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Action Plans and Municipal Noise Reduction Plans in Portugal

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ABSTRACT

In 2006, following the European Directive 2002/49/CE, the Portuguese government adjusted its legal framework regarding noise, issuing the decree-law n.º 146/2006, introducing a new noise indicator (L_{den}) and period (evening). These two main changes implied the revision of the Portuguese Noise Code and, in January 2007, was approved the third Portuguese Noise Code (decree-law n.º 9/2007). These two pieces of legislation defined urban forms of occupancy, such as: Mixed Zone, Sensible Zone, Sensible Receivers, Dense Urban Areas and Quiet Areas within or outside city limits for which noise limits were settled regarding two periods of a day: den (daytime-evening-night) and night. In addition, enforced the importance of territorial planning instruments to prevent noise annoyance (noise maps and noise conflict maps) and the need to reduce noise levels wherever they exceeded the established limits (action plans and municipal noise reduction plans).

This paper analyses the development of Portuguese Guidelines for these two noise reduction plans, namely, legal framework, completion deadlines, minimum conflict limits, cost-benefit analysis and the associated administrative and technical procedures. Two case studies, indicative of the Portuguese median cities, are also commented.

1 INTRODUCTION

For several decades, many countries used noise maps not only to describe urban noise nuisance but also as a planning tool. It was considered important the adjustment of land use to effective noise characteristics of a particular location. As so, several European countries like United Kingdom, the Netherlands, France or Italy, for instance, have planning instruments based on noise levels besides their particular legal documents with reference to noise management.

The approval of the Environmental Noise Directive (END, European Directive 2002/49/EC) intended to harmonize noise managing system in Europe, regarding not only noise indicators but also its evaluation, calculation and measurement methods. Other purposes were noise data collection (strategy noise maps and action plans) and public participation concerning noise mapping results or even noise reduction strategies stated on action plans. In summary, the END was an effort to coordinate, at European level, the procedures of noise mapping, defining citizen protection mechanisms against environmental noise.

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Answering that challenge, most European countries transposed the END into their legal framework and began to gather all the requested information. subsequently, those countries were able to began the noise mapping production, identify the exceeding areas in terms of excessive noise exposition and initiate the analysis of the mitigation solutions most suitable on each situation.

2 EUROPEAN SITUATION

Noise maps have been frequently used as land use or urban planning tool and as a describing instrument of urban noise annoyance. As noise mapping are representation of environmental noise levels that later allow the comparison with target values (noise limits), they create the conditions to construct a population noise annoyance map (number of persons or dwellings in a certain area exposed to a certain noise).

Facing the time constrains impose by END (first phase strategic noise maps until 2007 and second phase until 2012), most European countries after or during END transposition began to identify the agglomerations fitting in each of those phases. Afterwards, they began drawing strategic noise maps for the most populated and dense municipalities an, in few cases, already have in course of action noise action plans. On Table 1 is presented a summary of END transposition status, the number of municipalities on each phase and the number or noise maps or actions plans concluded or in course of conclusion.

Table 1: Situation in Europe for **Noise Maps** and **Noise Action Plans**.

Noise Maps and Noise Action Plans in Europe						
Country	**Year of transposition**	**municipalities**			**Noise maps**	**Action plans**
		≥ 250.000	**≥ 100.000***	**total**		
Austria	2005	1	4	84	1	
Belgium	> 07.2005	1	5	589	1	
Bulgaria	2005	3	6	287		
Cyprus		-	2	196		
Czech Republic	> 07.2005	3	2	130	1	
Denmark	2004	1	3	111	1	1
Estonia	2007	1	1	227		
Finland	> 07.2005	1	5	431	1	
France	2006	24	34	2380	1	
Germany	2005	27	54	2073	1	
Greece	> 07.2005	2	6	1034	33	16
Hungary		1	8	289		
Ireland	2006	1	1	165		
Italy	2005	5	38	8101	1335	
Latvia		1	1	77		
Lithuania		2	3	103		
Luxembourg	2006	-	1	12		
Malta	2004	1	-	68		
Netherlands		6	21	443	28	
Poland	under transposition	12	27	2478		
Portugal	2006	2	5	308	200	2
Romania	2005	9*	17	268	1	
Slovakia		1	1	138		
Slovenia		1	1	210		
Spain	2003	18	36	329		
Sweden	2004	3	9	290	1	
United Kingdom	2006	28	48	434	2	

(Data under collection)

** not reported by the referring country*

3 PORTUGAL

3.1 Legal Framework

Until 1987, when the first Portuguese Noise Code was 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, were approved both 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 (amended by DL n.º 72/92, 28th April 1992 and DL n.º 292/89, 2nd September 1989). The scope of application of this 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 2 and considered suitable for buildings construction under the stated circumstances:

Table 2: 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.

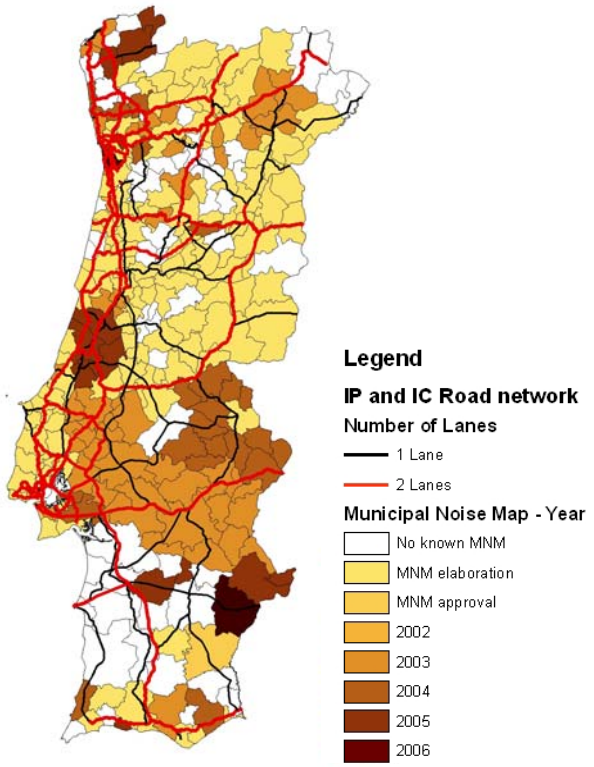
In 1990, the Directive n.º 85/337/CEE, 27th June 1985 was transposed into the Portuguese legal frame through the Decree-Law n.º 186/90, and Regulatory-Decree n.º 38/90. These pieces of legislation refer "*human environmental factors*" such as landscape, natural or built heritage and pollution (noise, 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 **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 3.

Table 3: 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

Municipalities were also advised to produce Municipal Noise Maps (MNM) before the definition of Noise Zoning, as they would be able to acknowledge the present situation in terms of environmental noise. Since then, most municipalities, with the financial support of the Portuguese Environmental Agency, decided to generate their own MNM (see Figure 1) 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 (MNRP).



Year	Noise Maps
No known MNM	59
MNM elaboration	126
MNM approval	2
2002	1
2003	52
2004	23
2005	16
2006	2
(Data under collection)	

Figure 1: Municipal Noise Map (MNM) approval year.

For prevention purposes, the RLPS impose (Art. 4) 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 (Art. 6) 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).

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 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 4.

Table 4: 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)

The number of municipalities with a noise map was broadened (all municipalities ought to have one and some – the agglomerations over 100.000 inhabitants and with more than 2500 inhabitants/km^2 – should also have a Strategic Noise Map), in addition was introduced the concept of an environmental noise report for each municipality every two years, and enforced the need for ***Municipal Noise Reduction Plans*** (or *Action Plans* for agglomerations). Concerning the transportation infrastructures and whenever a non-legal situation (noise limits are exceeded) is identified, noise mitigation measures are required and should be implemented on the following order: *on the source; on the path; on receiver.*

Previously, the possibility to minimize noise on the receiver (façade insulation) was not a legal option and, even now, it should only be used as a last resource when all the other possible actions were taken and when exterior noise (L_{den} and L_n) does not surpass 60 dB(A) and 50 dB(A) respectively.

3.2 Completion Deadlines

The elaboration deadline for ***Municipal Noise Reduction Plans*** and ***Noise Action Plans*** depends on the nature of the document and the agglomeration dimension. These deadlines are indicated in the two legislative documents: DRA (transposition of Environmental Noise Directive (END) - DL n. º 146/2006) and 3rd Noise Code (DL n. º 9/2007).

According to the 3rd Noise Code, "*Municipal Noise Reduction Plans*" ought to be done in two years, which means they should be concluded or in course of implementation until the 1st February 2009.

Referring to the DRA, "*Noise Action Plans*" have to be sent to **APA** – Agência Portuguesa do Ambiente (Portuguese Environmental Agency) and then to the European Commission in two moments, depending on agglomerations dimension and on the capacity of transportation infrastructures, as exposed on Table 5:

Table 5: Deadlines for **Municipal Noise Reduction Plans** and **Noise Action Plans** in Portugal.

	Agglomerations > 250 000 inhabitants	**Infrastructures of transport** Roads: > 6.000.000 cars/year Railways: > 60.000 trains/year Airports: all
Reference year	2006	2006
Send to APA	31.March.2008	28.February.2008
APA approval		18.July.2008
Send to European Commission	18.January.2009	18.January.2009
	Agglomerations > 100 000 inhabitants	**Infrastructures of transport** Roads: > 3.000.000 cars/year Railways: > 30.000 trains/year
Reference year	2011	2011
Send to APA	31.March.2013	28.February.2013
APA approval		18.July.2013
Send to European Commission	18.January.2014	18.January.2014

Agglomerations ≥ 250 000 inh and Pop. Density ≥ 2500 inh/km² (Lisbon, Porto)
Agglomerations ≥ 100 000 inh and Pop. Density ≥ 2500 inh/km² (Amadora, Odivelas, Oeiras, Matosinhos)

These action plans ought to be evaluated every five years or whenever there is a significant change concerning noise sources or urban expansion mechanisms disturbing environmental noise.

3.3 Municipal Noise Reduction Plans (MNRP)

Noise prevention and control are the prime goals for a healthy environment and population well-fare, as stated in current noise legislative documents, whose actions influence social-economic development and territorial management strategies and should be implemented counting on their future interference with those policies.

Some of the Portuguese agglomerations enclose solid urban areas, in several cases, exposed to extremely high noise levels. In these situations, mitigation measures era required. The ***Municipal Noise Reduction Plan*** (MNRP) is the instrument, which settles the course of action to reduce those noise levels to a non harmful stage considering human health. It can be regarded as very ambitious due to the ambivalence of its action, both on environmental noise reduction and on the perpetuation of the soundscape quality.

Therefore, MNRP are regarded as ***noise management tools*** on a long-term global noise reduction scheme implying public participation and involvement. These plans gather several participants either from municipal departments (environment, planning, construction works, traffic management, etc.) or from exterior entities (consultants, infrastructures authorities or other competent bodies, private investors, etc.) also with the public participation of the population in general.

As will be analysed in the Case Studies chapter, MNRP might be elaborated either by municipal departments or by exterior consultants. However, in any case, the coordination of all involved experts should be kept under municipal responsibility, whose management team should include their own noise specialists apart from the specialist mentioned on the previous paragraph.

According to the 3rd Noise Code and the transposed END, all municipalities with a Noise Zoning Map (Mixed Zones, Sensitive Zones, Sensitive Zone within an agglomeration or Sensitive Zone on free-field conditions) and with a Noise Map or Strategic Noise Map should identify all Conflict Areas (over exposed areas) in need of noise mitigation actions stated on MNRP whose minimal content should include the ***municipality characterization***, in terms of geographical location, territorial dimension number of inhabitants and noise zoning maps; a summary of ***noise map data*** like calculation and measurements methods, transportation infrastructures description (placement, cross section, traffic data, circulation velocity) or

other major noise sources; and all the ***responsible authorities*** like the municipality itself, transportation authorities and other private companies. It must also incorporate:

- *noise maps by source and competent authority;*
- *conflict areas description;*
- *evaluation of the estimated number of people exposed;*
- *expected noise reduction by conflict area and by source, expressed for L_{den} and L_n;*
- *appointed noise reduction measures as well as their expected efficiency and reduction on the number of affected people and responsible authorities;*
- *cost-effectiveness assessment and cost-benefit assessment.*

Finally, the MNRP should be summarized for a public consultation session, focusing all the major aspects previously appointed.

3.4 Conflict Areas

One of the most important responsibilities of Municipal Noise Reduction Plans is the identification of all *conflict areas*, which refers to human occupied zones where ***environmental noise*** surpasses the correspondent ***noise limit***.

Environmental noise is defined as the unwanted or harmful outdoor sound created by human activities, including noise emitted by means of transport, road traffic, rail traffic, air traffic, and from sites of industrial activity and described by a noise annoyance indicator like day-evening-night noise indicator ($\mathbf{L_{den}}$) or night-time noise indicator ($\mathbf{L_n}$).

Noise limit depends on area usage, which means, on Noise Zoning established by municipal authorities referred to the following forms of occupancy:

- ***Mixed Zone****: coexistence of housing occupancy with other uses;*
- ***Sensitive Zone****: include hospitals, schools, housing (almost exclusively, small commerce allowed), religious buildings and public facilities en route for a quiet environment.*

3.4.1 Conflict Criteria

Conflict exists whenever an expectation is not fulfilled. As municipalities induce environmental noise expectations when they draw their Municipal Director Plan and establish different land use opportunities on those territorial management instruments, future inhabitants or owners expect to have the proper environmental conditions for that particular activity.

Like mentioned before, in order to analyse any conflict situation, in terms of municipal environmental noise, one should compare noise exposition with noise limits for a specific region, which means, in practice, that ***conflict areas are the result of overlapping municipal noise maps and noise zoning maps***.

3.4.2 Order of intervention

Sensitive or mixed zones when exposed to noise levels higher than the limits established on the 3rd Noise Code ought to have an intervention whose purpose is the reduction of environmental noise. Considering that, in each municipality, several situations will have to be solved, it is important to know the advisable intervention order.

As first priority, all the situation exceeding ***more than 5 dB(A)*** the noise limit for that particular location should be remediate. In addition, among all of them, the order of intervention is dependent on the conjugation of two functions: *Higher global noise reduction needed; higher number of exposed persons.*

The intervention cost was not considered as an important selection factor.

3.5 Cost-benefit Analysis

After the identification of all Conflict Areas on a municipality and the determination of the needed environmental noise reduction by source, it is time to estimate the investment value and the future revenue, in terms of environmental and well-fare benefit.

The procedure we are intending to adopt implies the assessment of the exposed population (although this is a requirement in the case of Action Plans, that is not the case for Municipal Noise Reductions Plans), whenever possible by source and reduction level, then the evaluation of the implementation cost for mitigation measures with the knowledge and future confirmation of efficiency and finally the environmental benefit will be evaluated relating the ***direct cost*** and ***direct benefit***. For the time being, there is no intention of introducing any external costs analysis on those noise reduction plans.

4 CASE STUDIES (MUNICIPAL NOISE REDUCTION PILOT-PLANS)

For the analysis of the draft version of the National Guide on Municipal Noise Reduction Plans was suggested its application on two different situations. One, regarding ***Maia*** Municipality, where there are all sorts of main transportation modes are present (major roads, railways, metro and airports) and as well as forms of urban occupancy, with a Municipal Noise Map executed by outsourcing. Another, concerning ***Santa Maria da Feira*** Municipality, with all forms of urban occupancy but only with major roads and railways, with a Municipal Noise Map carried out on Municipal technical services (insourcing).

The recommended list of activities included the analysis of the present ***Noise Maps*** together with ***Noise Zoning Maps*** (Sensitive zones, Mixed zones, Quiet Areas and Sensitive buildings) which will allow the team to identify ***Conflict Areas*** (where environmental noise levels exceed noise limits). Later with Municipal representatives, the hierarchy of Conflict Areas will be established, according to the selected criteria, in order to define the future interventions schedule. In each of these areas, the responsible authorities will be identified (private entities, transport infrastructure authorities or municipality itself) and will receive the intended noise target which allow the accomplishment the settled legal limits for the global noise sources emission.

For Conflict Areas under Municipal responsibility the appropriated mitigation measures (among all the measures indicated on the Guide) will be selected and then, a noise simulation will take place, in order to see if the chosen measures will be enough to eliminate the existent conflict (reduce environmental noise levels to legal limits or under).

Afterwards, there will be an economical evaluation of those measures, concerning not only to their implementation cost, but also the inconveniences caused by the eventual construction constraints and the number of buildings and inhabitants positively affected by those noise reduction strategies.

4.1 Maia

This municipality used to occupy all the territory between Porto and Ave River from the shore to approximately 20 km inland. As a passing point, it was served by a dense road network and its vast dimension caught the attention of the neighbour municipalities, which were able to redraw cities limits, and reduced the area of Maia municipality. This situation reduced the strategic importance of Maia recovered several centuries later (20th century).

Photo 01 – Quinta da Caverneira

Nowadays, Maia as become one of the most important municipalities, in terms of industrial activities, especially in view of the fact that there are diverse transportation infrastructures present, like major roads or railway and airports.

Photo 02 – Aerial view of the international airport (Porto)

Considering these transportation conditions, Maia is crossed by three major roads from the Principal and Complementary National Road Network (***IP1/A3*** on the eastern part of the territory and in the north/south direction, ***IP4/A4*** on the eastern part of the territory and ***IC24*** in the middle part with east/west direction) several railway lines and two airports, an international and a domestic. Regarding demography, Maia has been able to increase the number of inhabitants. Since the last census (2001) and according to INE (National Statistic Institute), the population of Maia raised from about ***120.000*** to ***133.000 residents*** and a ***population density of 1500 inh/km^2***. Under these circumstances Maia will be a municipality that needs to present a strategic noise map and an action plan on the second phase (over 100.000 and less than 250.000 inhabitants), which means 2013. Meanwhile, as the 3rd Noise Code imposes an earlier date for the conclusion of Municipal Noise Reduction Plans, this instrument will have to be concluded no later than 2009.

Photo 03 – Aerial view of Maia centre

4.2 Santa Maria da Feira

This ancestral municipality had its evolution based on the strategic geographical location favouring the agglomerations foundation and the establishment of meeting points and passageways since the Roman Empire. All the routes connecting Braga to Lisbon and Porto to Viseu enlighten the importance of this city, which became an important agricultural and industrial region (cork, shoes, paper, ceramics, etc.) as its position support excellent transportation conditions. Considering these transportation conditions, Santa Maria da Feira (S.M. Feira) is crossed by three major roads from the Principal and Complementary National Road Network, ***IC24*** on the northern part, ***IP1/A1*** in the middle along the north/south direction and ***IC2*** in the inner part. Regarding demography, S.M. Feira has been able to increase the number of inhabitants. In fact, since the last census (2001) and according to INE (National Statistic Institute), the population of S.M. Feira raised from about ***136.000*** to ***144.000 residents*** and a ***population density of 650 inh/km^2***. On these circumstances and as the municipality of Maia, S.M. Feira will be a second phase municipality needing to present a strategic noise map and an action plan on 2013. In the meantime, as the 3rd Noise Code impose an earlier date for the conclusion of Municipal Noise Reduction Plans; this instrument will have to be concluded no later than 2009.

Photo 04 – S.ta M.a Feira castle

Photo 05 - *Visionarium* building

5 CONCLUSIONS

This study, presently in progress, focus on the Portuguese municipalities needs, according the 3rd Noise Code approved on January 2007. This document, under elaboration for the Portuguese Environmental Agency (APA), will constitute the national guidelines for Municipal Noise Reduction Plans. The draft version is being tested on the two cities mentioned on chapter 4 and, by the end of 2007, it is expected to have the simulation results, whose input will allow the improvement of this Guide.

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