THE BARTLETT - INSTITUTE FOR ENVIRONMENTAL DESIGN AND ENGINEERING

UCL

# Soundscape – definizioni, raccolta dati ed analisi

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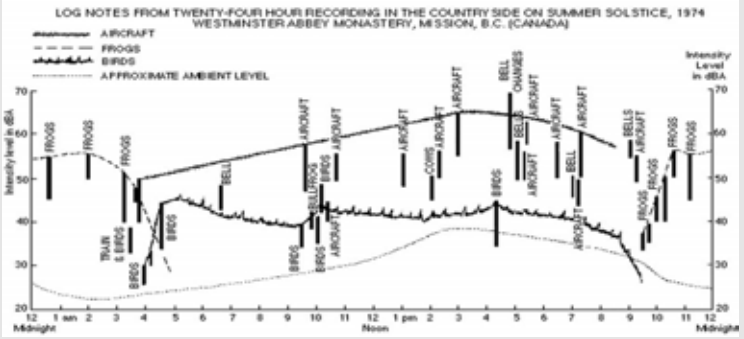
# BACKGROUND

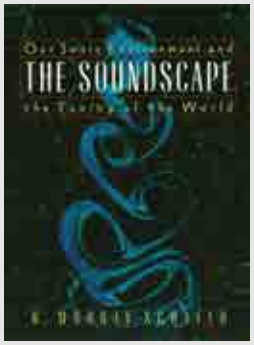
- 80m cittadini UE affetti da rumore ambientale (OMS).
- Costo sociale del rumore da traffico 0.2-2% PIL.
- Rumore principale causa di esposti/reclami
- Influenza su udito, parlato, qualitá del sonno, condizioni cardiovascolari, etc.

*tuttavia…*

- La riduzione dei livelli di rumore ambientale non é sempre praticabile o conveniente - né garantisce migliore qualitá della vita
- Il disturbo da rumore (noise annoyance) dipende solo in parte dal rumore in sé
- Approccio alternativo → Soundscape – *paesaggio sonoro*

# SOUNDSCAPE: ORIGINI DEL CONCETTO





Schafer, R. M. (1993). ***The soundscape: Our sonic environment and the tuning of the world***. Simon and Schuster.

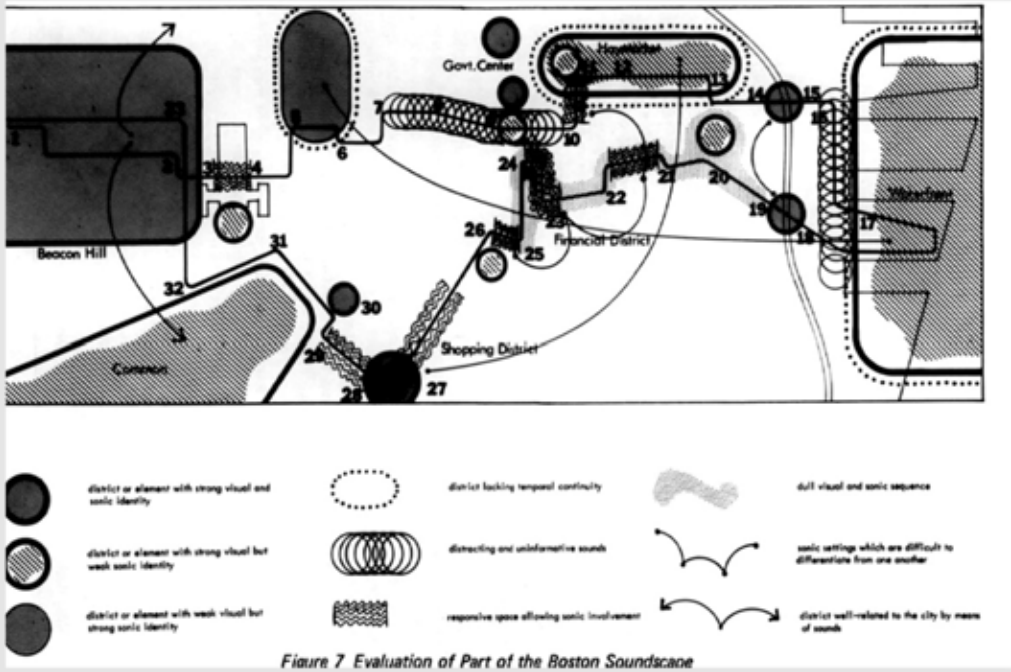
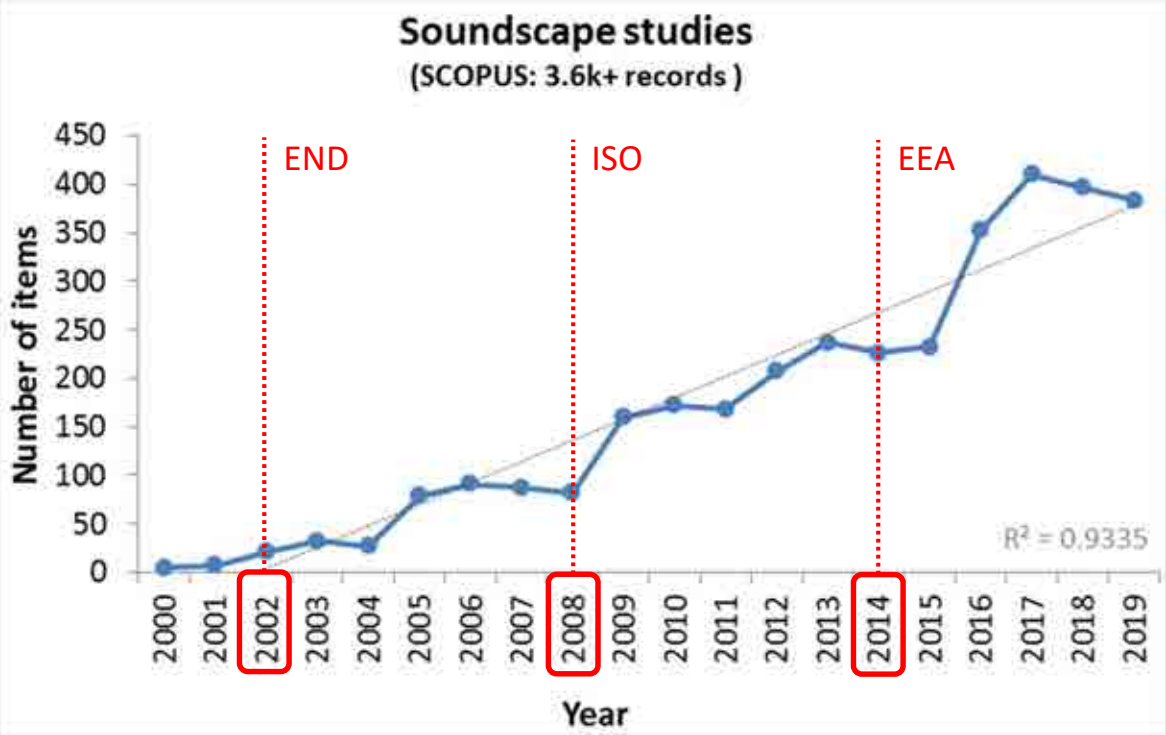



*Figure 7 Evaluation of Part of the Boston Soundscape*

Southworth, M. **The Sonic Environment of Cities**. (1969). Environment and Behavior, 1(1), 49–70. https://doi.org/10.1177/001391656900100104




**SCOPUS QUERY:** **TITLE-ABS-KEY(soundscape)** AND ( LIMIT-TO ( SUBJAREA,"PHYS" ) OR LIMIT-TO ( SUBJAREA,"ARTS" ) OR LIMIT-TO ( SUBJAREA,"SOCI" ) OR LIMIT-TO ( SUBJAREA,"COMP" ) OR LIMIT-TO ( SUBJAREA,"ENVI" ) OR LIMIT-TO ( SUBJAREA,"ENGI" ) OR LIMIT-TO ( SUBJAREA,"EART" ) OR LIMIT-TO ( SUBJAREA,"PSYC" ) OR LIMIT-TO ( SUBJAREA,"MULT" ) OR LIMIT-TO ( SUBJAREA,"NEUR" ) OR LIMIT-TO ( SUBJAREA,"ENER" ) OR LIMIT-TO ( SUBJAREA,"BUSI" ) OR LIMIT-TO ( SUBJAREA,"DECI" ) OR LIMIT-TO ( SUBJAREA,"HEAL" ) OR LIMIT-TO ( SUBJAREA,"NURS" ) OR LIMIT-TO ( SUBJAREA,"ECON" ) ) AND ( LIMIT-TO ( **PUBYEAR,2000-2020**)

# SOUNDSCAPE: STANDARDIZZAZIONE

ISO 12913-1:2014 Acoustics – Soundscape – Part 1: **Definition and conceptual framework**

UNI ISO 12913-1:2015 Acustica – Paesaggio sonoro – Parte 1: **Definizione e impostazione concettuale**

ISO/DIS 12913-2 Acoustics – Soundscape – Part 2: **Data collection and reporting requirements**

ISO/TS 12913-2:2018 Acoustics – Soundscape – Part 2: **Data collection and reporting requirements**

ISO/TS 12913-3:2019 Acoustics – Soundscape – Part 3: **Data analysis**

ISO/TS 12913-4:xxxx Acoustics – Soundscape – Part 4: Soundscape Design Interventions **(?)**


ISO/TC 43/SC 1/WG 54 Perceptual assessment of soundscape quality

# ISO 12913-1:2014 - definizioni

**Soundscape** (paesaggio sonoro) "[…] *un ambiente sonoro come* ***percepito*** *e vissuto e/o compreso da una persona o un gruppo, nel contesto*" (ISO, 2014/UNI, 2015)

SOUNDSCAPE ≠ AMBIENTE SONORO

Ambiente sonoro = **fenomeno fisico** | Soundscape (paesaggio sonoro) = **costrutto percettivo**

Ambiente sonoro → **PERCEZIONE**→ Soundscape

# ISO 12913-1:2014 - definizioni

Il **contesto** include le interrelazioni tra persone, attivitá, e luogo, nel tempo e nello spazio.

# ISO 12913-1:2014 - definizioni

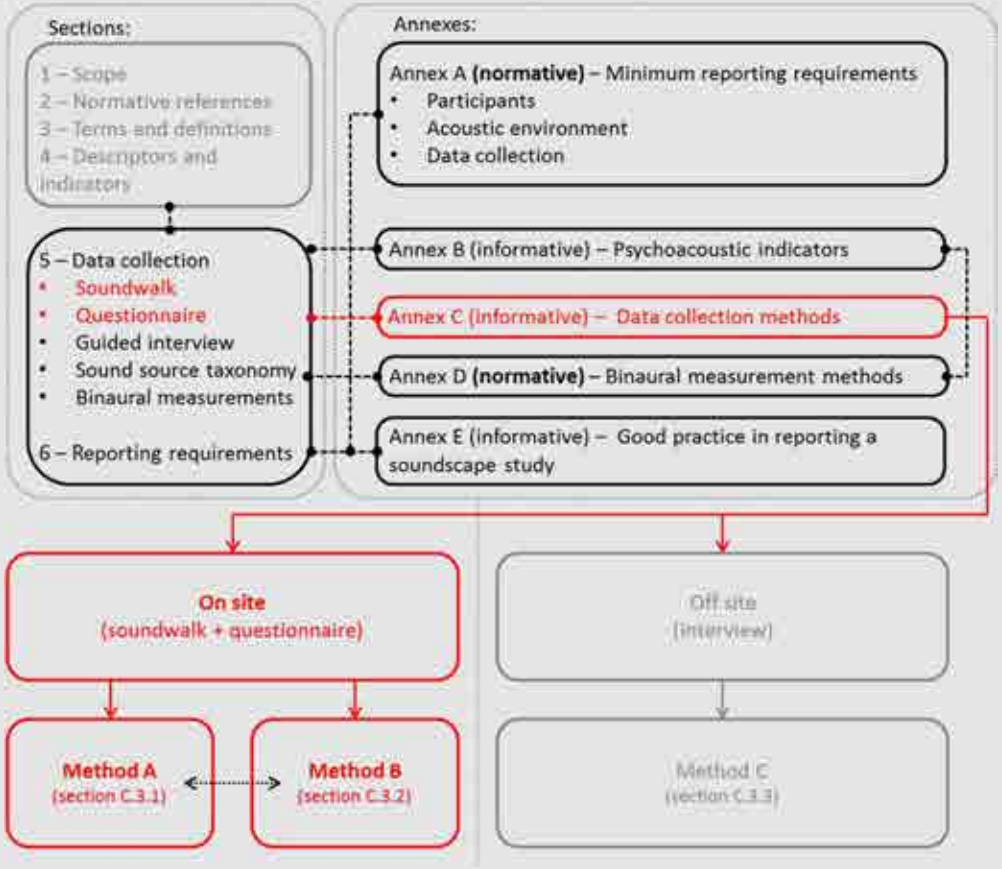
**Outcome** (ésito): conseguenza generale di medio- o lungo-termine facilitate dall'ambiente sonoro

Different outcomes which might determine preference for the soundscape in different places and contexts. Most are examples of *direct outcomes*; those in italics examples of *indirect* or *enabled outcomes*.

| | | |
|---|---|---|
| Acceptability | Identification of place | Relaxation |
| Appropriateness | Importance | Safety |
| Clarity | Information | Satisfaction |
| Comfort | Liveliness | Sense of control |
| *Communication* | Naturalness | Solitude |
| Enjoyment | *Nature appreciation* | Tranquility |
| Excitement | Nostalgic attachment | Uniqueness |
| Happiness | Peacefulness | Variety |
| Harmony | Place attachment | Well-being |

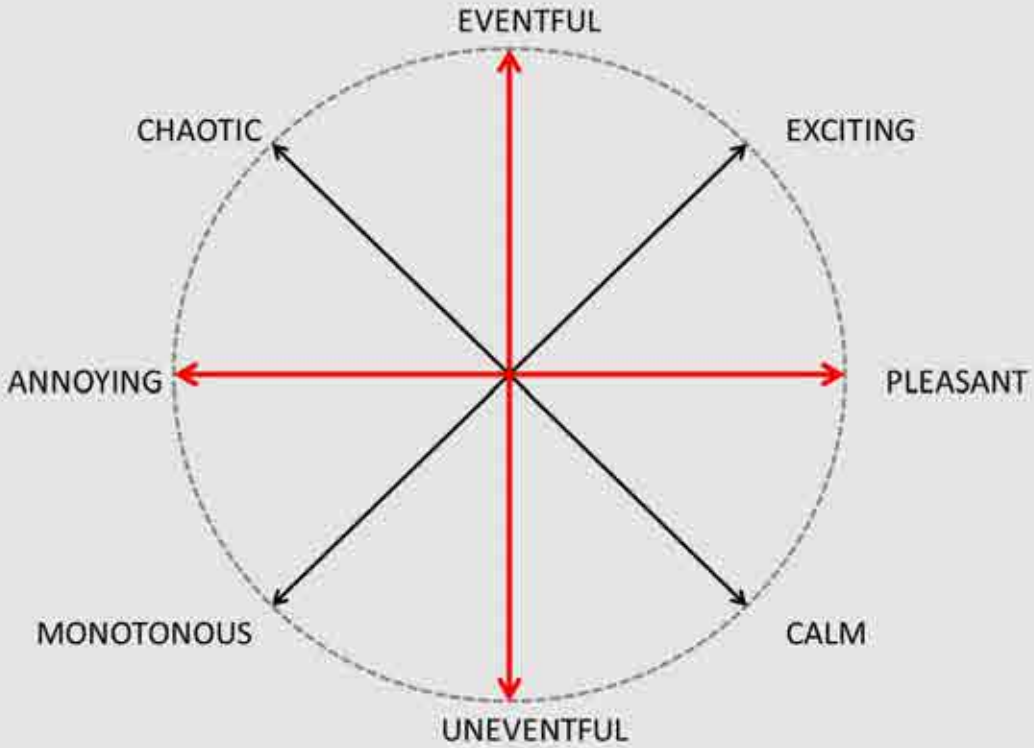
Brown, A. L., Kang, J., & Gjestland, T. (2011). Towards standardization in soundscape preference assessment. *Applied Acoustics*, *72*(6), 387-392.

# ISO/TS 12913-2:2018 – raccolta dati



# ISO/TS 12913-2:2018 (Metodo A) – raccolta dati

# ISO/TS 12913-2:2018 (Metodo A) – [modello teorico]




Axelsson, Ö., Nilsson, M. E., & Berglund, B. (2010). **A principal components model of soundscape perception**. The Journal of the Acoustical Society of America, 128(5), 2836-2846.

# ISO/TS 12913-2:2018 – questioni aperte: traduzione

## Soundscape Attributes Translation Project [SATP]

| English | eventful | vibrant | pleasant | calm | uneventful | monotonous | annoying | chaotic |
|---|---|---|---|---|---|---|---|---|
| Italian | dinamico / vario | vivace/ stimolante | piacevole / confortevole | calmo / tranquillo | stabile / stazionario | monotono / noioso | spiacevole / irritante | caotico / confuso |
| Japanese | 活気がある / 色々なことが起こる (kakki-ga-aru / iroirona-koto ga okoru) | 楽しい (tanoshii) | 快い (kokoro-yoi) | 穏やかな (odayaka-na) | 何も起こらない (nani-mo okoranai) | 単調な (tancho-na) | うるさい (urusai) | 雑然とした (zatsuzen-to-sita) |
| Korean | 활동적인 / 역동적인 (hwaldongjeog-in / yeogdongjeog-in) | 활기찬 / 생동한 (hwalgichan / saengdonghan) | 유쾌한 / 기분 좋은 (yukwaehan / gibun joh-eun) | 조용한 / 차분한 (joyonghan / chabunhan) | 비활동적인 / 정적인 (bihwaldongjeog-in / jeongjeog-in) | 단조로운 / 지루한 (danjoloun / jiluhan) | 불쾌한 / 성가신 (bulkwaehan / seong-gasin) | 혼란스러운 / 혼잡한 (honlanseuleoun / honjabhan) |
| Malay | meriah | rancak | menyenangkan | tenang | tidak meriah | membosankan | membingitkan | huru-hara |
| Spanish | con actividad / dinámico | estimulante / vibrante | agradable / placentero | calmado / tranquilo | sin actividad / estático | monótono / aburrido | desagradable / molesto | caótico / confuso |
| Swedish | händelserikt / livligt / aktivt | levande / spännande / uttrycksfullt | behagligt / trivsamt / tilltalande | lugnt / stilla / rogivande | händelselöst / inaktivt / passivt | enformigt / andefattigt / livlöst | störande / obehagligt / otrivsamt | kaotiskt / rörigt / bullrigt |
| Turkish | hareketli | heyecan verici | keyifli | dingin | durağan | sıradan | keyifsiz | kargaşalı |
| Vietnamese | sôi động / sinh động | sống động / náo nhiệt | dễ chịu / thoải mái | yên bình / tĩnh mịch | tẻ nhạt / nhàm chán | đơn điệu / buồn tẻ | khó chịu / phiền toái | hỗn loạn / hỗn độn |

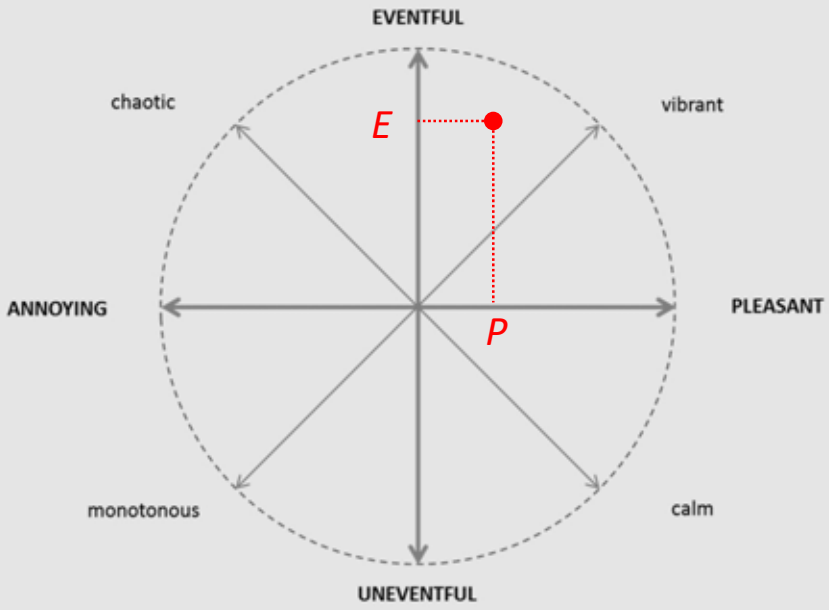
Aletta, F., Oberman, T., Axelsson, Ö., Xie, H., Zhang, Y., Lau, S. K., ... & Kang, J. (2020, October). **Soundscape assessment: Towards a validated translation of perceptual attributes in different languages**. In *INTER-NOISE and NOISE-CON Congress and Conference Proceedings* (Vol. 261, No. 3, pp. 3137-3146). Institute of Noise Control Engineering.

# ISO/TS 12913-2:2018 (Metodo B) – raccolta dati

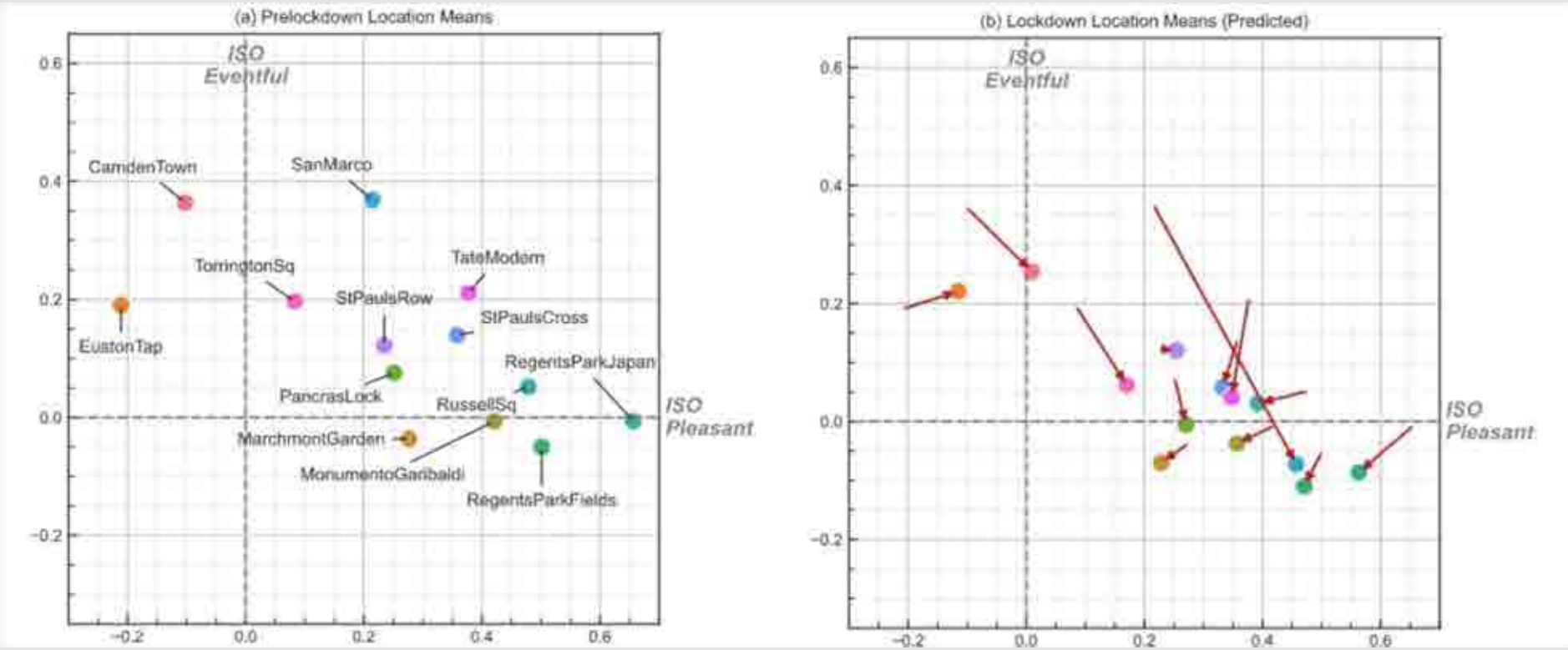
# ISO/TS 12913-2:2018 (Metodo C) – raccolta dati

# ISO/TS 12913-3:2019 – analisi

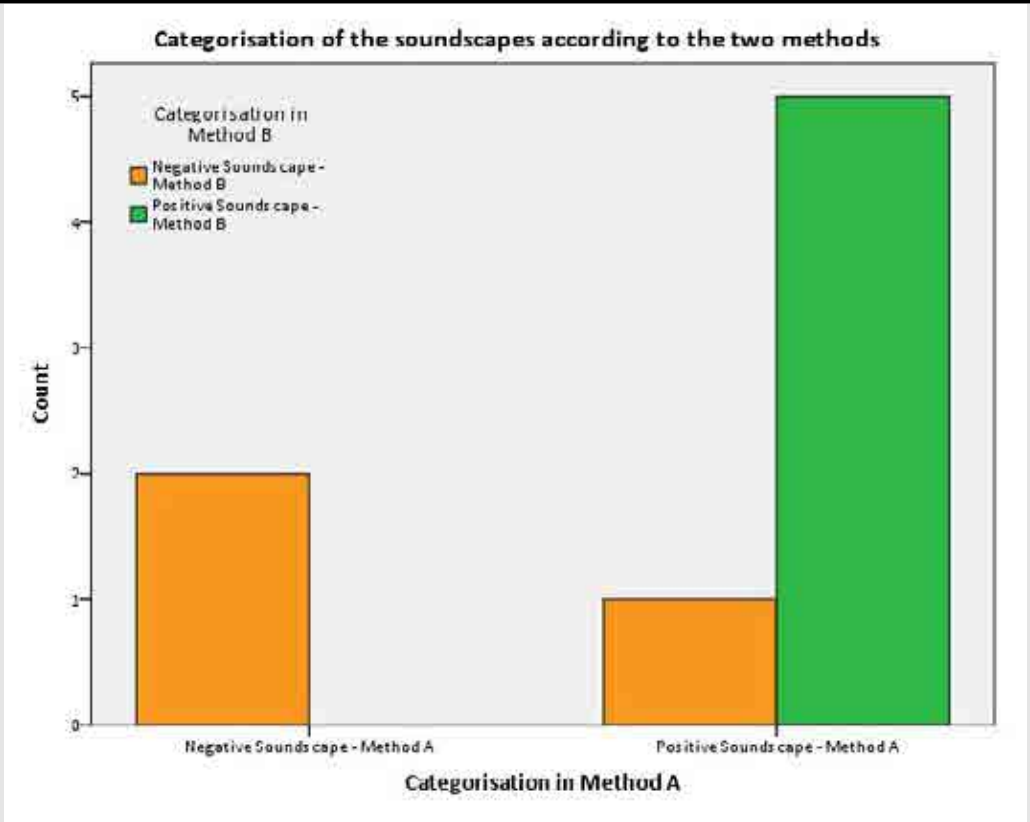
# ISO/TS 12913-3:2019 – analisi

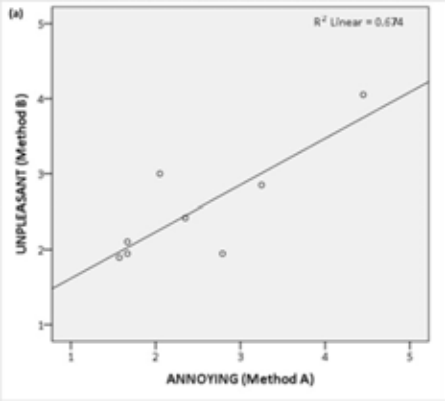


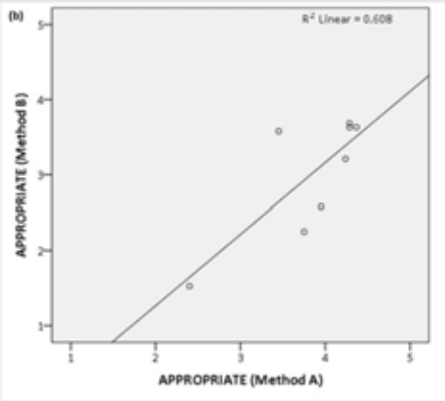
# ISO/TS 12913-3:2019 – analisi



# ISO/TS 12913-2:2018 – confronto?

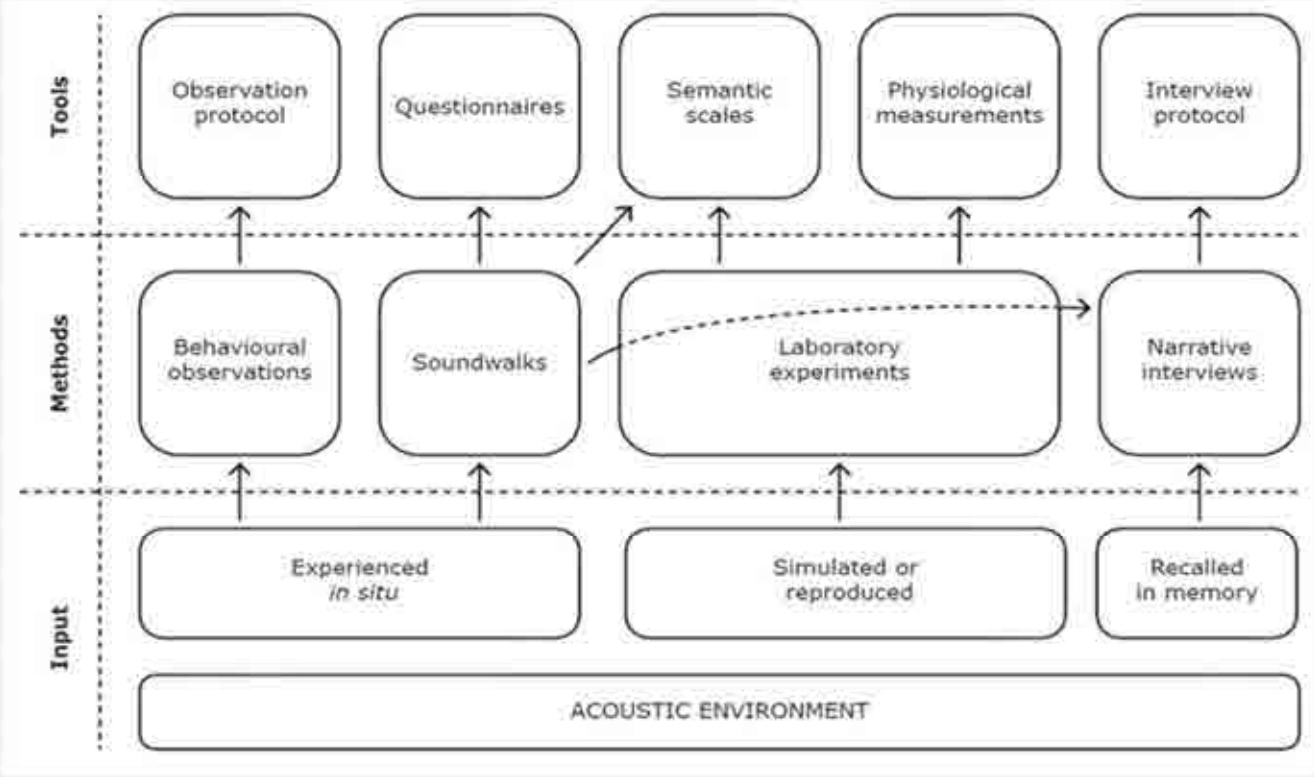



Aletta, F., Guattari, C., Evangelisti, L., Asdrubali, F., Oberman, T., & Kang, J. (2019). **Exploring the compatibility of "Method A" and "Method B" data collection protocols reported in the ISO/TS 12913-2: 2018 for urban soundscape via a soundwalk**. Applied Acoustics, 155, 190-203.

# OLTRE LA ISO?



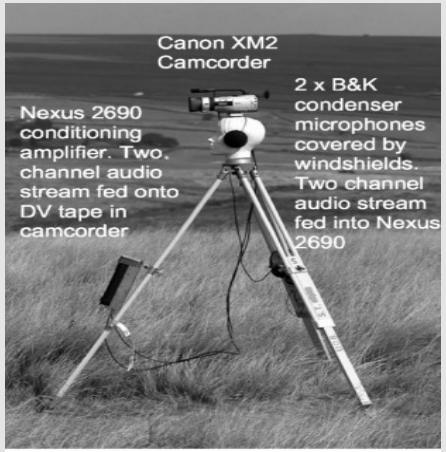

Aletta, F., Kang, J., & Axelsson, Ö. (2016). **Soundscape descriptors and a conceptual framework for developing predictive soundscape models**. Landscape and Urban Planning, 149, 65-74.

# MODELLI PREVISIONALI

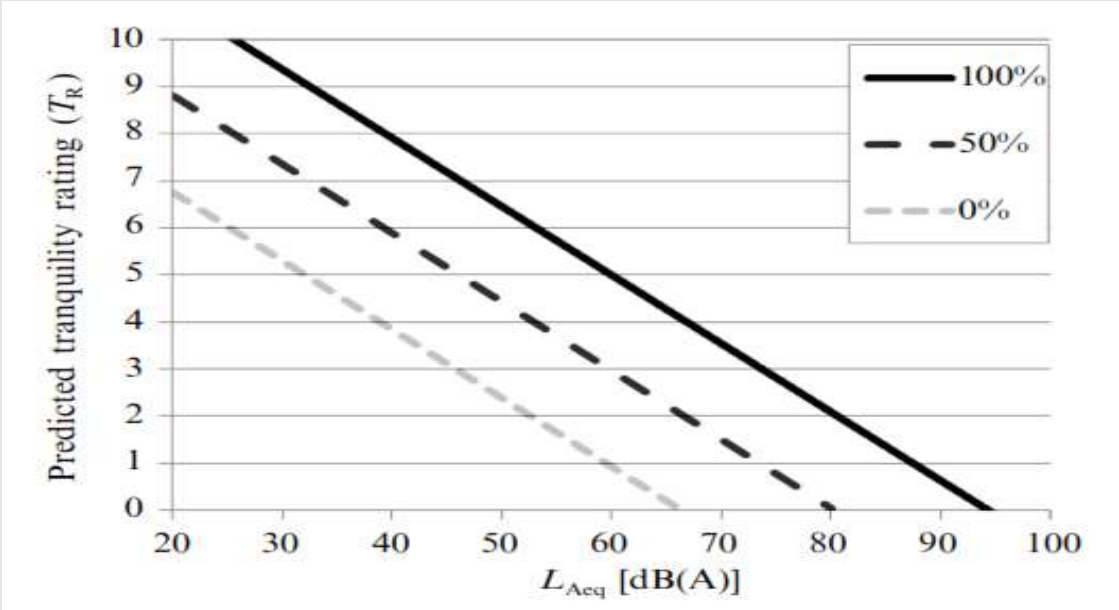
| LINEAR MODELS | |
|---|---|
| REFERENCE | EQUATION |
| Pheasant et al., 2008 [46] | $Tranquillity = 13.93 - 0.165L_{Amax} + 0.027NF$ |
| Pheasant et al., 2008 [46] | $Tranquillity = 8.57 - 0.11L_{Aeq} + 0.036NF$ |
| Pheasant et al., 2010 [47] | $Tranquillity = 9.68 - 0.146L_{Aeq} + 0.041NFC$ |
| Tse et al., 2012 [40] | Long formula available in the original manuscript |
| Watts et al., 2013 [48] | $Tranquillity = 10.55 - 0.146L_{Aeq} + 0.41NFC + Mf$ |
| Brambilla et al., 2013 [49] | $rChaotic - Calm = 10.537 - 0.129L_{Aeq} - 3.435R + 2.105S + 0.03(A/H)$ |
| Ricciardi et al., 2015 [21] | $SoundQuality = 4.48 - 0.27OL + 0.12V + 0.52VA - 0.12T$ |
| Ricciardi et al., 2015 [21] | $SoundQuality = 8.11 - 0.38OL + 0.20V + 0.15B - 0.15T$ |
| Ricciardi et al., 2015 [21] | $SoundQuality = 19.08 - 0.19L_{50} - 0.06(L_{10} - L_{90})$ |
| Hong and Jeon, 2015 [28] | Long formula available in the original manuscript |
| Lavandier et al., 2016 [41] | $SoundPleasantness = 8.71 - 0.74OL + 0.33V + 0.18B$ |
| Fan et al., 2016 [50] | $Valence = 0.231 - 0.433N - 0.937S_{std} + 0.808MFCC5_{std} + 0.626MFCC18 - 2.046MFCC32 + 0.732MFCC23$ |
| Fan et al., 2016 [50] | $Arousal = -1.441 - 0.317N + 0.556N_{std} + 4.064e-10Sroll + 4.296MFCC26_{std} + 0.64MFCC5_{std} - 0.038MFCC2 - 0.604MFCC28$ |
| Herranz-Pascual et al., 2016 [55] | N/A |
| Çakır Aydın and Yilmaz, 2016 [51] | $SoundQualityIndex = 7.2935 - 0.05851N - 0.3723R - 0.7792S$ |
| Lindborg and Friberg, 2016 [54] | $Pleasant = 0.893Type - 0.393N_{10} + 0.005Extraversion - 0.046Agreeableness + 0.037Conscientiousness - 0.111EmotionalStab - 0.053Openness$ |
| Lindborg and Friberg, 2016 [54] | $Eventful = 0.842Type + 0.325N_{10} + 0.112Extraversion - 0.065Agreeableness + 0.044Conscientiousness - 0.112EmotionalStab - 0.005Openness$ |
| Puyana Romero et al., 2016 [42] | $S.Quality = 0.166L_{Aeq} - 0.033R - 0.207L_{A50} - 0.086N_5 + 0.027SM\_Sea + 0.037SM\_Fountain + 0.045SM\_Singular - 0.027SM\_Garden + 0.048SM\_Traffic$ |
| Hong and Jeon, 2017 [56] | Spatially lagged and geographically weighted regressions available in the original manuscript |
| Aumond et al., 2017 [44] | $Pleasantness = 9.70 - 0.47OL - 0.21T + 0.12V + 0.09B$ |
| Aumond et al., 2017 [44] | $Pleasantness = 16.48 - 0.25L_{50,LOW} - 15.82TSFD_{500Hz} + 16.82TSD_{500Hz}$ |
| Kang et al., 2018 [45] | $Pleasant = -0.577T + 0.252NS$ |
| Kang et al., 2018 [45] | $Annoying = 0.64T - 0.144NS$ |
| Kang et al., 2018 [45] | $Chaotic = 0.437T + 0.223OT - 0.152NS$ |
| Kang et al., 2018 [45] | $Calm = -0.582T + 0.24NS - 0.110T$ |
| Boes et al., 2018 [32] | $Sound\ Quality = 6.65 + 0.2739NS - 0.1726\ MS$ |
| Aletta and Kang, 2018 [53] | $Vibrancy = 0.682R + 0.436PEOPLE + 0.383Fb - 0.579N + 0.272MUSIC$ |

Lionello, M., Aletta, F., & Kang, J. (2020). **A systematic review of prediction models for the experience of urban soundscapes**. *Applied Acoustics*, *170*, 107479.

# ESEMPIO: TRANQUILLITY PREDICTION TOOL




$$T_R = 9.68 + 0.041 N_{CF} - 0.146 L_{Aeq} + M_F$$




Pheasant, R. J., Watts, G. R., & Horoshenkov, K. V. (2009). **Validation of a tranquillity rating prediction tool**. Acta Acustica united with Acustica, 95(6), 1024-1031.

Quali prioritá per la ricerca nell’ambito del paesaggio sonoro?

Interviewee #4

*In my opinion, we still need to develop empirically well-founded models on soundscape perception and its contextual factors. This primarily includes the understanding of human activities, behaviors, and associated attention processes. Based on that, we need to create novel ideas to improve soundscapes while taking into account residents' and users' perspectives. Here, a challenge is and will be to work together in transdisciplinary teams of soundscape experts and establish a common language when speaking about sound. Lastly, we need to reach broader audiences who make key decisions on urban environments and who can support us in carrying out soundscape interventions and in conducting large-scale participatory and observatory studies.*

(*Jochen Steffens*—Technische Universität Berlin, Germany)

Aletta, F., & Xiao, J. (2018). **What are the current priorities and challenges for (urban) soundscape research?.** *Challenges*, *9*(1), 16.

# TEMI RICORRENTI

| Theme | Sub-Themes | Perceived Priorities (Challenges) |
|---|---|---|
| Academia–Practice gap | • Normative context<br>• Design and planning guidelines<br>• Education and training for soundscape professionals | To bridge soundscape research and practice (architecture, urban planning, landscape design, etc.) |
| Applicability of the soundscape framework | • Indoor environments<br>• Quiet areas<br>• Scale of intervention<br>• Common language to communicate<br>• Techniques for representation<br>• Operational tools (methods) | To explore how to adapt the current (urban) soundscape frameworks for other contexts/disciplines. |
| Multisensory interactions in soundscapes | • Sound-visual<br>• Sound-smell<br>• Sound-haptic | To identify impacts of other sensory inputs for soundscape appraisal. |
| Relationships between soundscape and behaviour | • Antisocial behaviours<br>• Use of spaces<br>• Crowd's movements/flows | To understand how people react to different types of sounds, behaviourally and psychologically, in specific contexts. |
| Technology for soundscapes | • Sensors and apps<br>• Virtual/Augmented Reality tools<br>• Data archives and platforms<br>• Repositories of soundscape studies/interventions | To analyse data collected from emerging technologies, archives and platforms in an ecologically valid way. |

# CONCLUSIONI

- Il corpus di letteratura sul paesaggio sonoro é in aumento: crescita stabile negli ultimi 20 anni
- Il processo di standardizzazione in Corso ha contribuito allo sviluppo della disciplina ma rimangono nodi non risolti.
- I modelli previsionali (con nuovi indicatori e descrittori) sono necessary per l'approccio al paesaggio sonoro quale strategia progettuale di maggiore impatto sull'ambiente costruito.

## Thank you

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