North Rhine-Westphalia State Environment Agency

Odours and their effects on residents

- How to measure and regulate odour impact

FIXED ON NITROGEN
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on Nitrogen
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Contents - Keywords

- **Odours and relevance of single substances**
- **Odour parameters**
  odour quality, odour frequency, odour concentration, odour intensity, hedonic tone, odour annoyance, health effects caused by odours
- **How to measure odour**
  olfactometry, field measurements, dispersion modelling
- **Exposure-response relationships**
  industrial odours, livestock farming
- **Odour regulation in Germany**

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Relevance of single chemical substances for odour effects

N-Compound	Installation	Odour
Ammonia	Waste water treatment, livestock farming, composting	pungent
Try methyl amine	Rendering plant	fishy
Ethylamine	Resin chemistry, oil manufacturing	pungent
Indole	Waste water treatment, livestock farming	faecal (high conz.) flowery (low conc.)
Pyridine	Waste water treatment, coffee bean roasting	fishy, musty, unpleasant
Pyrazine	Chocolate production, coffee bean roasting	earthy, roasty

Relevance of single chemical substances for odour effects

- Detection of odours at the odour detection port but no peak at the GC MS-detector
- Only in a very few cases single chemical substances play the major role in creating odours
  - a catalyser in foundries which is a amine (smell like rotten fish)
  - H_2S in steel production (smell like rotten eggs)

Odours in general are created by mixtures of (unknown) substances

Odour Parameters

- **Odour quality**
  - "How does it smell?"
  - It smells like flowers, compost, pigs, …
    or a certain installation
    or musty, sweet, pungent
  - Odour concentration must be above recognition threshold
  - Description by panel members according to a list of odour qualities **or** with their own words by unknown odours

Odour Parameters

- **Odour frequency - Odour impact**
  - "How often does it smell in a certain area?"
  - Odour concentration must be above recognition threshold to differentiate between certain installations
  - Unit: odour impact per year [%]
  - Measured in the field with selected and trained panel members or calculated by dispersion modelling

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Odour Parameters

- **Odour concentration**
  - "Do you perceive an odour - yes or no?"
  - Odour concentration must be above detection threshold
  - It is a measure for the amount of odour in exhaust air
  - Unit: Odour units per cubic meter [ou/m³]
  - Measured by olfactometry with selected and trained panel members

Odour Parameters

- **Odour intensity**
  - "How strong is the odour?"
  - Odour concentration must be above detection threshold
  - Six-point intensity scale:
    0-not detectable, 1-very weak, 2-weak, 3-distinct,
    4-strong, 5-very strong, 6-extremely strong
  - Measured by olfactometry in exhaust air or in the field with selected and trained panel members

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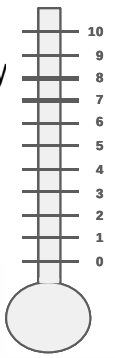
Odour Parameters

- **Hedonic tone of odours**
  - "How pleasant or unpleasant is the odour?"
  - Odour concentration must be above recognition threshold (It could depend on odour concentration)
  - Nine-point scale:
    (-4) -extremely unpleasant … (0) -neither pleasant nor unpleasant … (4)- extremely pleasant
  - Measured by olfactometry in exhaust air or in the field with selected and trained panel members

Odour Parameters

- **Odour annoyance**
  - Complex of negative human reactions occurring in response to ambient odour exposure
  - "What is the degree of odour annoyance of residents?"
  - Odours must be recognisable in residential areas
  - Annoyance degree is correlated e. g. to odour frequency
  - Measured by questionnaires in face-to-face interviews carried out by trained and supervised interviewers
  - 11-point graphic scale ("annoyance thermometer") and/or 7-point verbal scale



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Odour Parameters

- **Health effects caused by Odours**
  - There are no scientific findings that odours in general cause health effects
  - "Are the recognisable odours causing nausea and sickness?"
  - There are only very few single cases where nausea and sickness causing odours provoke health effects
  - Known examples are rendering plants or champignon breeding farms
  - But there are no methods to assess such odours

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How to measure odour

Odour concentration

- European Guideline DIN EN 13725 on dynamic olfactometry
- n-Butanol (odour threshold 123 µg/m³) as a reference in addition H_2S
- Quality requirements
- Panel selection
- Fixed presentation of odorants
- Retrospective screening to assure quality of emission measurements

➢ Sampling is an objective of Guideline VDI 3880 (in progress)

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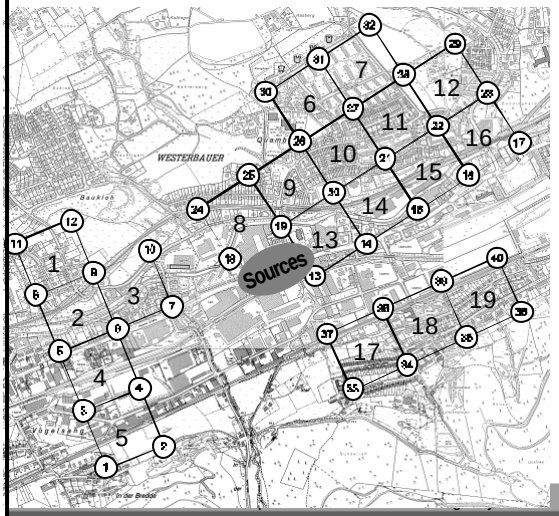
How to measure odour

Field measurements with panels



... in a grid

- Detection of recognisable odours caused by installations in an assessment area
- According to Guideline VDI 3940 Part 1/2006
- Using of trained and selected panel members

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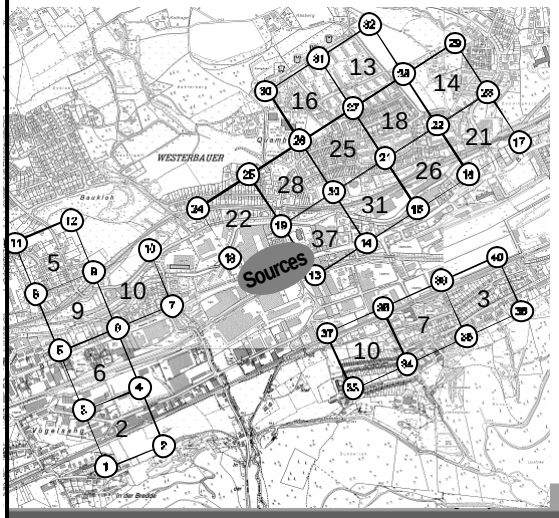
How to measure odour

Field measurements with panels



... in a grid

- Odour impact expressed as odour frequency in **% hours per year**
- Additionally measurement of odour intensity and hedonic tone possible

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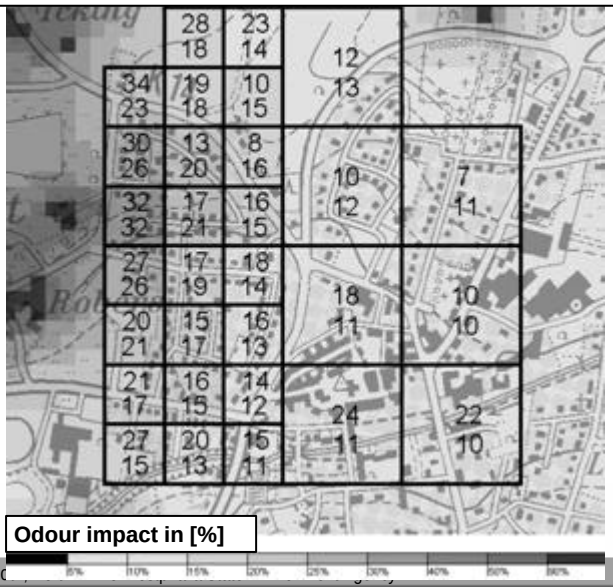
How to measure odour
Dispersion modelling



Odour impact / odour frequency [%]

upper number: results field measurements

lower number: results dispersion modelling

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Methods in use to determine odour impact in ambient air in Germany

Used method	Percentage of appliance
Dispersion modelling	approx. 65 %
Field measurements with panels	approx. 20 %
Simplifying methods	approx. 15 %

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Odour Regulation
Situation in Germany

Recognisable odours caused by installations are treated as a nuisance.

The question in odour regulation according to the German Federal Immission Control Act "BImSchG" is:

Is the nuisance significant?

GOAA
Guideline on Odour in Ambient Air

This Guideline is the odour assessment procedure in Germany since 1993

Legal framework:
German Federal Immission Control Act (BImSchG)
German technical instructions on air quality control (TA Luft)

Internet: www.lua.nrw.de/luft/gerueche/GOAA_200303.pdf

Odour Regulation Situation in Germany

- Germany 16 federal states
- NRW
  North Rhine Westphalia:
  - 18 million habitants
  - State with the most citizens in Germany
  - Capital: Dusseldorf
  - Biggest city: Cologne (1 million habitants)

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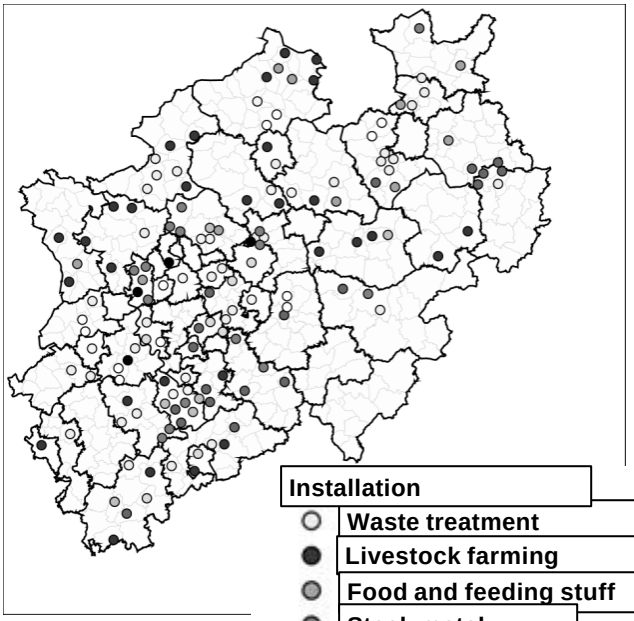
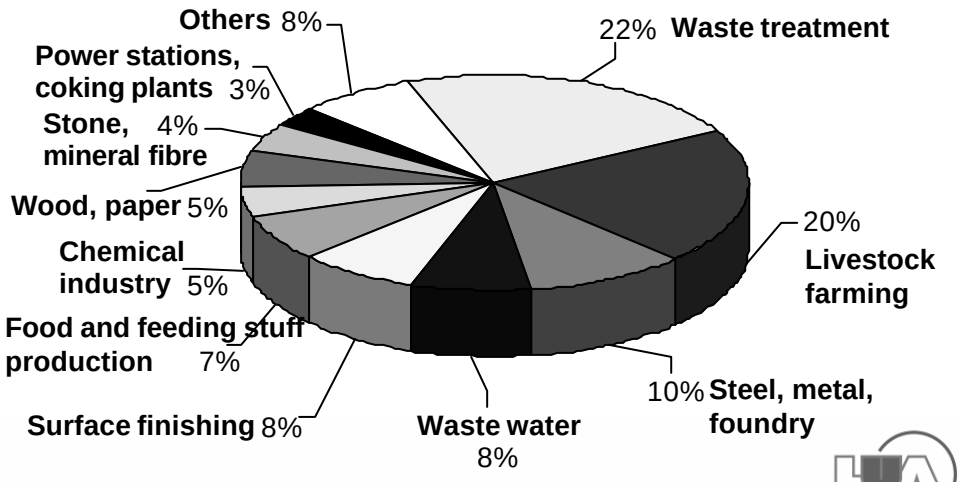


Surveys in NRW

- From 2001 to 2005
- For different installations

Installation	
Waste treatment	Surface finishing
Livestock farming	Chemical industry
Food and feeding stuff	Wood, paper
Steel, metal	Stone, mineral f.
Waste water	Power stations
	Others

Surveys in NRW



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Guideline on Odour in Ambient Air

Immission Limit Values

Residential, mixed area		Trade, industrial zones	
relative frequency	% h/a	relative frequency	% h/a
0.10	10	0.15	15

If the total odour impact exceeds the immission limit values a significant nuisance is given.

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Evaluation of limit values in the GOAA

Systematic investigations
of the relationship
between **odour exposure** and
annoyance response of residents
in the vicinity of installations

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Evaluation of the limit values in the GOAA

- Initial investigations in 1989 and 1990
- Hedonic-Project:
  Additional investigation on industrial odours with respect to odour intensity and hedonic tone in 1999 - 2003
- Additional investigation on odours caused by livestock farming with respect to different animal species in 2003 - 2006

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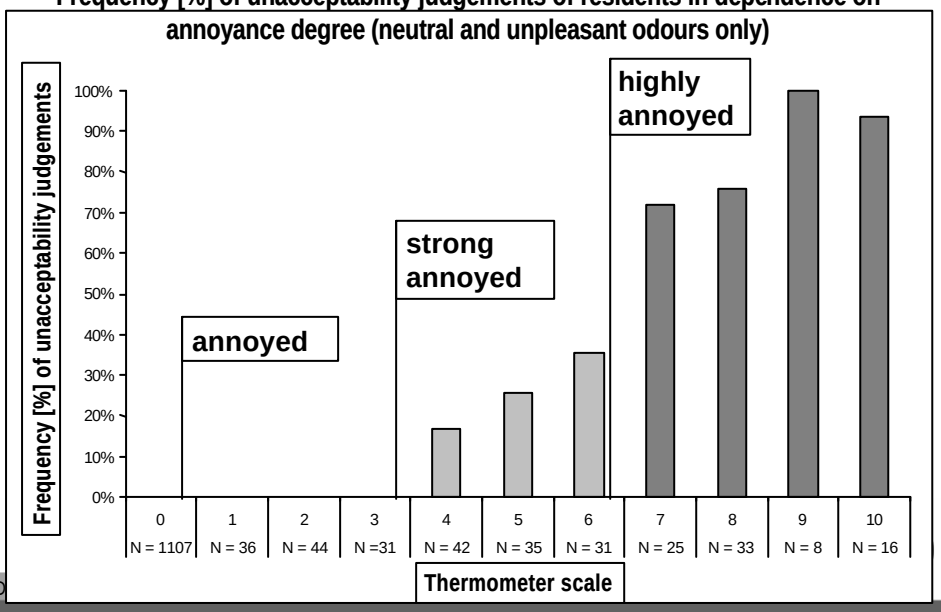
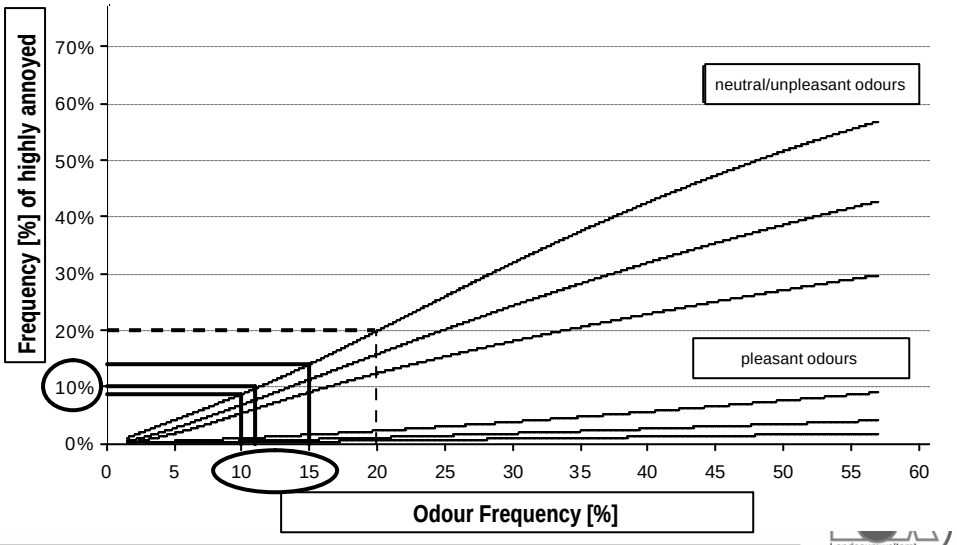
Hedonic-Project



Evaluation of limit values on the basis of highly annoyed residents



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Actual situation in livestock farming

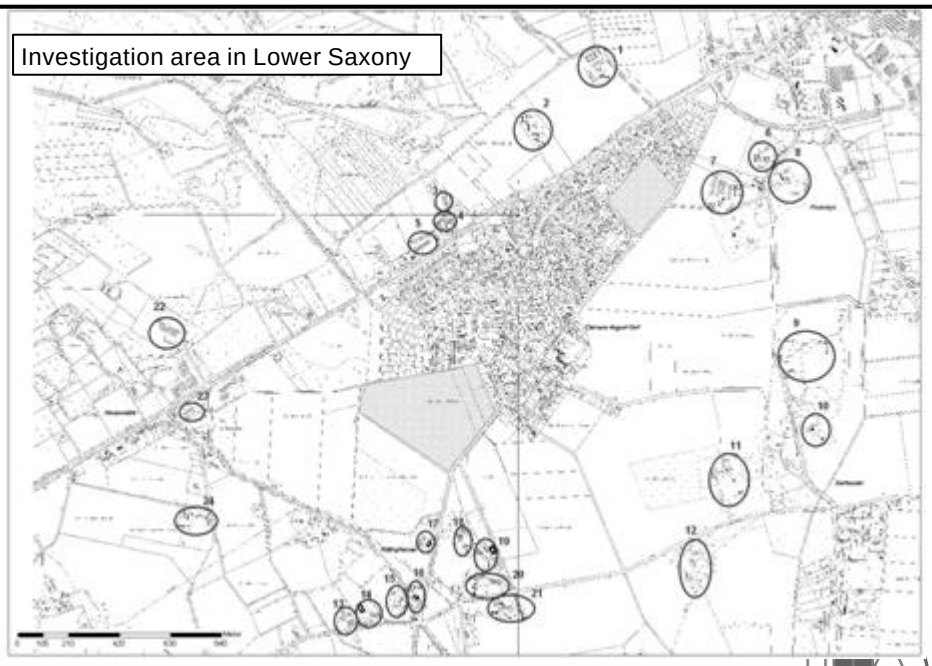
- Extreme density of livestock farms in some areas !
- Minimum set back distances are not applicable and are often not accepted by the public!
- Increasing problems in licensing and surveillance of stables
- Annoyance of residents was not take into account in the past
- Do agricultural odours have a bigger acceptance by the public than industrial odours ?

Reaction: New evaluation systems were created with the objective to reduce distances but without scientific background

Consequence: Lack of legal certainty

Project: Assessment of Odour from Livestock Farming

Investigation area in Lower Saxony



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Project: Assessment of Odour from Livestock Farming

Odour impact caused by poultry, pigs, diary cows, manure, silage and dung

Assessment area		Main animal species	Odour impact Min	Max
NRW	I	Diary cows	6%	32%
	II	Poultry	5%	17%
	III	Diary cows	3%	60%
BW	I	Pigs	3%	41%
	II	Pigs	3%	42%
	III	Pigs	25%	81%
	IV	Pigs	0%	34%
NI	I	Poultry	6%	20%
	II	Pigs	4%	13%
SN	I	Diary cows	4%	25%
MV	I	Pigs	9%	38%

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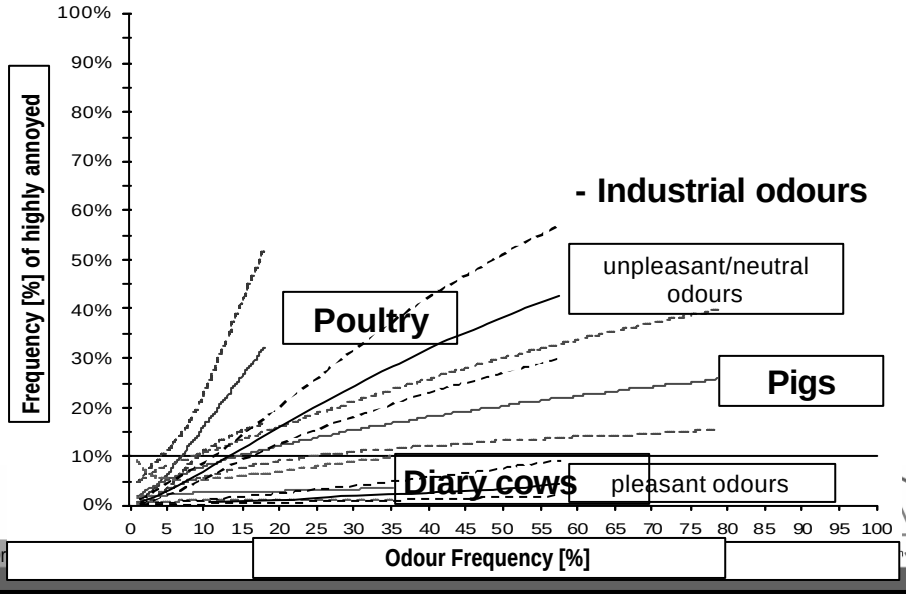
Project: Assessment of Odour from Livestock Farming



Results of the projects on industrial and livestock farming odours

- The odour impact / odour nuisance concept of the Guideline on Odour in Ambient Air based on limit values is suitable and sufficient to predict odour annoyance
- Annoyance appears with recognition
  (no additional effect of odour intensity)
- Hedonic tone has only to be included in regulation for really pleasant industrial odours
- Odour quality depending on animal species has a significant effect on the on the exposure-response- relationship
- **"Odour sequence" with decreasing annoyance potential**

  poultry > unpleasant/neutral industrial odours > pigs
  > pleasant industrial odours > diary cows

Conclusions

- Suitable parameters to describe odour effects are odour quality, odour concentration, odour frequency, hedonic tone and annoyance
- There are standardised methods to measure or calculate odours
  - Olfactometry to measure in exhaust air
  - Field measurements with panels
  - Dispersion modelling
- Odour effects are caused by gaseous mixtures not by single chemical substances

Conclusions

- The degree of odour annoyance depends on the extent of odour impact
- The dominating parameter is the odour frequency - only in some cases associated with other parameters (pleasant odours, odour quality)
- Applying limit values is a suitable and sufficient way to avoid significant nuisance

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