***national level*** concerns the territorial planning policy (national program of territorial planning politics – PNPOT, "Programa Nacional das Políticas de Ordenamento do Território"), the definition of guidelines for special plans with territorial incidence – PSIT ("Plano Sectorial de Incidência Territorial") – and for special territorial plans – PEOT ("Plano Especial de Ordenamento do Território", ex.: areas of protected landscape, coastal zone, areas for nature preservation, areas for agricultural purposes …);
- the ***regional level*** emerges through the regional territorial plans (PROT, "Plano Regional de Ordenamento do Território") and;
- the ***local level*** with the inter-municipal territorial plans (PIOT, "Plano Intermunicipal de Ordenamento do Território"), Municipal Territorial Plans (PMOT, "Plano Municipal de Ordenamento do Território"), municipal director plan (PDM), urban development plan (PU) and detailed local plan (PP).

In 2003, with the Decree-Law n.º 104/2003, 23rd May, were extinguished all Regional Coordination Commissions and Regional Directorates for the Environment and Territorial Planning and subsequently created the Regional Development and Coordination Commission (CCDR) as the main link between local and central administration. The CCDR are regional services of the Ministry of the Environment, Territorial Planning and Regional Development (MAOTDR), endowed with administrative and financial autonomy, charged to execute, within the respective geographical areas, the environmental, territorial planning and regional development policies towards a sustainable regional growth. These five CCDRs, indicated on Figure 2, represent the following five Portuguese regions considered on the continental part of Portugal:

- North (CCDR Norte);
- Centre (CCDR Centro);
- Lisbon and Tagus Valley (CCDR LVT);
- Alentejo (CCDR Alentejo) and;
- Algarve (CCDR Algarve).

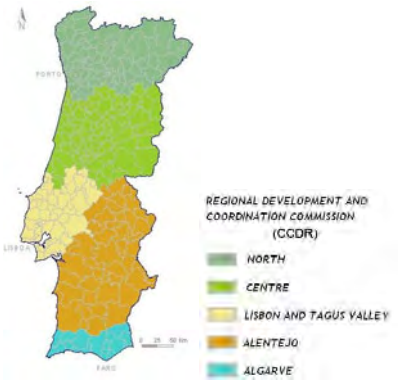

Figure 2: Portuguese Regions (CCDR)

In the moment, only three municipalities (out of 308) do not have the first municipal director plan (PDM) approved. The reason for that particular situation concerns the date of birth of those new municipalities (1998). As so, their territorial planning policy is based on Preventive Norms derived from the "parent" municipalities.

Since 2000, when the 2nd Noise Code was approved, the environmental factor – ***Noise*** – should have become an important tool on territorial management. But, only in 2007, when the last revision of Territorial Management Plans Regimen was issued, noise was recognized as a ***Public Utility Constraint*** that ought to be incorporated on *Municipal Constraints Map*.

3 METHODOLOGY

3.1 Data

The ***noise indirect effects on municipal taxes income*** was modeled considering three main areas: *Territorial Management*, *Noise* and *Real Estate Taxation*.

Concerning ***territorial management***, was collected all the significant data on municipal territorial partition like urban space characteristics, indentifying the constructions, the most relevant activities, the *spatial distribution of uses* and the *construction potential coefficient* (COS – Coeficiente de Ocupação do Solo) by use; and the effective *constraints* as ecological, natural and agricultural reserves, forest and wood production areas, protection area to the transportation infra-structures (airport, aerodrome, railway, metro and road), preservation area to patrimonial constructions, etc.. In fact there was a common constraint between territorial management and noise, the Noise Classification Zones.

With reference to ***noise***, was gathered all the information related to the previous noise map and was introduced and calculated the new L_{den} and L_n parameters. With this information congregated with territorial planning guidelines were designed the municipal noise classification zones. Subsequently, it was possible to determine the presence of *conflict areas*[5]and the related *degree of conflict* (how many dB(A) exceeding the legal noise limits).

In relation to the ***real estate taxation model***, the new IMI Code (2003 and revised in 2006) was the primary working material. The included concepts and their interoperability were deeply studied in order to effectively apply them to the present case study. The calculation of *equivalent area* (A) and the definition of the *location coefficients* were the most important tasks, especially as there was no data available. All the data had to be calculated or determined through indirect techniques.

3.2 Methodology application

The first information needed refers to vacant building area. The analysis of the present situation, in terms of construction, revealed the current status of land occupation. Joining that information with building restrictions was calculated the *vacant land for construction*, according to the future activities and class of use.

But, for the purpose of this study, the interesting vacant land for construction did not refer to its total extent. In fact, the relevant area for analysis was the one under a noise conflict. So, the following step was the area selection. Between all the vacant lands for construction, it was only interesting the consideration of *noise conflict influenced areas* whose primary occupation would be noise susceptible as housing, commerce and services.

Afterwards, as the patrimonial value is construction area dependent, there was the need to estimate the maximum total construction area (abc – area bruta de construção) possible. On municipal director plan (PDM – Plano Director Municipal) regulations, in line with the possible uses of each class of urban space, are specified the construction parameters (COS) which allowed the calculation of the expected *total construction area of the municipality under a noise conflict*.

The computation of *equivalent area* (A) involved the observation of complementary information with diverse nature. On one side there is the evaluation of the possible construction area (A_a and A_b) and, on the other, the remaining area of the allotment (A_c and A_d). The influence of taxation model arises at this point with the *location coefficient for land value* and, afterwards, with *housing location coefficient*. These two factors along with the *construction value*, *area function* and *quality and comfort coefficients* will consent to the estimate of the total patrimonial value as a ***regular urban property***.

This process will be applied once more but in the context of "other" urban property. In

[5] Human occupied areas where environmental noise surpasses the correspondent ***noise limit***.

this case, the important factors are the *construction value*, *housing location coefficient* and the *allotment area* which will determine the new patrimonial value as ***other urban property***.

The last procedure refers to the real estate tax calculation – IMI value. Each municipality has an individual tax value with a maximum of 0.5%. The application of that tax to the previously calculated patrimonial values will endorse the estimate of the tax income loss for the municipality.

3.3 Methodology scheme

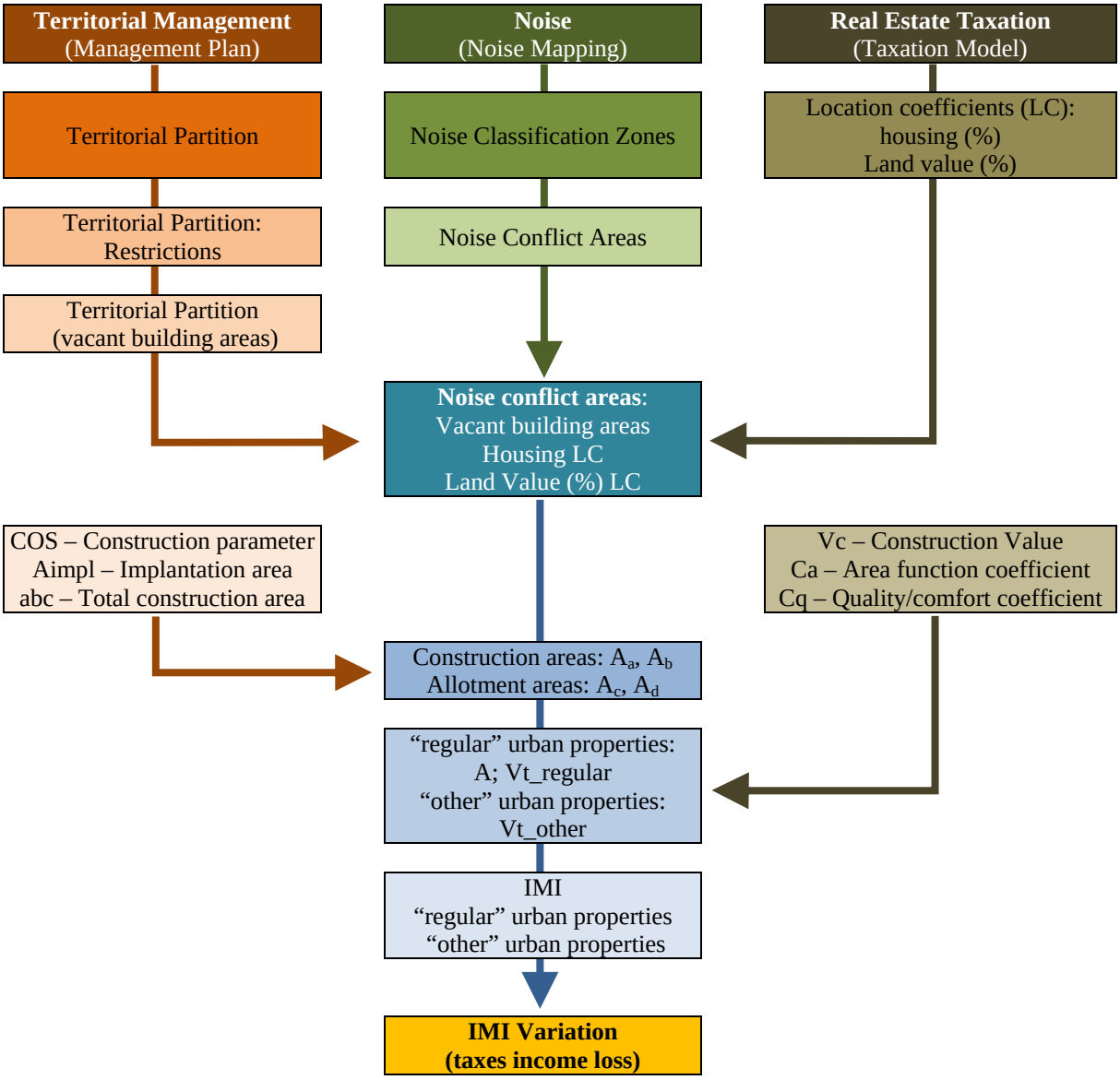

Figure 3: *Modeling scheme* for estimating ***noise indirect effects*** on municipal "Urban Property" taxes income.

4 CASE STUDY

4.1 Description

The Great Porto Metropolitan Area (GAMP), located in the north of Portugal, consists of 14 municipalities (Espinho, Gondomar, Maia, Matosinhos, Porto, Póvoa de Varzim, Valongo, Vila do Conde, Vila Nova de Gaia, Arouca, Santa Maria da Feira, S. João da Madeira, Trofa and Santo Tirso), extended over an area of 1.575 km^2, with a population of approximately

1.570.800 inhabitants. Maia (Figure 4) is one of those fourteen Municipalities, has a territorial extent of approximately 83 km^2, distributed over 17 parishes and about 136.000 residents.

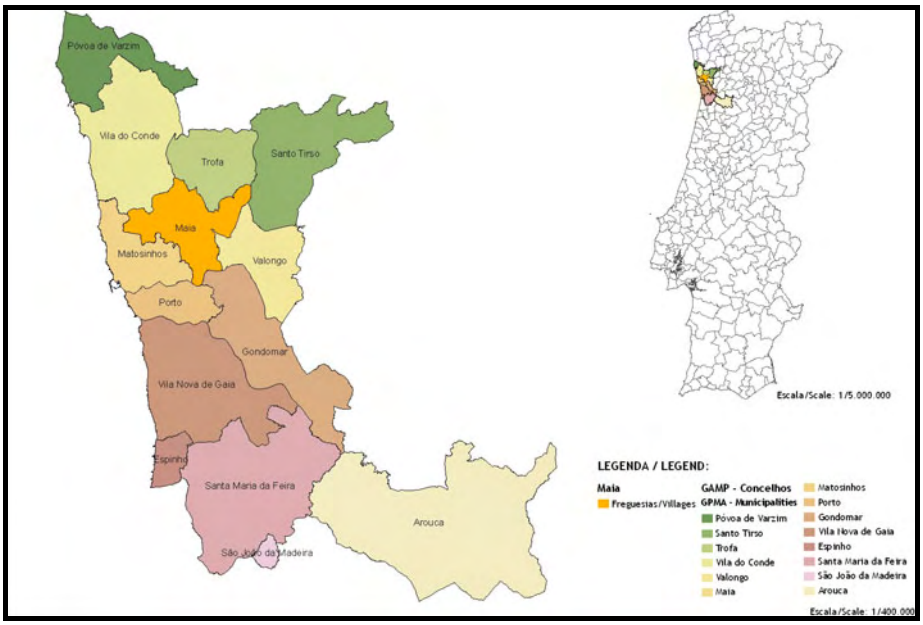

Figure 4: Case-study municipality (MAIA) location.

Maia is endowed with a good highway network (A3, A4 and A41/IC24); airport infra-structures (Sá Carneiro International Airport and a Municipal Aerodrome); and also two railway infra-structures (Minho Line and a Metro Line, with 3 branches: Red (B), Green (C) and Lilac (E)).This municipality is characterized for a strong tertiary sector which represents about 72% of the economical activity (with 5300 commercial units and 3600 services units), following the secondary sector with 27% and finally a residual component (2%) of the primary sector (Figure 5).

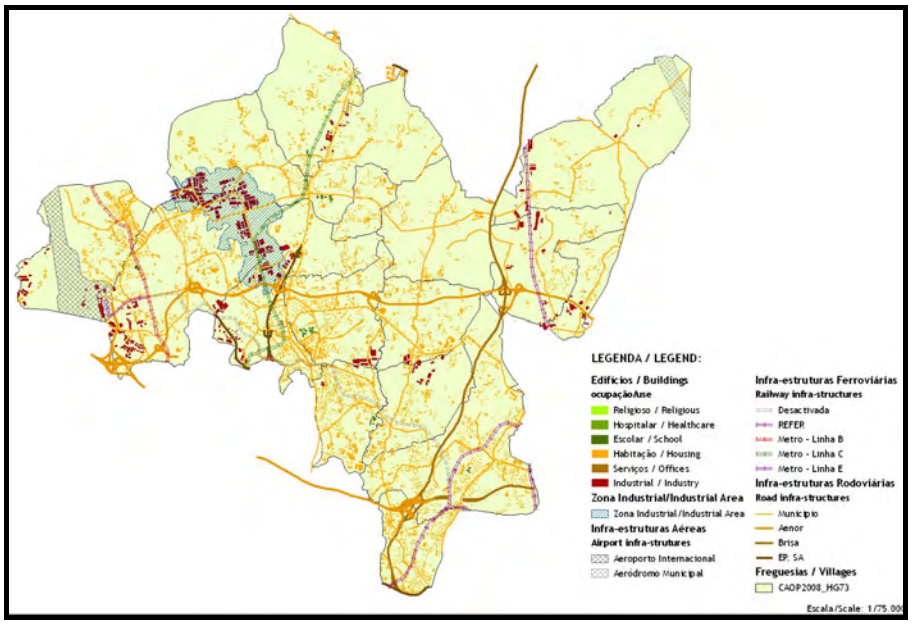

Figure 5: Territorial characteristics of Maia Municipality.

Since 2003, when the Immovable Property Taxation Code changed, the municipal taxes income had major variations, especially on the initial adjustment period until 2005. Ever since the IMI revenue had a constant increase. One of the main causes for this augment is the application of the new formulas, which raised the patrimonial value of urban properties on its pursuit for an up-to-date estimation of the immovable property value.

Table 5: ***IMI revenue*** in Maia municipality

	2002	2003	2004	2005	2006	2007
			€			
IMI revenue	11 289 816	15 434 457	13 728 106	14 130 240	14 266 919	16 218 807
Variation		36,71%	-11,06%	2,93%	0,97%	13,68%

4.2 Assumptions and simplifications

To achieve such a large context analysis and considering the quality and nature of data it was indispensable to consider some straightforward assumptions.

In order to obtain an accurate value to *Immovable Property Tax Loss* one needs to identify all urban properties classified as "*land for construction*". As the data provided by the Municipality did not endow information about property limits it was not possible to determine, on a proprietor basis, a faithful number and area of properties already built and with building permit or building potential. To answer that situation it was assumed that vacant "*land for construction*" would be about 40% of the total vacant area of the municipality. This number was the result of the assessment made for several block of houses for which some of this information was available by the comparison between the implantation area and total allotment area. The outcome of that survey showed an effective soil allotment occupation of 60%, which represent approximately 40% of free land inside the property.

To determine the building potential of the vacant "*land for construction*" was used the maximum construction coefficient possible (COS) for each urban area category.

For the patrimonial value calculation is required the knowledge of the relationship between *private and dependent areas* (A_a and A_b). Considering that, in this Municipality, the total construction area (abc) includes both principal function area and complementary ones (parking lots, store-rooms, etc.) and there are some indications on the municipal director plan about the extent of these spaces, it was decided that A_a was 80% of the total construction area and A_b as the remaining area (20% abc).

For C_q, the *quality and comfort coefficient*, 1.0 was the selected value as it is not known the future type of construction. In the case of "*land for construction*" the only majority factor is the one referring to the construction of a house (instead of dwellings), not appropriate to the present situation.

About V_c, *construction value/m*^{2}, was used V_c = 615 €/m^2, the construction cost stated by the Portuguese government for 2008.

4.3 Methodology application

The study began with analysis of municipal director plan data, including the territorial management plan, the constraints map and the present situation, in terms of construction, which revealed the current status of land occupation. The association of all the information made possible the calculation of the *vacant land for construction*, giving support to the definition of new building perimeters according to future activities and class of use as indicated on Figure 6.

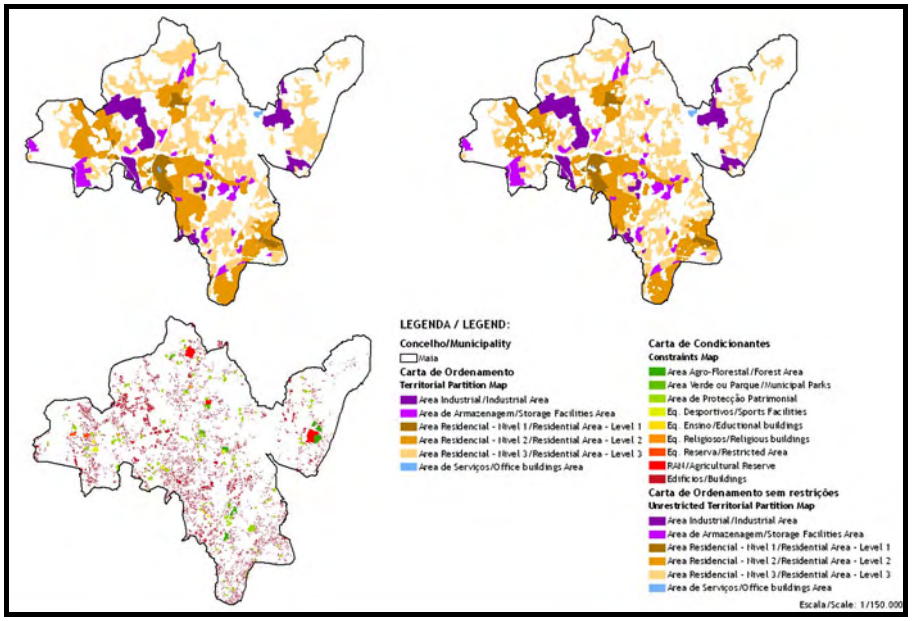

Figure 6: New building perimeters: "*vacant land for construction*" Map

The next step was the study on noise interference on territorial management plans. It began with the consideration of Maia municipal noise map, which had to be calculated for the new L_{den} and L_n parameters; followed by the connection with Noise classification map and with the previously evaluated new building perimeters.

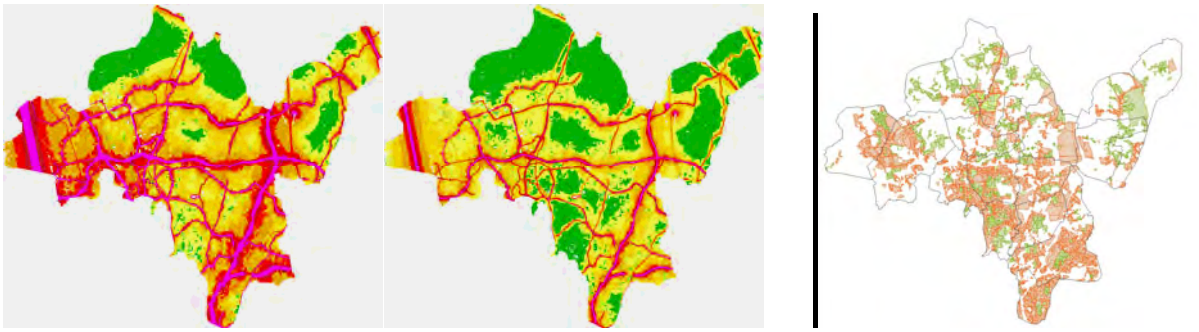

Figure 7: Noise map (left: L_{den} and center: L_n) and Noise classification areas of Maia

The result of all these variables was the relevant area for analysis, new building perimeters under a noise conflict. Between all the vacant lands for construction, it was only interesting the consideration of *noise conflict influenced areas* whose primary occupation would be noise susceptible as housing, commerce and services.

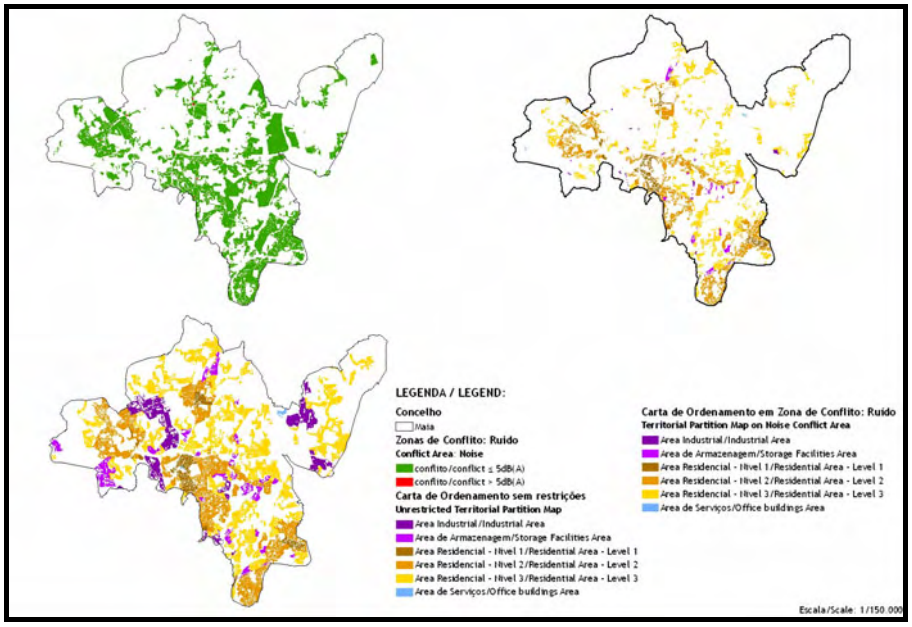

Figure 8: New building perimeters on Noise Conflict Areas.

The following stage was the estimate of the maximum total construction area for which were used the construction parameter COS and the maximum impermeable area. These two factors, vital for the estimation of potential building capacity and expected implantation area, allowed the evaluation of *municipal total construction area under a noise conflict*.

The computation of *equivalent area* (A) involved the evaluation of the possible construction area (A_a and A_b) and the remaining area of the allotment (A_c and A_d) simultaneously with the location coefficient for land value, through equation (4).

$$\boldsymbol{A = (A_a + 0.3\,A_b) \times \%\,T + (0.025\,A_c + 0.005\,A_d)}$$

where, as mentioned before,

A_a = *80% abc*

A_b = *20% abc*

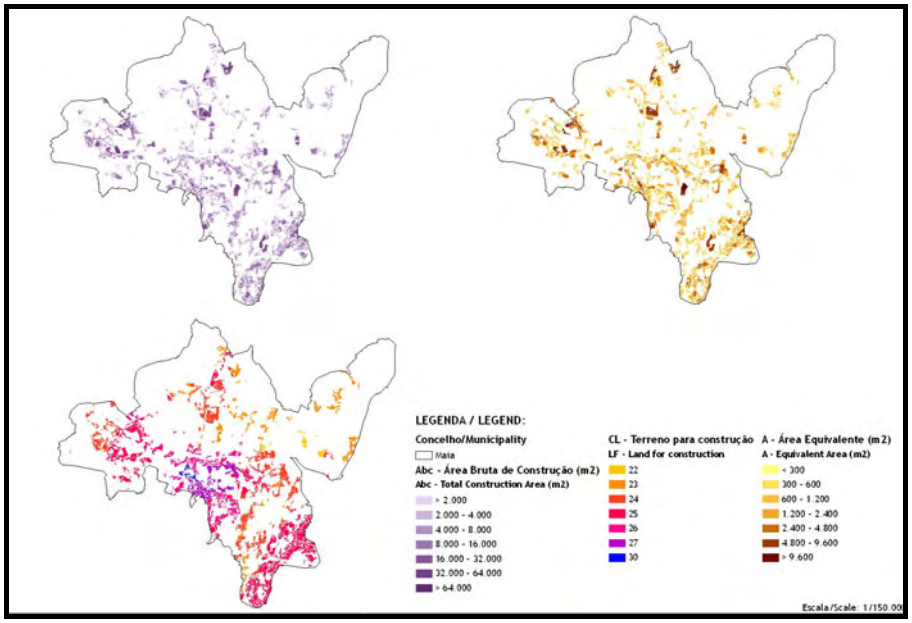

Figure 9: Patrimonial value component: A (***Equivalent Area***)

Finally, the *patrimonial value* – for "regular" urban properties – was estimated through equation (3) influenced the *construction value*, *equivalent area*, *area function* and *quality and comfort coefficients* and *housing location coefficient*:

$$V_t = V_c \times A \times C_a \times C_l \times C_q$$

where:

V_c = 615 €/m^2

C_q = 1.0 (explanation on paragraph 4.2 – Assumptions and simplifications)

This process was reproduced for "other" urban property and the referring *patrimonial value* was estimated through equation (5) influenced by the *construction value*, *housing location coefficient* and the *allotment area*:

$$V_t = V_c \times A_{terreno} \times C_l \times 0.005$$

The graphical analysis of this "transfer" situation is presented on Figure 10 where the reduction on taxes income is quite obvious, even from the visual point of view.

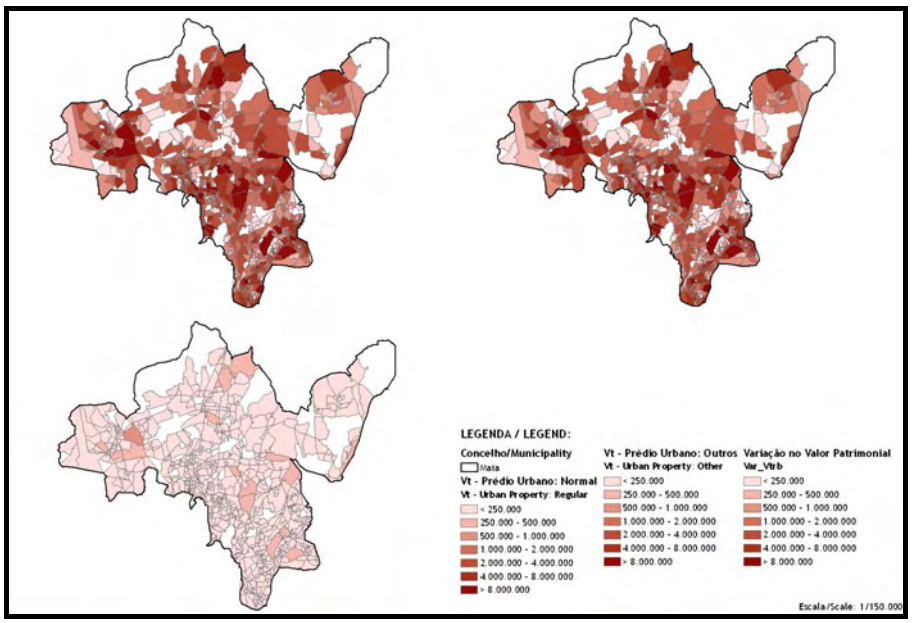

Figure 10: ***Patrimonial value Variation*** on Noise Conflict Areas, regarding statistical subsection

The last procedure was the real estate tax calculation – IMI value.

For Maia, the adopted tax value was 0.5% (maximum). The application of this tax to the previously calculated patrimonial values permitted the estimate of the IMI tax income for Maia municipality in both situations: *regular* urban properties and *other* urban properties.

5 RESULTS AND DISCUSSION

The economical outcomes of this study are impressive. It is almost an "*all or nothing*" comparison. On one hand, the natural consideration of the urban characteristic of the municipal vacant land as "*land for construction*" an, on the other hand, the inadequacy of the same territory land division operation or construction due to elevated noise levels and the consequent categorization as "*other property*".

As it can be seen on Table 6 and Figure 11 the differences on the Patrimonial Value and, consequently, on IMI are massive in every parish and also at municipal level. The reduction of Patrimonial Value to, approximately, 2.5% of the initial value regardless of its construction capacity will be an important factor for the proprietors in order to impose noise reduction mitigation measures.

Facing that fact municipalities will only have two options whether they implement noise reduction plans and maintain the same tax income level or forget about noise reduction and agree on an important reduction on IMI taxes revenue.

Table 6: ***Patrimonial value*** and IMI calculations (adapted from Taxation Code 2003).

Parishes	A (m^2)	V_c €/m^2	C_a	C_q	C_L	V_t regular	V_t other	IMI regular €	IMI other	IMI Variation
Águas Santas	483 976	615	0.99	1.00	1.16	343 004 999	9 815 654	1 714 639	48 696	1 665 943
Castelo da Maia	324 047	615	0.99	1.00	1.09	208 731 346	6 621 343	1 043 435	32 897	1 010 538
Folgosa	79 047	615	0.99	1.00	1.00	48 556 802	1 845 842	242 699	9 155	233 544
Maia	700 646	615	0.98	1.00	1.37	590 820 102	12 619 554	2 953 628	62 607	2 891 021
Milheirós	106 880	615	0.95	1.00	1.06	68 305 959	2 281 516	341 446	11 326	330 120
Moreira	271 436	615	0.96	1.00	1.20	198 302 301	4 757 337	991 317	23 596	967 721
Nogueira	150 062	615	0.96	1.00	1.16	105 493 730	3 319 668	527 351	16 483	510 868
Pedrouços	217 895	615	0.98	1.00	1.22	162 341 622	3 926 906	811 569	19 506	792 063
Silva Escura	54 340	615	1.01	1.00	0.98	33 416 051	1 233 692	167 021	6 105	160 916
São Pedro Fins	22 399	615	0.96	1.00	0.94	12 039 465	481 224	60 171	2 378	57 793
V. N. da Telha	84 878	615	0.97	1.00	1.14	59 078 717	1 696 086	295 317	8 403	286 914
Municipality	**2 495 606**	**615**	**0.98**	**1**	**1.12**	**1 830 091 094**	**48 598 822**	**9 148 593**	**241 152**	**8 907 441**

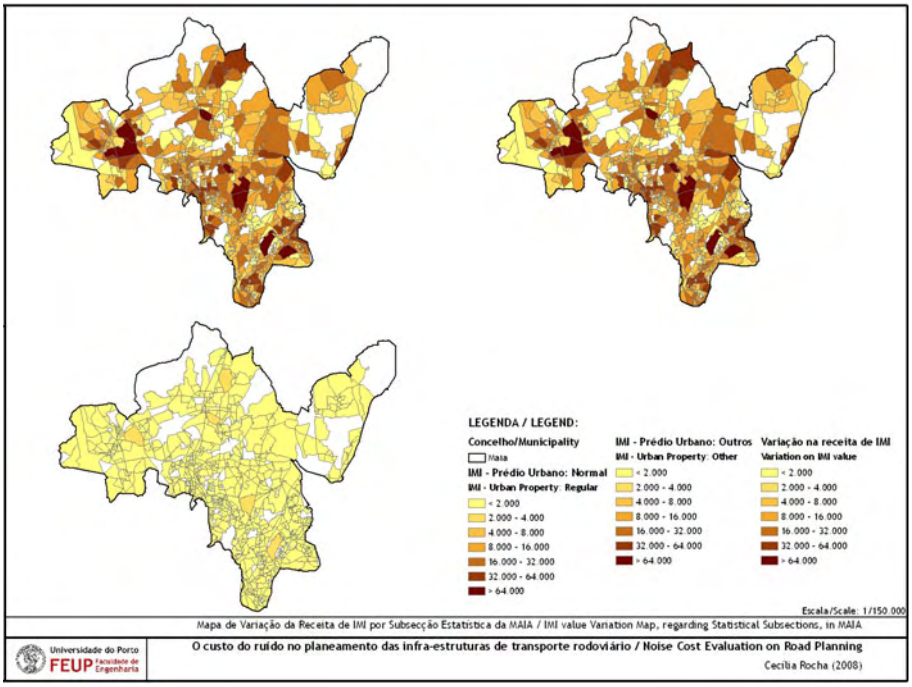

Figure 11: ***Variation on IMI*** value on Noise Conflict Areas, regarding statistical subsection

6 CONCLUSIONS

This study was the first one that attempted to measure a particular indirect effect of noise – *noise influence on municipal taxes income*. The results show this evidence. The simple change in taxation classes induced a loss of approximately ***9 million Euros*** on a single Municipality. This results do not intend to be the most accurate possible and have incorporated several assumptions and simplifications.

They are particularly significant in showing municipalities the importance of their investment in noise mitigation measures, regardless the investment cost. It is also important to enlighten that *this 9 million Euros are an annual income*, reduced for as long as it takes to fulfill the environmental noise limits imposed by the present Noise Code.

This is a relevant matter considering the fact that 41% of municipal taxes income and ***20%*** of ***Maia municipality budget*** comes from this particular *Immovable Property Tax*. It is an important encouragement for municipalities to produce and implement the Municipal Noise Reduction Plans.

7 REFERENCES

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