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Europe's Transition to Strategic Noise Mapping Under CNOSSOS-EU: Data Needs Assessment and Recommendations in the Context of Ireland

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ABSTRACT

In accordance with Art. 6.2 of the Environmental Noise Directive (END), a Common Noise assessment method (CNOSSOS-EU) for road, railway, aircraft, and industrial noise will come into effect for the 2022 noise mapping round applicable to all EU nations. This paper identifies Ireland's key adaptation needs, with particular focus on road (CRTN) and rail (RMR 1996) source requirements. In the context of CRTN, CNOSSOS-EU introduces five categories of vehicle. If data gaps exist, default decomposition of heavy vehicles into alternative categories is recommended based on road type, dominant flow, or equal distribution. Other specific data needs and recommendations relate to road-surface gradient, roadside topography, and the

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requirement for detailed spatial information, particularly in relation to the location of intersections. In the context of RMR, practitioners should focus on track base and railhead roughness in the initial stages of CNOSSOS-EU implementation. In relation to brake type data, stock category assumptions will need to be made based on vehicle type, vintage, and examination of publically accessible photographs.

Keywords: CNOSSOS-EU transition, CRTN to CNOSSOS-EU, RMR 1996 to CNOSSOS-EU, CNOSSOS-EU data needs
I-INCE Classification of Subject Number: 76

1. INTRODUCTION

In accordance with Art. 6.2 of the Environmental Noise Directive (END) [1], the European Commission recently developed a common noise assessment method (CNOSSOS-EU) for road, railway, aircraft, and industrial noise, to be used by member states for the purpose of strategic noise mapping (SNM) as required by Article 7 of the END. The CNOSSOS-EU method will come into effect for all EU nations during the next noise mapping round in 2022. This paper explores Ireland's main adaptation needs for transitioning to the CNOSSOS-EU standardised noise method and the standardised approach for population-exposure estimation based on the Commission Directive (EU) 2015/996 of 19 May 2015 [2]. This assessment is based on an examination of CNOSSOS-EU methodologies for road, rail, air, and industry for informing data needs in the Irish context. Given that standardised methods already exist for aircraft noise, CNOSSOS-EU has less significant implications for this source. Furthermore, particular attention is also paid to road and rail sources as these are the areas that will be most directly affected by the move towards standardised calculation and exposure estimation procedures operational under CNOSSOS-EU.

2. Road Source

2.1 Classification of Vehicles

The UK "Calculation of Road Traffic Noise: 1998" (CRTN) method previously used for SNM in Ireland from 2007 to 2017 applied two vehicle categories, one for light and one for heavy vehicles. CNOSSOS-EU introduces five categories of vehicle for road-traffic noise: 1) Light motor vehicles (i.e. < 3.5 tons); 2) Medium heavy vehicles (i.e. > 3.5 tons); 3) Heavy Vehicles (i.e. > 3.5 tons); 4) Powered two-wheelers (i.e. < 50cc and > 50cc); and 5) Open category (i.e. hybrid electric or entirely electric vehicles). The fifth vehicle classification is prospective, as the proportion of hybrid or electric vehicles on European roads is currently insignificant.

In the context of the Dublin City Agglomeration, the responsible authority, Dublin City Council (DCC), uses the Sydney Coordinated Adaptive Traffic System (SCATS) to estimate the total volume of road traffic at 1100 junctions across the city which covers an area of 122 km². Total traffic volume is calculated every 15 minutes over a 24-hour period. In previous rounds of SMN DCC have used annual survey counts at 33 key locations across the city in order to estimate the percentage of Heavy Vehicles (HVs). For SNM, average hourly values over the survey period from 7am to 7pm are applied as a percentage to each hour of the SCATS data from 7.00am to 12.00am - an 18 hour period, which historically the CRTN L10 18Hr calculations were based on. Outside agglomerations the authority responsible for Ireland's national road network is Transport Infrastructure Ireland (TII), which provide hourly traffic count data collected from 328 traffic counters located across Ireland's National Road Network. The classes of vehicle currently classified by TII are based on a EURO 6 (plus motorbike) Classification Scheme. Classification is achieved using inductive loop based traffic counting equipment across the road network. For the most part, classification *is not* based on weight but primarily on length. TII currently use 7 classifications: 1) **MBIKE** – Motorbikes; 2) **CAR** – Passenger Cars and Small Goods Vehicles; 3) **LGV** – Large Goods Vehicles; 4) **BUS** – Buses including Mini-Buses; 5) **HGV_RIG** – Heavy Goods Vehicles with Rigid Trailers; 6) **HGV_ART** – Heavy Goods Vehicles with Articulated Trailers; and 7) **CARAVAN** – Caravan.

The primary transitional issue associated with the new vehicle classification system relates to the two heavy vehicle categories applicable under the CNOSSOS-EU method. In the context of DCC, considering current methods used, the optimal recommendation would be for annual survey data to distinguish each category of HV, and over a full 24 hour period if possible. Alternatively, the European Commission [3] recommends that in cases where, "separate traffic data for categories 2 and 3 are not available or the proportion of vehicles in one of these categories is low … it is recommended that a nationally established default decomposition of heavy vehicles into two categories can be used, based on type of road under study. Alternatively, if one of the two categories dominates the flow strongly, this category is recommended to be used for the whole traffic flow" (p.39) [3]. If this methodology cannot be achieved, the European Commission [3] suggests that current heavy vehicle flow information may be equally separated into two categories. However, such methodologies do not pertain to the necessary accuracy preferable for cross-national comparison. In this regard, it is possible that more accurate estimates may be achieved from commercial vehicle registration data collected by the Central Statistics Office (CSO). Such information could potentially provide approximations of vehicle class, which could then be extrapolated to relevant traffic flows. In the context of TII, this authority's method of classification has limited accuracy in identifying certain classes of vehicle and currently suffers from cross-category overlap between existing TII classification and CNOSSOS-EU classification. Bearing this in mind, under the CNOSSOS-EU method: **MBIKE** would be classified under category 4, without the subcategory a) and b) referring to powered two-wheelers < 50cc and > 50cc respectively; **CAR** would be classified under category 1 without cross-category overlap; **LGV** would be classified under category 2, but buses < 3.5 tonnes would not be included; **BUS** may be classified under category 3 as the majority of operational buses are > 3.5 tonnes. However, buses < 3.5 tonnes would also be included in this category; **HGV_RIG** and **HGV_ART** would be classified under category 3 without cross-category overlap; and **CARAVAN** would be classified under category 1 without cross-category overlap.

A secondary transitional issue associated with the new vehicle classification system relates to the new category 4 'powered two-wheelers', due to the fact that data is not currently collected for this type of vehicle within agglomerations. In relation to this, the European Commission [3] states that, "it is an acceptable simplification to neglect category 4, if the traffic data for this category is unavailable or if the vehicle fleet is not significant" (p.39) [3]. In Ireland, figures from the CSO (1997-2017) describe a total of 3,577,851 new category 4 vehicles registered between 1997 and 2017, with a total of 63,474 new motor cycles registered during the same period. This figure accounts for 1.77% of the total number of new registry vehicles during the period. This suggests that the percentage of category 4 vehicles operational on the Irish Road Network is minor. Tests should be conducted to examine the contribution of this category to the overall sound power levels at the point of the receiver.

2.2 Vehicle Speed

The CNOSSOS-EU method recommends the calculation of average speed for each vehicle category. Ireland currently uses the legal speed limit on respective roads as a measure of average speed. A sensitivity analysis between speed limit and actual vehicle speed may determine whether the speed limit is suitable as utilisation as the average speed input for the CNOSSOS-EU model. If it cannot be used within agglomerations, average vehicle speed will need to be recorded using vehicle-speed monitors. Outside agglomerations, vehicle speed is an output of the TII's Traffic Monitoring Unit (TMU).

2.3 Number and Position of Equivalent Sound Source

The CRTN method placed the point source at 0.5m above the road surface [4]. The CNOSSOS-EU methodology recommends that a standardised single point source is placed at 0.05m above the road surface for *all* vehicle categories. Where multiple lanes are modelled, it is preferable that each lane should be represented in terms of respective source lines positioned in the centre of each individual lane [5]. However, such accuracy may not be practical in the context of SNM. In such cases, Shilton et al. [5] recommend that it may be adequate to method one source line if positioned in the centre of a two-way road. Where there are multi-lane roads, Shilton et al. [5] recommends that one source line per carriageway may be positioned in the outer lane.

2.4 Acceleration and Deceleration

The calculation of propulsion noise proposed by CNOSSOS-EU also accounts for speed variation in proximity to junctions with traffic lights and roundabouts. As such, the CNOSSOS-EU method provides information for the correction of rolling noise and propulsion noise associated with acceleration and deceleration on a flat surface in the context of intersections with traffic lights and roundabouts. Practitioners may have to acquire far more detailed spatial information in relation to the positioning of traffic lights and roundabouts. However, if the cost of data acquisition outweighs the benefits of inclusion within SNM methods then implementation may prove unfeasible, particularly in the context of large agglomerations. A sensitivity analysis may have to be performed in order to ascertain the legitimacy of implementing such measures.

3. Rail Source

3.1 Classification of tracks and support structure.

Data on the various types of track composing rail networks must be applied to the CNOSSOS-EU method. Tracks are classified by: 1) track base; 2) railhead roughness; 3) rail pad type; 4) additional measures; 5) rail joints; and 6) curvature (p.14) [2]. Track base includes: 1) [**B**] ballast; 2) [**S**] slab track; 3) [**L**] ballasted bridge; 4) [**N**] non ballasted bridge; 5) [**T**] embedded track; and 6) other (p.14) [2]. Railhead roughness is divided into 4 classes: 1) [**E**] well maintained and very smooth; 2) [**M**] normally maintained; 3) [**N**] not well maintained; and 4) [**B**] not maintained and in bad condition (p.14) [2]. Rail pad type is divided into: 1) [**S**] soft (150-250 MN/m); 2) [**M**] medium (250 to 800 MN/m); and 3) [**H**] stiff (800-1000 MN/m) (p.14) [2]. Besides track base and railhead roughness, rail pad type is the third most important parameter requiring classification, with additional measures, rail joints, and curvature only applicable in particular cases (e.g. damped tracks, old jointed tracks, small-radius curves) [6].

However, it is important to emphasise that, in the classification of tracks and support structures, a minimum number of track attributes have a significant influence on noise emission, primarily track base and railhead roughness [6]. Therefore, it is imperative for practitioners to focus on track base and railhead roughness in the initial stages of CNOSSOS-EU implementation. Data must be applied in relation to track-base and sleeper-type as well as brake-type data. In relation to brake-type data, stock category assumptions will have to be made based on vehicle type and vintage and examination of publically accessible photographs (e.g., where brake discs are visible). In the scenario where vehicles have a combination of disc brakes and cast-iron tread brakes, only the latter is recommended for classification. In the context of railhead roughness, the RMR 1996 method assumed the general hypothesis that all railheads are relatively smooth. This approach is widely considered to result in an underestimation of railway noise emission [7]. However, railhead roughness is regarded to be the most challenging attribute to acquire [6]. It is defined according to EN15610:2009, which excludes pits and spikes [6]. However, a revision is expected to be published early 2019.

3.2 Elevated Structures

Data sets for elevated structures such as bridges are required for CNOSSOS-EU implementation. The Irish Environmental Protection Agency (EPA)[8] st ate that OSi datasets do not clearly identify elevated structures such as bridges. Datasets may need to be manually generated through field surveys and aerial photography analysis [8]. Some of the existing SNMs may have already identified bridge locations, and included bridge objects within the datasets, such as Cork agglomeration. However, bridge type would still need to be added via some form of survey.

4. Industrial Noise

In the context of industrial noise, there has never been any SNM of industrial sites in Ireland. The first stage of SNM should begin by cataloguing all applicable industrial sites within the agglomeration under analysis. The Irish EPA has a register of Integrated Pollution Prevention and Control (IPPC) licensed industries in Ireland. Since these plants have sound emission control conditions attached to their licences, this data could potentially be extracted from reports submitted under the licensing requirements. The data is measured rather than modelled; however, it could be used to carry out population assessments once sound levels at the boundary of industrial sites are identified. The ISO 8297: 1994 method is considered appropriate in order to meet the criteria recommended under CNOSSOS-EU. It is based on measuring the sound pressure level on a closed path (measurement contour) surrounding the industrial plant and determining an appropriate measurement surface.

5. Sound Propagation

5.1 Spatial Dimensions of Buildings

In the Irish context, building height has previously been set at a default standardised level of 8 metres, with receivers positioned at 4 metres [9]. Precise building height parameters will need to be integrated into future SNM under the CNOSSOS-EU methodology. In relation to sound propagation, geographic information systems (GIS) are proficient at generating accurate spatial dimensions for buildings along a horizontal plane but not along a vertical plane. DCC has a database on all building heights in DCC area, however, for other agglomerations in Ireland building height data will need to be retrieved from

Ordinance Survey LiDAR data (a high resolution elevation data-set yielded from a Light Detection and Ranging technique).

5.2 Noise Barriers

Accurate information regarding the position of noise barriers is also required, as even minor inaccuracies in height can result in major discrepancies in noise calculation. Noise barrier data may be acquired using Google Maps and Google Street-view. The ability of practitioners to access accurate information regarding the position of noise barriers is also problematic [10]. Again, the accuracy of such information may be limited by the quality of GIS mapping software, but also inaccurate information from supplementary noise barrier inventories which result in difficulties with transferring road segment data to GIS coordinates [10]. This is relevant since TII reports that GIS mapping software are the main source of information regarding noise barrier locations [10]. In the context of noise barrier dimension, minor inaccuracies in height can result in major discrepancies in noise calculation when the propagation plane converges adjacent to the top perimeter of the barrier [11]. This may be problematic since GIS data on barrier height is usually highly inaccurate or even missing [10]. DCC has noise barrier data for that agglomeration. R3 SNMs for Cork agglomeration, Dún Laoighaire-Rathdown County Council (DLRCC), South Dublin County Council (SDCC), and Fingal County Council (FCC) successfully included remote capture of noise barrier data by using Google Maps and Google Streetview. Furthermore, TII report that the construction of noise barriers in Ireland did not occur before circa 1995 [10] so, in the majority of circumstances, records of barrier dimensions should be available on request. TII also report that information on barrier dimensions have been collected for 2006 and 2012 rounds of SNM [10]. In terms of the horizontal position of noise barriers, TII report that development contract protocol depends on a maximum horizontal tolerance of +/- 15mm to road source, with a < 0.3m margin of error in relation to barrier height [10].

Sound absorption effects are required under the CNOSSOS-EU method. However, Ireland does not currently account for sound absorption. Therefore, this should be included in the records of future construction (Olsen, 2015). For the present time the use of default values may be a possibility. The EPA [8] recommend that SNM should include noise barrier information where possible in proximity to major road, rail, and industrial noise sources, both within agglomerations and in areas in close proximity to agglomerations.

6. Estimating Population Exposure

In the context of evaluating population exposure, the first task for practitioners is to distinguish between residential and non-residential. In Ireland, the An Post GeoDirectory provides a national database containing such information. In the case of multi-occupancy buildings, the GeoDirectory database provides data on the total number of residential dwellings within respective buildings. In the Irish context, CASE 2 “the dwelling floor space is known on the basis of dwelling units” (p.95) [2] is applicable in determining the number of inhabitants of a building. In 2017, the EPA released a revised section 10 pertaining to their *Guidance Note for Strategic Noise Mapping* [8] which provided a detailed methodology for exposure assessment. It is recommended that noise mapping software use PRIME2 building polygons as a component of the calculation method whereby GeoDirectory points are spatially joined to PRIME2 building data in order to calculate residential building exposure [12]. However, the more difficult task involves assigning populations to each respective building. General census data for Small Area Population Statistics (SAPS) is readily available from the Census Statistics Office (CSO)

Ireland. Once all data sources are acquired, a spatial join between GeoDirectory points/PRIME2 spatial join data and SAPS data [12] should be performed. PRIME2 data contains information concerning the size and location of buildings (e.g. building height, number of floors, floor space) and/or data relating to building-type (e.g. detached, semi-detached, terraced, multi-story building). This can provide an estimate of population per residential building based on an equal distribution scheme. The EPAs revised section 10 document guidelines were also implemented in R2 and R3 of SNM in Ireland. These methods were based on GeoDirectory and CSO datasets, and in the case of R3, the newly available OSi PRIME2 buildings themes were utilised, and SAPS data was used for exposure assessment.

7. CONCLUDING REMARKS

The objective of this paper has been to identify Ireland's key transitioning needs under CNOSSOS-EU which has included an examination of CNOSSOS-EU methodologies for road, rail and industry in order to inform data needs in the Irish context. It has also provided guidance and recommendations for future practitioners. The Commission Directive (EU) 2015/996, on which CNOSSOS-EU is based, will be modified appropriately in accordance with any future technical and scientific developments required for the successful implementation of the CNOSSOS-EU method, and, similarly, will make any adjustments deemed necessary, based on the experience of Member States. As such, the assessment needs and recommendations outlined in this paper may change in accordance with future phases implemented under the CNOSSOS process.

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6. REFERENCES

1. European Commission. *Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise*. Official Journal of the European Communities (2002).
2. European Commission. *Commission Directive (EU) 2015/996 of 19 May 2015 establishing common noise assessment methods according to Directive 2002/49/EC of the European Parliament and of the Council*. Official Journal of the European Communities (2015).
3. European Commission. *Develop and Implement Harmonised Noise Assessment Methods. Process Applied to Establish CNOSSOS-EU/National Methods Equivalence for Road Source data* (2012).
4. Department of Transport Welsh Office. *Calculation of Road Traffic Noise*. London: Her Majesty's Stationery office (1988).
5. Shilton, Simon J., Fabienne Anfosso Lédée, and Hans Van Leeuwen. "Conversion of existing road source data to use CNOSSOS-EU." *Proc. of Euronoise* (2015).
6. Paviotti, Marco, Simon J. Shilton, Rick Jones, and Nigel Jones. "Conversion of existing railway source data to use CNOSSOS-EU." *EuroNoise 2015* (2015).
7. Murphy, Enda, and Eoin King. *Environmental noise pollution: Noise mapping, public health, and policy*. Newnes (2014).
8. Environmental Protection Agency. *Guidance Note for Strategic Noise Mapping*, Version 2. Environmental Protection Agency, Ireland (2011).

9. King, Eoin A., Enda Murphy, and Henry J. Rice. "Implementation of the EU environmental noise directive: Lessons from the first phase of strategic noise mapping and action planning in Ireland." *Journal of environmental management* 92, no. 3 (2011).
10. Olsen, Herold. Conference of European Directors of Roads (CEDR). *CEDR Call 2012: Noise: Integrating strategic noise management into the operation and maintenance of national road networks. DISTANCE: Developing Innovative Solutions for TrAffic Noise Control in Europe. Issues and Assessement of Data Types related to CNOSSNOS-EU Requirements.* Final Report (2015).
11. Kephalopoulos, Stylianos, Marco Paviotti, and Fabienne Anfosso Ledee. "Common noise assessment methods in Europe (CNOSSOS-EU)." *Common noise assessment methods in Europe (CNOSSOS-EU)* (2012).
12. Environmental Protection Agency. *Revised Section 10: Methodology for Exposure Assessment – Post Processing and Analysis. EPA Guidance Note for Strategic Noise Mapping for the Environmental Noise Regulations 2006 (Version 2 – August 2011).* The Environmental Protection Agency Ireland (2017).