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Noise Pollution: Managing the Challenge of Urban Sounds

By Rajiv Bhatia, 20 May 2014

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Overview

Hearing evolved to alert humans to changes in their environments. But, it is a sense that human's can't turn on and off voluntarily.

The sounds we hear become noise when they are unwanted—when sounds interferes with thinking, concentrating, working, talking, listening, or sleeping.

With active populations, road traffic, industry, and construction, cities are expectedly noisy places. Still, noise is a leading source of dissatisfaction for city residents.

Urban noise affects more than quality of life issue; the level of noise in many cities can cause serious and long-term harm to health,

Noise not only makes hearing, concentrating, and working more difficult,

Noise disturbs sleep. Insufficient or poor quality sleeps results in stress, fatigue, and changes in body's chemical balances.

Noise interferes with cognitive functions, including attention, concentration, memory, reading ability, and sound discrimination. The long-term consequences of these effects on children 's development are particularly significant.

Long term exposure to noise from road, rail, and air traffic results in physiological and psychological stress, which indirectly may contribute to heart disease, and high blood pressure.

Chronic or repeated exposure to sounds at or above 85 decibels can cause hearing loss.

While urban noise may seem inevitable and unavoidable, even the most dense and active places can take steps to limit noise.

Many cities and states have laws that limit noise in residential areas; however, these laws are variably enforced.

While there has been progress in limiting noise along airport flight paths, relative to other environmental problems, such as air pollution, there has been limited progress on noise management over the past several decades.

Health protective laws, attention to design and planning, and improvements to machines can minimize noise from transportation, construction, mechanical equipment, entertainment, and human behavior.

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Noise is measured in terms of its frequency as well as intensity of sound; the dB(A) weights sounds in the audible range of humans.

Because noise is measured using a logarithmic scale, a 3 dB(A) change in noise, a level which is generally noticeable, corresponds to a doubling in the power of the generated noise. A 10 dB(A) change in noise represents an eightfold increase in power, and corresponds to a doubling of perceived loudness.



Measures of noise exposure integrate sound power over a period of time.

- The $L_{eq}(1\text{hour})$ measure represents an average noise exposure over a one-hour time period.
- The L_{dn} is a measure of cumulative noise exposure over a 24 hour period with a penalty for sound at night. Intermittent and impulsive noise is also impactful on health.
- The sound equivalence level (SEL) represents the cumulative power of noise in a 1 s period and is also an important measure of exposure, including for effects on sleep.

The instantaneous maximum or peak values L_{max} is a measure used for equipment regulation but not typically used as a measure of human exposure. Peak values (L_{max}) influence exposure measures over short durations but their influence declines with increasing exposure duration.

Sources of Urban Noise

Cities have many sources of noise; many of the more significant and preventable sources arise from traffic and industry. Motor vehicle traffic is usually the single greatest contributor of noise in most cities.

TRAFFIC

Motor vehicle noise, including noise from automobiles, motorcycles, buses, and trains, is a result of (1) vehicle traction systems including the engine, braking, exhaust (2) the interface of the wheel and the road or rail and (3) displacement of air, which is important at high speeds.

While modern vehicle are designed to limit noise, some people make illegal modifications to exhaust systems, which are designed to create obnoxious noise.

Traffic noise disproportionately affects residents living near highways and freight and transit routes A heavy truck will produce approximately twenty to thirty times more sound energy than a personal automobile.

Emergency response vehicles are problematic sources of noise for residents living near hospitals or police and fire stations.

Public sanitation vehicles make loud noises when picking up or compacting refuse.

Alarms and back-up beepers are relatively new but highly obnoxious forms of traffic noise and are largely unregulated.

Traffic noise is not inevitable; cities can minimize traffic noise by maintaining roads, constructing sound barriers, reducing vehicle speeds, enforcing illegal vehicle modifications, carefully routing freight trucks, choosing electric buses, and increasing the use of public transit, bicycles, and walking.

INDUSTRY

Many noise complaints result from proximity of housing to businesses, industries, and institutional uses.

Residential-industrial noise conflicts arise from mechanical equipment, loading and unloading of delivery vehicles, heavy truck backup beepers, generators, and refrigeration equipment.

Mechanical ventilation systems, particularly those on rooftops can be a significant annoyance if there is an adjacent residential building that is higher.

Modern construction involves diesel powered heavy equipment, loud electric and pneumatics tools and frequent freight delivery

Powered equipment, like gas powered leaf blowers used for property maintenance is a common source of noise annoyance.

SOUND LEVELS GENERATED BY VARIOUS SOURCES OF NOISE

| Sound Level | dba |
|---|--------|
| Quiet library, soft whispers | 30 |
| Quiet room | 40 |
| Normal conversation | 60 |
| Air conditioner at 20 feet, sewing machine | 60 |
| Vacuum cleaner, hair dryer, noisy restaurant | 70 |
| Moderate traffic | 75 |
| Heavy Traffic | 85 |
| Subway, motorcycle, truck traffic, lawn mower | 90-100 |
| Garbage truck, pneumatic drill | 100 |
| Chain saw | 110 |
| Rock band concert in front of speakers, thunderclap | 120 |
| Emergency Response Siren, Jet takeoff | 120 |
| Jackhammer | 130 |
| Gunshot blast, Jet engine | 140 |
| Rocket launching pad | 180 |

Health Effects of Noise

Chronic exposure to elevated levels of community noise creates significant health risks. These health impacts of noise depend on the intensity of noise, on the duration of exposure, and the context of exposure.

Noise annoyance is defined as “a feeling of resentment, displeasure, discomfort, dissatisfaction, or offense when noise interferes with someone's thoughts, feelings, or actual activities”

Moderate levels of noise can limit or interfere with the ability to conduct daily tasks and activity — to have an ordinary conversation, enjoy a leisure activities, rest, sleep, concentrate or get tasks done.

Noise from moderate levels of road traffic impairs cognitive functioning in children, including attention, concentration, sound discrimination, memory, and reading ability. Some children exposed to moderate levels of road traffic noise develop deficits in reading ability and suffer lower school in school performance.

Noise interferes with sleep. Noise can make it difficult to fall asleep, and abrupt noises can cause awakenings, which the sleeper may not sense or recall. Even at levels below which awakening may occur, noise produces measurable physiological reactions, such as increase in heart rate and body movements and can cause disturbances of natural sleep patterns by causing shifts from deep to lighter stages. People affected by noise may get up "tired" or "not rested" in the morning.

Sleep disturbance can begin at relatively modest noise levels (40 dB). At the level of noise produced by a busy road, the proportion affected by sleep disturbance becomes significant. Average nighttime noise level of 65 dB will result in self-reported disturbance of sleep in about 15% percent of the population. A single noise event at 80 DB will result in awakenings in about a third of the population.

Noise is a biological stressor; it triggers autonomic chemical mechanisms for arousal and alertness. Consequentially, noise may cause or aggravate conditions related to chronic stress.

While evidence is not yet conclusive, exposure to higher levels road traffic noise is associated with higher a risk for myocardial infarction and exposure air traffic noise is associated with hypertension.

| Agency | Measure | Health Protective Threshold Value |
|---|------------------------------------|-----------------------------------|
| USEPA ^[1] (file:///C:/Users/BeckyS/Downloads/UrbanNoiseIssueBrief.docx#_ftn1) | L _{dn} , Indoors | 45 dbA |
| WHO | L _{eq} (16h), Outdoors | 55 dbA |
| WHO | L _{night} , Outdoor | 40 dbA |
| State of California | L _{dn} , Indoor | 45 dbA |

Definitions: L_{dn} = Day-night average sound level; L_{eq} = Equivalent Continuous Sound Level; L_{night} = Average nighttime noise level; dB = decibels; dbA = A-weighted decibels

Noise Regulation and Control

Noise is regulated at a national and local level.

At the national level, regulations limit the allowable sound levels produced by aircraft, railway and roadway vehicles and certain heavy equipment. For example, almost all aircraft in current operation must meet standards for runway takeoffs, landings, and sidelines, which depend on the aircraft's weight and its number of engines. US Federal Highway Standards limit the maximum allowable noise emission level for a new heavy-duty truck is 80 dbA at 50 feet from the centerline of traffic.

The number of people negatively affected by airport noise levels 65 dbA or higher has fallen in the U.S. and other places. However, noise may substantially increase for residents living near a newly planned airport.

Emissions standards have a number of shortcomings: emissions standards are not global for they are unavailable for many types of machines; and they may not apply to equipment already in use.

Furthermore, emissions standards do not address the problem of cumulative emissions. This means that while an individual vehicle may be quiet, the growth and spread of traffic of air, road, and rail traffic have offset vehicle-focused technological improvements.

For example, emissions standards for new highway and railway construction and operation typically allow small incremental increases in noise levels. Overtime, these permitted incremental increases become significant and health adverse.

Experience with noise regulation in developed do not demonstrate significant improvements in exposure to environmental noise especially road traffic noise.

State and local governments can apply ability to regulate land development to prevent noise-sensitive land uses from being located adjacent to noisy source and to ensure developments are planned, designed, and constructed to minimize noise impacts and protect occupants.

California requires each municipality and county to have a Noise Element of its General Plan, which includes as sound level contour maps to illustrate the pattern of sound levels fall

Some states and cities have stringent building codes for new homes, hotels, schools, and hospitals requiring acoustical analysis and insulation to protect building occupants from exterior noise sources and sound generated within the building itself.

Some cities have laws, which prohibit sound above a certain threshold level from trespassing over property line.

Some cities limit noisy activities such as the operation of domestic power tools or gasoline-powered lawn equipment in residential areas to certain times of the day.

Enforcement of all noise laws is variable and often subjective. Even where laws exist, municipalities may not have sufficient or trained noise enforcement personnel, the ability to monitor noise compliance, or the willingness to pursue enforcement actions against noise transgressors.

WHAT CITIES CAN DO

INCOMPATIBLE LAND USES

Businesses including markets, restaurants, bars, shops, and auto services can generate noise conflicts because of delivery vehicles, ventilation or refrigeration equipment, the use of powered machines and tools, and musical equipment.

Cities can implement zoning controls and other land use policies to limit or avoid the proximity of noisy and noise-sensitive uses.

CONSTRUCTION

Construction can be noisy because of heavy equipment such as pile drivers and bulldozers, as well as saws, jackhammers, and trucks, particularly when it occurs during evening and morning hours.

Cities can implement and enforce policies limiting the use of construction equipment at night.

Cities can require quiet equipment when construction occurs at night or near sensitive uses, such as hospitals.

TRAFFIC NOISE

Traffic is the single most important contributor to background noise levels in most urban areas.

Federal and State agencies limit how much the noise may be emitted by motor vehicle engines; however, no laws limit the number of vehicles on a street or the times they operate.

Trucks, buses, and trams are much louder than other vehicles.

Municipalities can purchase quieter public service and transit vehicles (e.g. electric and hybrid buses). They can also monitor and regulate private refuse service vehicles.

Vehicles that clean streets and collect refuse and recyclables, and compost often operate in the early morning hours.

Control of vehicle speed and maintenance of streets can limit general traffic noise.

Local regulations can limit the use of vehicle alarms and back up beepers .

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MACHINERY AND EQUIPMENT

Commercial and residential buildings have fixed mechanized and powered equipment for either operation of a business or for ventilation, air conditioning, refrigeration, transport, and other needs.

Cities can ensure machinery and equipment installed in new buildings are as quiet as possible.

Cities can implement and enforce noise standards for loud machinery and equipment and can restrict on the use, location, or timing of specific equipment or activities to protect health and sleep.

PROTECTION OF RESIDENTIAL INTERIORS

Noise in residential interiors can come from sources within the building such as other occupants or building systems, or from external sources such as traffic and nearby businesses.

Cities can adopt building standards to require quiet interiors (e.g. 55 dBA Day and 40dbA Night).

Cities can monitor and enforce noise standards in residential areas

Subsidize acoustical retrofits (e.g. double pane windows, mechanical ventilation) for existing residential buildings near traffic noise sources

ENTERTAINMENT

Amplified sound systems in bars, restaurants, and clubs generate significant noise.

Cities can permit and monitors entertainment venues requiring building insulation and limiting hours of operation.

Outdoor gatherings and events at stadiums and entertainment venues are often disruptive to surrounding neighborhoods.

Cities can permit and regulate outdoor public events to limit noise impacts.

Additional Resources and Readings

[US Noise Control Act \(http://www2.epa.gov/laws-regulations/summary-noise-control-act\)](http://www2.epa.gov/laws-regulations/summary-noise-control-act)

[WHO Regional Office for Europe \(http://www.euro.who.int/en/health-topics/environment-and-health/noise\)](http://www.euro.who.int/en/health-topics/environment-and-health/noise)

[European Environmental Agency \(http://www.eea.europa.eu/themes/noise/intro\)](http://www.eea.europa.eu/themes/noise/intro)

[WHO Guidelines on Community Noise \(http://www.who.int/docstore/peh/noise/guidelines2.html\)](http://www.who.int/docstore/peh/noise/guidelines2.html)

[Night Noise guidelines for Europe \(http://www.euro.who.int/en/health-topics/environment-and-health/noise/publications/2009/night-noise-guidelines-for-europe\)](http://www.euro.who.int/en/health-topics/environment-and-health/noise/publications/2009/night-noise-guidelines-for-europe)

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| REGIONS UK Noise Maps for England (http://services.defra.gov.uk/wps/portal/noise/!ut/p/c/04_SB8K8xLLM9MSSzPy8xBz9CGP0os3hnd0cPESMFAwMD42BTA093f1Nvk2ATAwNnA6B8JG55A2MCusNB9) |
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[\[1\] \(file:///C:/Users/BeckyS/Downloads/UrbanNoisesIssueBrief.docx#_ftnref1\)](#)
 USEPA. Noise Levels Identified as Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety. 1974

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