Noise Monitoring in Madrid

Madrid City Council
Background

- Madrid was identified as a noisy city
- Project set up to:
  - Quantify
  - Confirm
  - Inform the public
  - Form the basis for a strategic noise control policy
  - Provide database for research and improvement of noise management
City Council of Madrid System

- Stationary noise monitoring system formed by 25 stations
- Portable noise monitoring system formed by 14 boxes
- Measured noise map periodically updated (100 m resolution)
- Noise prediction model
- All supplied by Brüel & Kjær
Dec 2001: "decibel d’Or" for innovation in noise control
Leading light in Spain and now in Europe
Now expanding and moving towards Integrated Urban Noise Management
Noise policy now drafted
Loyal Brüel & Kjær customer:
- Best products
- Best support
- Best advice
Combining Measurements & Calculations to Map Noise in Madrid

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Madrid - SADMAM

- Dynamic Noise Mapping
- Calibrate EU END maps
- Determine temporal variations in noise exposure
- Using high-end Mobile NMTs
Contents

- Introduction & Background
- The SADMAM System
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  - Model creation
- Various Aspects of Technique & Practicalities
  - Integrating GPS, measurement data and GIS
  - Modelling multiple sources from noise measurements in a complex environment
- Conclusions
- Acknowledgements
Introduction & Background

- Madrid’s Environmental Administration runs probably the largest urban noise-monitoring network with attended and unattended terminals
  - Much real data collected over ~30 years
  - 3 urban noise maps based on measurements
  - Latest noise map (2002) based on 4395 measuring points

- The measurement-based noise map is very expensive and complicated to upgrade and data exploitation is limited and not user friendly

- Madrid City Council needed an integrated solution to:
  - fulfill the EU Directive 2002/49/EC
  - dynamically upgrade Madrid’s noise map
  - integrate the several acoustic systems they have
  - avoid infrastructure and human resource problems

-> **SADMAM**

*Sistema Actualización Dinámica Mapa Acústico Madrid*
The SADMAM System

- Noise calculation software Lima Advanced 7812-C
- Noise Monitoring Software Type 7802
- Several mobile monitoring stations
  - Now validating 3 mobile stations to collect, fast, economically and accurately, time- and space-referenced samples of noise data
  - Each station consists of:
    » a Smart car for easy parking in strategic places
    » High-end Noise Monitoring Terminal Type 3637A
      - Weatherproof Microphone Type 4184 on a pneumatic mast for 4 m height positioning
      - Garmin GPS device for automatic measurement position
    » Mobile phone for contact with system manager
    » Batteries for long term autonomy
    » Non-acoustically skilled driver

- ArcGIS
- SQL Server data base
SADMAM Model Creation Process

Mapas GMU
1:1000

Automated building & terrain generation

EDIFICIOS - FACHADAS
LINEAS DE NIVEL
PTOS ACOTADOS

LimA
SADMAM System Overview
Integrating GPS, Measurement Data and GIS

- GPS is standard in the Brüel & Kjær Noise Monitoring Terminal Type 3637
  - The GPS position is logged 4 times per s
  - Every hour, the terminal position is determined from average logged GPS positions
- When downloading measurements, Noise Monitoring Software 7802 identifies if the terminal has moved:
  - if max. position change limit exceeded
  - e.g. 4” (~100 m in Madrid)
- Position automatically plotted on site map
- Changes in terminal position also automatically identified
- Accuracy OK
Integrating Measurements in Calculations

- Reverse engineering determines source emission levels from proximity measurements
- Know source behaviour & carefully choose the receiver positions
- Urban roads (separated by buildings)
- Weather influences are negligible (close proximity)
- Can also qualify road surface correction

A: noise dominated by major road only. Determines major road emission
B: noise dominated by minor road only. Determines minor road emission
E: noise from major and minor road. Verifies/improves source emissions

C & D: noise from adjacent road. As other road emissions are known, road emission be determined. Optimizes road emissions
Current Actions

- System integration & test
- 1st reports & maps
- Local area level correlations
Local Area Correlation

- Area around Arturo Soria permanent noise monitoring terminal (P-NMT)
  - $L_{\text{eq,1hr}}$: 11:00:00 - 11:59:59

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Summary

- The main goal of Madrid’s SADMAM system for dynamic noise mapping and automated calibration of noise maps is to produce fast and cheap real noise maps that represent both long-term and shorter-term levels including realistic propagation.

- With mobile noise monitoring terminals, installed over shorter periods at strategic places, noise maps of smaller areas can be made and updated to be representative of the actual situation (e.g. traffic modifications or special events).

- Combined measurements and calculations give high quality output results for Madrid to efficiently validate and improve the quality of their strategic noise maps that will form the basis of action plans.

- Public confidence in the maps grows and unnecessary actions based on incorrect results will be avoided.

- The authors thank the City Council of Madrid for their cooperation in making this paper.