Social Inequalities of Objective and Subjective Environmental Threats: (Replicative) Results of two Surveys with Georeferenced Respondent Data

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San Servolo, 22.11.2017
Outline

1. Environmental Justice Research and Research Gap
2. Design of the Studies
3. Results
4. Discussion
Outline

1. Environmental Justice Research and Research Gap
2. Design of the Studies
3. Results
4. Discussion
Environmental Justice: Theoretical Concept

General conjecture:
- the socially disadvantaged additionally have a higher burden in environmental risks.

Explanatory approach: rational choices in the housing market
- Preferences in the housing market (location, equipment, environmental quality) determine the rent and buying prize
  ➔ High-status people tend to leave areas with a low environmental quality
  ➔ …and have better opportunities to move into an area with good environmental quality
= Segregation
Noise exposure ≠ noise annoyance

Only 1/3 of noise annoyance results from acoustic characteristics of noise (Marquis-Favre/Aubrée/Vallett 2005).

e.g. noise sensibility, attitudes towards the source of noise or the perceived control over the situation are coping resources that determine the degree of noise annoyance.

Assumptions concerning social status and noise annoyance (Fyhri/Klaeboe 2006):

- Well educated and high earning people have more coping resources (−)
- Stating a high noise annoyance can be considered as a coping strategy (+)

Studies point out a positive effect of social status on noise annoyance (Meyer 2012).
Environmental Justice: State of Research

- **Research in the USA:**
  - Several studies of the late 20th century show that hazardous waste landfills are significantly more often located in communities with a high proportion of black citizens (e.g. Brown 1995, Mohai/Saha 2015)

- **Research in German speaking countries:**
  - Mostly epidemiological studies which show that high earners, highly educated people and German (resp. Swiss) citizens are less exposed to environmental risks such as air and noise pollution (Mielck 2004; Stronegger/Freidl 2004; Bolte et al. 2004).
  - These studies are mainly based on subjective statements on exposure to street traffic and air pollution, use bivariate analyses and only refer to a subset of the population (such as children or specific areas).
  - Recent studies with objective environmental data and more advanced analysis methods reveal only a small positive effect for income and (German resp. Swiss) citizenship (Diekmann/Meyer 2010; Meyer 2011, Lakes/Brückner/Krämer 2014).

- **Contradictory findings in some recent studies for France and Italy** (Padilla et al. 2014; Forastiere et al. 2007).
Conclusion

While theory and empirical research in the USA indicate a correlation between social status and environmental risk exposure, studies confirming this relationship in Germany are missing.

Hence in this presentation two questions are addressed:

1. Do citizens with a low social status or a migration background have a higher risk of objective noise exposure?

2. Do citizens with a low social status or a migration background report a lower noise annoyance when controlling for objective noise?
Analysis Approach

- Our perspective is a local context – the City of Mainz.

- Main survey: DFG project “Environmental Justice: Social Distribution, Justice Evaluations and Acceptance Levels of Unfavorable Local Environmental Conditions”

- Replication survey: teaching project.

- In our analyses, we will first focus on the (main) DFG survey and then cursory ask if results are replicable with the second survey.
Outline

1. Environmental Justice Research and Research Gap
2. Design of the Studies
3. Results
4. Discussion
### Study Design

- **Two postal surveys in the City of Mainz, autumn 2016.**

<table>
<thead>
<tr>
<th></th>
<th>Survey 1</th>
<th>Survey 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Background</strong></td>
<td>DFG project „Environmental Justice“</td>
<td>Teaching project, University of Mainz</td>
</tr>
<tr>
<td><strong>Sample</strong></td>
<td>Random sample of the population aged 18 to 70 in Mainz, official population register</td>
<td>Geographic street section sample (Bauer 2014)</td>
</tr>
<tr>
<td><strong>Response rate</strong></td>
<td>45 % (COOP 2)</td>
<td>29 % (COOP 2)</td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>1802</td>
<td>580</td>
</tr>
<tr>
<td><strong>Analysis</strong></td>
<td>CCA</td>
<td>CCA, design weight</td>
</tr>
<tr>
<td><strong>n</strong></td>
<td>1455</td>
<td>461</td>
</tr>
</tbody>
</table>
Geo-Referenced Survey Data

- Survey 1 (DFG): Geocoding of the respondents' addresses.
Geo-Referenced Survey Data

- Survey 2 (teaching project): Street section sample
- Geo-referencing at street section-level, less exact than in survey 1.
Dependent Variables

- Objective and subjective indicators for aircraft noise and street traffic noise.

- Objective noise exposure:
  - Source: public authorities (street traffic), NGO „Umwelthaus“ (aircraft).
  - Calculated average noise level for each coordinate on the map of Mainz. Models are based on parameters like traffic intensity, velocity, nature of the road, distance to the street, number of flights and aircraft type, and sound reducing obstacles.
  - Mean of 24h.

- Subjective noise annoyance:
  - “How annoyed are you [by day, at night] by the following noise sources?”
  - Mean index of day/night.

- All indicators are standardized with mean 0 and SD 1 for analysis.
Independent Variables

- Social status / migration characteristics:
  - Academic education (1 = yes)
  - Home owner (as a proxy for income)
  - Migration background (1 = no German nationality or not born in Germany)

- Other:
  - Age
  - Gender
  - House type (apartment house, row house, detached house)
  - Daily time spent at home (1 = more than 20h)
  - Car user (1 = yes)
  - Flight user (1 = yes, last 12 months)
Outline

1. Environmental Justice Research and Research Gap
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4. Discussion
Descriptive Analysis: Aircraft Noise

[Graph showing density distribution of standardized noise exposure for two surveys: objective and subjective.]
Descriptive Analysis: **Aircraft Noise**

![Graph showing density of standardized noise exposure across different surveys](image)

- **Survey 1: objective**
- **Survey 2: objective**
- **Survey 1: subjective**
- **Survey 2: subjective**

Graph x-axis: Standardized noise exposure
Graph y-axis: Density
Descriptive Analysis: **Street Traffic Noise**

Survey 1: objective
Survey 1: subjective
Descriptive Analysis: **Street Traffic Noise**

![Graph showing density of standardized noise exposure]

- **Survey 1: objective**
- **Survey 1: subjective**
- **Survey 2: objective**
- **Survey 2: subjective**

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Social Inequalities of Objective and Subjective Environmental Threats

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JGU Mainz
### Objective and Subjective Noise Exposure: Correlations

#### Survey 1 (DFG project, n=1455):

<table>
<thead>
<tr>
<th></th>
<th>Aircraft obj.</th>
<th>Aircraft subj.</th>
<th>Street obj.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft obj.</td>
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<tr>
<td>Aircraft subj.</td>
<td>0.49</td>
<td></td>
<td></td>
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<tr>
<td>Street obj.</td>
<td>0.03</td>
<td>−0.09</td>
<td></td>
</tr>
<tr>
<td>Street subj.</td>
<td>0.00</td>
<td>0.12</td>
<td>0.41</td>
</tr>
</tbody>
</table>
### Objective and Subjective Noise Exposure: Correlations

**Survey 1 (DFG project, n=1455):**

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<td>0.49</td>
<td></td>
<td></td>
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<tr>
<td>Street obj.</td>
<td>0.03</td>
<td>-0.09</td>
<td></td>
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<tr>
<td>Street subj.</td>
<td>0.00</td>
<td>0.12</td>
<td>0.41</td>
</tr>
</tbody>
</table>

**Survey 2 (teaching project, n=461):**

<table>
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<th></th>
<th>Aircraft obj.</th>
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<th>Street subj.</th>
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</thead>
<tbody>
<tr>
<td>Aircraft obj.</td>
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<td>0.54</td>
<td></td>
</tr>
<tr>
<td>Aircraft subj.</td>
<td>0.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Street obj.</td>
<td>-0.13</td>
<td>-0.11</td>
<td></td>
</tr>
<tr>
<td>Street subj.</td>
<td>-0.02</td>
<td>0.22</td>
<td>0.30</td>
</tr>
</tbody>
</table>

**Bold:** p<0.05 for correlation.  
**Italic:** p<0.05 for difference between study 1 and study 2.
Study 1 (DFG project):

- Academic education
- Migration background
- Home owner
- Age (decades)
- Gender: female
- Detached house
- Row house
- Often at home (>20h/d)
- Car user
- Flight user
- Objective aircraft noise

Objective noise
Subjective noise

R² = 0.01

OLS regressions, b coefficients and 95%-CI, N = 1455
Social Gradient of **Aircraft** Noise Exposure

**Study 1 (DFG project):**

- **Objective noise**
- **Subjective noise**

![Graph showing OLS regressions, b coefficients and 95%-CI, N = 1455](image)

R² = 0.01

R² = 0.38
Social Gradient of **Street Traffic** Noise Exposure

**Study 1 (DFG project):**

![Graph showing relationships between various factors and noise exposure](graph.png)

- Academic education
- Migration background
- Home owner
- Age (decades)
- Gender: female
- Detached house
- Row house
- Often at home (>20h/d)
- Car user
- Flight user
- Objective aircraft noise

Objective noise vs Subjective noise

- OLS regressions, b coefficients and 95%-CI, N = 1455

$R^2 = 0.05$
Social Gradient of Street Traffic Noise Exposure

Study 1 (DFG project):

<table>
<thead>
<tr>
<th>Objective noise</th>
<th>Subjective noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic education</td>
<td>-0.053</td>
</tr>
<tr>
<td>Migration background</td>
<td>0.144</td>
</tr>
<tr>
<td>Hown owner</td>
<td>-0.151</td>
</tr>
<tr>
<td>Age (decades)</td>
<td>-0.024</td>
</tr>
<tr>
<td>Gender: female</td>
<td>-0.057</td>
</tr>
<tr>
<td>Detached house</td>
<td>-0.133</td>
</tr>
<tr>
<td>Row house</td>
<td>-0.194</td>
</tr>
<tr>
<td>Often at home (&gt;20h/d)</td>
<td>-0.020</td>
</tr>
<tr>
<td>Car user</td>
<td>-0.255</td>
</tr>
<tr>
<td>Flight user</td>
<td>-0.037</td>
</tr>
<tr>
<td>Objective traffic noise</td>
<td>0.020</td>
</tr>
<tr>
<td>Flight user</td>
<td>-0.157</td>
</tr>
<tr>
<td>Flight user</td>
<td>-0.079</td>
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<tr>
<td>Objective noise</td>
<td>-0.133</td>
</tr>
<tr>
<td>Objective noise</td>
<td>0.390</td>
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</tbody>
</table>

OLS regressions, b coefficients and 95%-CI, N = 1455

R² = 0.05
R² = 0.18
## Results So Far

<table>
<thead>
<tr>
<th>Noise Type</th>
<th>Objective Effect</th>
<th>Subjective Effect</th>
<th>Social Gradient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft noise</td>
<td>objective</td>
<td>subjective</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>yes (partly)</td>
</tr>
<tr>
<td>Street traffic noise</td>
<td>objective</td>
<td>subjective</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>less pronounced</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>no</td>
</tr>
</tbody>
</table>
### Replication With Study 2

<table>
<thead>
<tr>
<th>Source of Noise</th>
<th>Social Gradient</th>
<th>Replication?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft noise</td>
<td>Objective</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td>Subjective</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td>Difference of effects</td>
<td>yes (partly)</td>
</tr>
<tr>
<td>Street traffic noise</td>
<td>Objective</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td>Subjective</td>
<td>Less pronounced</td>
</tr>
<tr>
<td></td>
<td>Difference of effects</td>
<td>no</td>
</tr>
</tbody>
</table>
Replication With Study 2

**Objective aircraft noise:**

- Academic education
- Migration background
- Home owner
- Age (decades)
- Gender: female
- Detached house
- Row house
- Often at home (>20h/d)
- Car user
- Flight user

**Inequality Measures:**

- **Social Inequalities:**
  - 0.006
  - -0.018
  - -0.011
  - -0.035
  - 0.016
  - 0.004
  - 0.121
  - 0.107
  - 0.136
  - -0.030

- **Academic education:**
  - -0.164
  - -0.340
  - -0.200
  - 0.002
  - 0.166

**Inequality Measures:**

- **R^2 = 0.01**
- **R^2 = 0.06**

OLS regressions, b coefficients and 95%-CI, N=1455 and N=460

DFG data
Teaching project data
Replication With Study 2

- **Subjective aircraft noise:**
  - Academic education
  - Migration background
  - Hown owner
  - Age (decades)
  - Gender: female
  - Detached house
  - Row house
  - Often at home (>20h/d)
  - Car user
  - Flight user
  - Objective aircraft noise

- R² = 0.38

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DFG data  Teaching project data

OLS regressions, b coefficients and 95%-CI, N=1455 and N=460
Replication With Study 2

Objective street traffic noise:

- Academic education
- Migration background
- Hown owner
- Age (decades)
- Gender: female
- Detached house
- Row house
- Often at home (>20h/d)
- Car user
- Flight user

R² = 0.05

R² = 0.09

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Replication With Study 2

- **Subjective street traffic noise:**

![Diagram showing regression analysis of different factors on subjective street traffic noise. The factors include Academic education, Migration background, Hown owner, Age (decades), Gender: female, Detached house, Row house, Often at home (>20h/d), Car user, Flight user, and Objective traffic noise. The y-axis represents the factors, and the x-axis represents the regression coefficients. The graph shows two datasets: DFG data and Teaching project data. The R² values are 0.18 and 0.12.]

OLS regressions, b coefficients and 95%-CI, N=1455 and N=460
Replication With Study 2

- Problem with multiple testing?
  - Here: $2\times10+2\times11=42$ tests for different coefficients
  - 2,1 randomly significant with $p=.05$

- We found 4 significant differences.
Outline

1. Environmental Justice Research and Research Gap
2. Design of the Studies
3. Results
4. Discussion
Discussion

- How to deal with replication?
  - Adjusting the sample?
  - Choice of alpha level / power issues?

- How can (social) differences in the subjective annoyance be explained?

- Next step: Improvement of Geodata (regarding housing data)
Thank you very much!

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juergen.schiener@uni-mainz.de


Brown, Phil 1995: Race, class, and environmental health: a review and systematization of the literature, Environmental research 69 (1), S. 15–30.


Forastiere, Francesco; Stafoggia, Massimo; Tasco, Carola; Picciotto, Sally; Agabiti, Nerina; Cesaroni, Giulia; Perucci, Carlo A. 2007: Socioeconomic status, particulate air pollution, and daily mortality. Differential exposure or differential susceptibility, American journal of industrial medicine 50 (3), S. 208–216.


Padilla, Cindy M.; Kihal-Talantikite, Wahida; Vieira, Verónica M.; Rossello, Philippe; Le Nir, Geraldine; Zmirou-Navier, Denis; Deguen, Severine 2014: Air quality and social deprivation in four French metropolitan areas—a localized spatio-temporal environmental inequality analysis, Environmental research 134, S. 315–324.

# Descriptive Analysis: Independent Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Survey 1</th>
<th>Survey 2</th>
<th>Diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic education (1=yes)</td>
<td>50,5</td>
<td>51,6</td>
<td></td>
</tr>
<tr>
<td>Home owner (1=yes)</td>
<td>38,5</td>
<td>38,0</td>
<td></td>
</tr>
<tr>
<td>Migration background (1=yes)</td>
<td>17,3</td>
<td>12,4</td>
<td>*</td>
</tr>
<tr>
<td>Age (decades)</td>
<td>4,2</td>
<td>4,7</td>
<td>***</td>
</tr>
<tr>
<td>Gender (1=female)</td>
<td>54,2</td>
<td>55,3</td>
<td></td>
</tr>
<tr>
<td>Apartment house (1=yes)</td>
<td>70,6</td>
<td>77,9</td>
<td>**</td>
</tr>
<tr>
<td>Row house (1=yes)</td>
<td>18,1</td>
<td>11,1</td>
<td>***</td>
</tr>
<tr>
<td>Detached house (1=yes)</td>
<td>11,3</td>
<td>11,1</td>
<td></td>
</tr>
<tr>
<td>Daily time spent at home (1= &gt;20h)</td>
<td>19,5</td>
<td>26,7</td>
<td>**</td>
</tr>
<tr>
<td>Car user (1=yes)</td>
<td>79,0</td>
<td>83,7</td>
<td>*</td>
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<tr>
<td>Flight user (1=yes)</td>
<td>59,9</td>
<td>61,0</td>
<td></td>
</tr>
</tbody>
</table>

*Indicated are percentages and the mean (SD) for age.*
Subjective Noise Annoyance: Study 1

<table>
<thead>
<tr>
<th>Lärmquelle</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
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<tbody>
<tr>
<td>Straßenverkehrslärm</td>
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<tr>
<td>Eisenbahnlärm</td>
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<tr>
<td>Fluglärm</td>
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<tr>
<td>Lärm durch Nachbarn</td>
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<tr>
<td>Lärm durch Lokale, Geschäfte, Leute auf der Straße</td>
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<tr>
<td>Andere Lärmquelle, nämlich:</td>
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</tbody>
</table>

- + day, windows closed; + night, windows open; + night, windows closed.
### Subjective Noise Annoyance: Study 2

#### F14
Wie stark fühlen Sie sich in Ihrer Wohnung tagsüber durch die folgenden Lärmarten gestört?

Bitte antworten Sie auf der Skala von 1 = „überhaupt nicht gestört“ bis 7 = „sehr stark gestört“. Mit den Werten dazwischen können Sie Ihre Antwort abstufen.

<table>
<thead>
<tr>
<th>Lärmart</th>
<th>Skala</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<th>7</th>
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<td></td>
</tr>
<tr>
<td>Lärm von Nachbarn</td>
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<tr>
<td>andere Lärmquellen</td>
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<td></td>
</tr>
</tbody>
</table>

#### F15
Und wie stark fühlen Sie sich in Ihrer Wohnung nachts durch die folgenden Lärmarten gestört?

Bitte antworten Sie auf der Skala von 1 = „überhaupt nicht gestört“ bis 7 = „sehr stark gestört“. Mit den Werten dazwischen können Sie Ihre Antwort abstufen.

<table>
<thead>
<tr>
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<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tr>
<td>Eisenbahnlärm</td>
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<td></td>
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Street Traffic Noise in Mainz
Street Traffic Noise in Mainz
Grundprinzip (GIS-Programm QGIS):
- Abgrenzung aller Wohn- und gemischten Bauflächen in Mainz.
- Zufällige Verteilung von 200 Punkten in den Flächen („Gießkannenprinzip“).
- Auswahl der 200 den Punkten am nächsten gelegenen Straßenstücke (Straßenstück: Straßenabschnitt zwischen zwei Einmündungen).

Sodann:
- Zufällige Auswahl von 68 Straßenstücken mit 3971 Haushalten, von denen in jedem Straßenstück jeder zweite Haushalt mit einem Fragebogen bestückt wurde.
- Resultierende Bruttostichprobe = 2000 verteilte Fragebögen.

Auswahlebene Person: Next-Birthday-Methode.
Designgewichtung für empirische Analysen.