Soundscape indicators and mapping

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Outline

Soundscape indicators | descriptors | indices

Towards soundscape indices

Soundscape mapping
Soundscape descriptors
*measures of how people perceive* the acoustic environment

Soundscape indicators
*measures used to predict* the value of a soundscape descriptor

**Soundscape INDICES**
*single-value scales* derived from either indicators or descriptors that allow for comparisons across soundscapes

e.g., Sound level (L) measured in dB is an indicator of perceived loudness (Ψ)

\[ Ψ = \frac{2^L}{10} \]
Soundscape indicators and descriptors: a review of the literature

<table>
<thead>
<tr>
<th>Descriptor Category</th>
<th>Descriptor(s)</th>
<th>Indicator(s)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise annoyance</td>
<td>Unbiased Annoyance</td>
<td>Loudness, sharpness and fluctuation strength</td>
<td>Zwicker (1991)</td>
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<tr>
<td>Noise annoyance</td>
<td></td>
<td>Loudness intrusiveness, sharpness and distortion of informational content</td>
<td>Preis (1997)</td>
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<tr>
<td>Evaluation index</td>
<td></td>
<td>Loudness, sharpness, roughness, impulsiveness and relative approach</td>
<td>Fiebig et al. (2009)</td>
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<tr>
<td>Pleasantness</td>
<td>Pleasantness of noise</td>
<td>Loudness, sharpness, roughness and tonality</td>
<td>Terhardt and Stoll (1981)</td>
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<tr>
<td></td>
<td>Unpleasantness of sound</td>
<td>Sound levels and the relative duration of categories of sound sources</td>
<td>Lavandier and Defréville (2006)</td>
</tr>
<tr>
<td>Quietness or tranquility</td>
<td>Perceived Quietness</td>
<td>Slope</td>
<td>Memoli and Licitra (2005)</td>
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<tr>
<td></td>
<td>Tranquillity</td>
<td>Sound levels and the percentage of natural features in a scene</td>
<td>Pheasant, Horoshenkov, Watts (2008)</td>
</tr>
<tr>
<td>Perceived affective quality</td>
<td>Pleasant, Unpleasant, Evenful, Uneventful, Calm, Monotonous, Exciting, Chaotic</td>
<td>ongoing or not investigated</td>
<td>Axelsson et al. (2010)</td>
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<td></td>
<td>Calm, Vibrant</td>
<td>ongoing or not investigated</td>
<td>Cain et al. (2013)</td>
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<td></td>
<td>Cacophony, Hubbub and Constant, Temporal</td>
<td>ongoing or not investigated</td>
<td>Davies et al. (2013)</td>
</tr>
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<td></td>
<td>Restorativeness</td>
<td>ongoing or not investigated</td>
<td>Payne (2013)</td>
</tr>
<tr>
<td>Soundscape quality</td>
<td>Environmental Sound Experience Indicator</td>
<td>unrevealed</td>
<td>Garcia Perez et al. (2012)</td>
</tr>
<tr>
<td></td>
<td>Sound Quality</td>
<td>$L_{50}$ and $L_{10}–L_{90}$</td>
<td>Ricciardi et al. (2015)</td>
</tr>
<tr>
<td></td>
<td>Appropriateness</td>
<td>ongoing or not investigated</td>
<td>Axelsson (2015)</td>
</tr>
</tbody>
</table>
How can we develop new predictive models?

Collecting soundscape data
[descriptors]

Characterising (acoustic) environment
[indicators]

Modelling
[indices]
Collecting soundscape data
Two indicators-descriptors models examples: **tranquillity** and **vibrancy**

Axelsson *et al.* (2010)
Cain *et al.* (2013)
Tranquillity model

\[ T_R = 9.68 + 0.041N_{CF} - 0.146L_{Aeq} + M_F \]

Pheasant, et al. (2008; 2010, inter alia)
# Vibrancy model

<table>
<thead>
<tr>
<th>Predictor</th>
<th>R² Change</th>
<th>Coefficient (β)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>0.39</td>
<td>0.682</td>
</tr>
<tr>
<td>PEOPLE</td>
<td>0.15</td>
<td>0.436</td>
</tr>
<tr>
<td>Fls</td>
<td>0.07</td>
<td>0.383</td>
</tr>
<tr>
<td>N</td>
<td>0.09</td>
<td>-0.579</td>
</tr>
<tr>
<td>MUSIC</td>
<td>0.06</td>
<td>0.272</td>
</tr>
</tbody>
</table>

Aletta & Kang (2018)
Towards soundscape indices

ERC ADVANCED GRANT @UCL: “Soundscape Indices” (SSID)
2018-2013
Conceptual framework for the modelling and development of soundscape indices

- **Physiological/Biological**
- **Psychological**
- **Physical/Psychoacoustical**
- **Contextual**

**Artificial Neural Network (ANN)**

**Regression Models**

**Descriptors**
- e.g., calmness, vibrancy...
- e.g., slope, $1/f$...

**Fuzzy Logic**

**Indices**
- Single Soundscape index, $i$
- Set of Soundscape indices, $j, k, l$...
Steps towards “soundscape indices”

• To characterise soundscapes;
• To determine key indicators and their influence on soundscape quality;
• To develop, test and validate soundscape indices;
• To demonstrate the applicability in sound environment management.
Field survey protocol

[APPENDIX C] QUESTIONNAIRE

To what extent do you presently hear the following four types of sounds?

SSI01 – Traffic noise (e.g., cars, buses, trains, airplanes)  
[1 – 5] [Not at all; A little, Moderately; A lot; Dominates completely]

SSI02 – Other noise (e.g., sirens, construction, industry, loading of goods)  
[1 – 5] [Not at all; A little, Moderately; A lot; Dominates completely]

SSI03 – Sounds from human beings (e.g., conversation, laughter, children at play, footsteps)  
[1 – 5] [Not at all; A little, Moderately; A lot; Dominates completely]

SSI04 – Natural sounds (e.g., singing birds, flowing water, wind in vegetation)  
[1 – 5] [Not at all; A little, Moderately; A lot; Dominates completely]

For each of the 8 scales below, to what extent do you agree or disagree that the present surrounding sound environment is...

PAQ01 – Pleasant  
[1 – 5] [Strongly agree; Agree; Neither agree, nor disagree; Disagree; Strongly disagree]

PAQ02 – Chaotic  
[1 – 5] [Strongly agree; Agree; Neither agree, nor disagree; Disagree; Strongly disagree]

PAQ03 – Vibrant  
[1 – 5] [Strongly agree; Agree; Neither agree, nor disagree; Disagree; Strongly disagree]

PAQ04 – Uneventful  
[1 – 5] [Strongly agree; Agree; Neither agree, nor disagree; Disagree; Strongly disagree]

PAQ05 – Calm  
[1 – 5] [Strongly agree; Agree; Neither agree, nor disagree; Disagree; Strongly disagree]

PAQ06 – Annoying  
[1 – 5] [Strongly agree; Agree; Neither agree, nor disagree; Disagree; Strongly disagree]

PAQ07 – Eventful  
[1 – 5] [Strongly agree; Agree; Neither agree, nor disagree; Disagree; Strongly disagree]

PAQ08 – Monotonous  
[1 – 5] [Strongly agree; Agree; Neither agree, nor disagree; Disagree; Strongly disagree]
Field survey locations

SSID team conducting a survey @ Byng Place, London (UK)

SSID team conducting a survey @ Piazza San Marco, Venice (IT)

Harbin University team conducting a survey @ Sidalin Sq, Harbin (CHN)

Harbin University team conducting recordings @ Harbin Campus, Harbin (CHN)
Auralisation lab

Prefabricated room that will feature a 12 speaker array for Ambisonics reproduction

@UCL Here East
Soundscape mapping

Noise mapping applied to “wanted” sounds

Sound sources perceived dominance maps

Perceived loudness of birdsong (Liu et al. 2013)

Soundscape mapping based on ANN

Psychoacoustic noise maps of public space “Nauener Platz” in Berlin. Schematic distribution of loudness (a), sharpness (b) and roughness (c) over the investigated area (Genuit, Schulte-Fortkamp and Fiebig, 2008).

Simplified mind map of public space “Nauener Platz” in Berlin. The numbers represent particular relevant locations indicated by residents in soundwalks. The terms represent core categories, which will have to guide the development of design of the investigated area.
Perceptual maps

Sensory maps relying on social media data

Concluding remarks

• Much work done in soundscape indicators and descriptors (need for a coherent framework)

• Need for developing soundscape index (operational tools)

• Feasibility of various soundscape mapping techniques (depending on scope and scale)
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