2011-05-24/25 Conference in Rapperswil (CH)
Leaching of Biocides from Facade Coatings

The importance of leaching data in the environmental risk assessment under the biocidal products directive 98/8/EC

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Energizing Chemistry

Agenda

Introduction

Relevance under the BPD

Environmental risk assessment

Tiered Approach

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Field

Summary

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Introduction
Application Fields & Overestimation

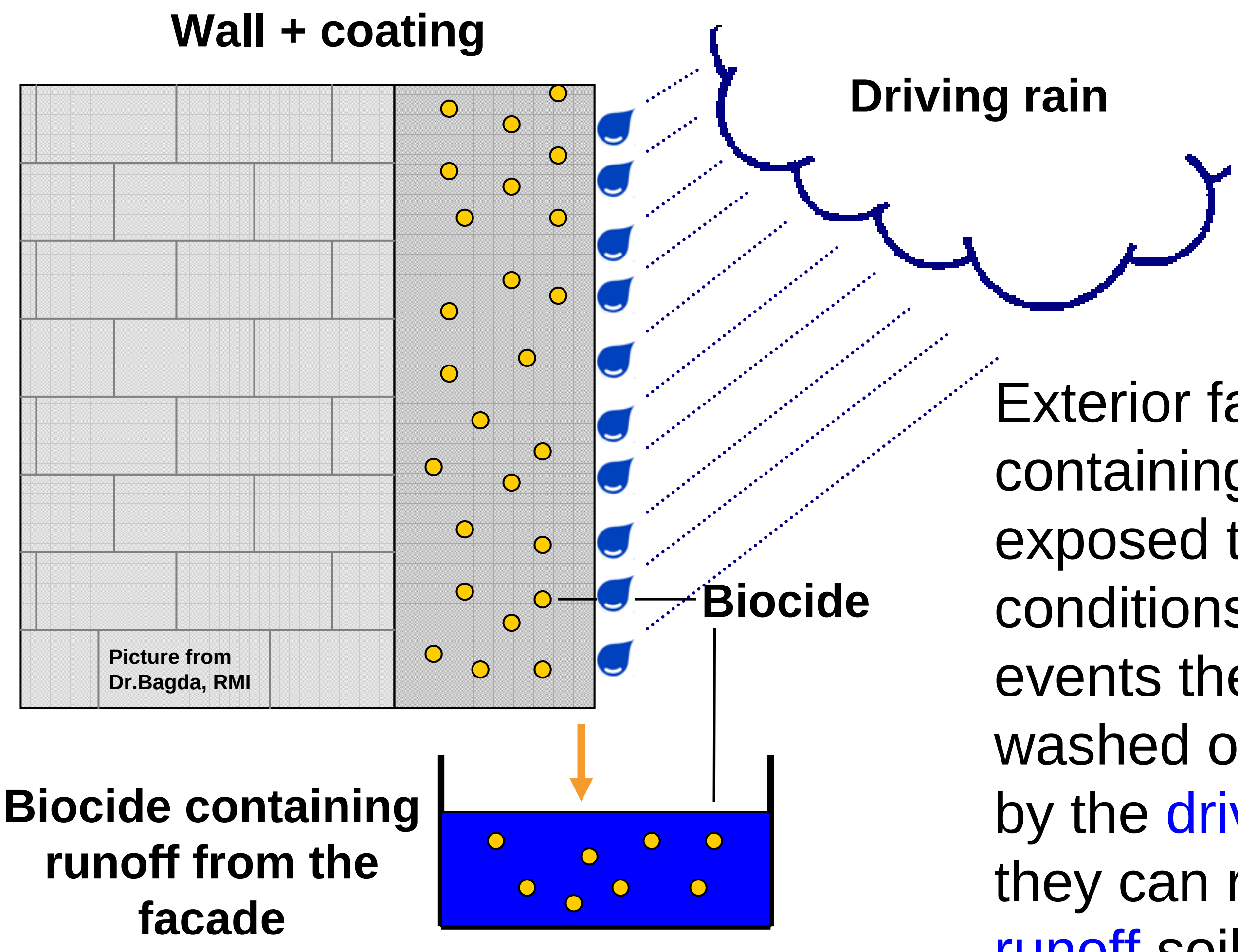
Exterior facades of timber or stone houses and its coatings are protected by film -, masonry – and wood preservatives in order to prevent the growth of algae and fungi.

Aqueous based paints & plasters and its components are containing in can preservatives in order to prevent microbial decomposition during storage.

The environmental risk assessment for active substances overestimates in these application fields the emissions due to the current determination and processing of the leaching data.

Therefore it is very important to understand all parameters which influences the leaching and the risk assessment in order to determine realistic emissions.

Introduction
Leaching caused by driving rain & runoff



Exterior facades with biocide containing coatings are exposed to the weather conditions and during rain events the biocides can be washed off from the surface by the driving rain and so they can reach with the runoff soil, surface water and ground water.

Introduction
Reason for Use of Biocides

Limited and decreasing energy sources

➔ require thermal insulation of exterior facades

➔ lead to decreasing surface temperature

➔ cause increasing moisture content

➔and better growing conditions for algae and fungi

Organic components in facade coatings

➔support in addition the growth of fungi

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Relevance under the BPD
Active Substances & Product Types

In the year 2010 639 active substance / product type combinations were supported (231 active substances)

Relevant PTs for the leaching of biocides		number of dossiers
PT 6	in can preservation	47(2008)
PT 7	film preservation	29(2009)
PT 8	wood protection	40(2008)
PT 10	masonry protection	27(2009)

The number of dossiers in these PTs are in summary 143

It is estimated that leaching from facades is relevant for

> 10% of all active substances and dossiers under the BPD

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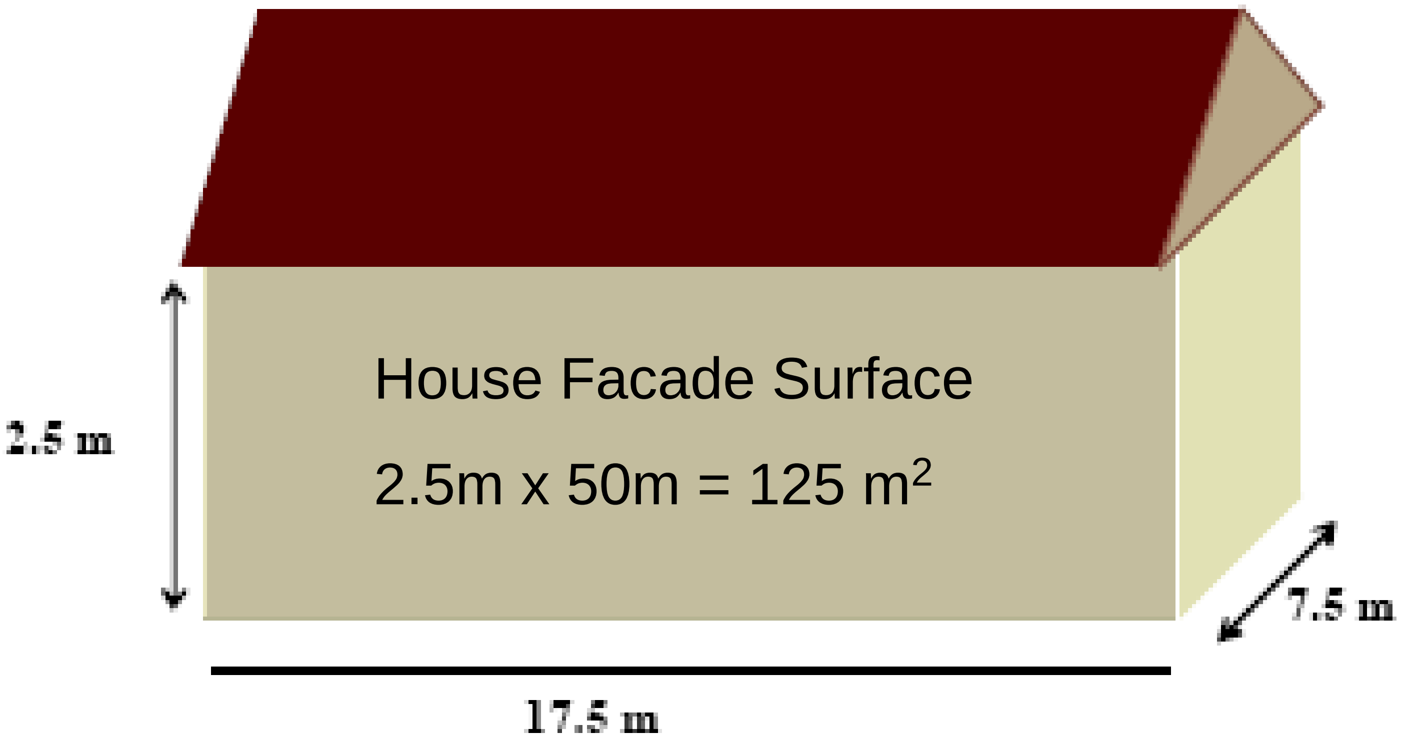
Environmental Risk Assessment
House Facade & Soil Compartment

This house from the emission scenario document is the basis for the environmental risk assessment of biocides used in facade coatings



Enlarged Soil Compartment Volume 0.5m x 0.5m x 50m = 12,5m^3
Enlarged Soil Compartment Surface 0.5 x 50m = 25m^2

Environmental Risk Assessment
Protection Goal Soil

The soil below a house is obviously not protected. The soil area below the emission szenario house is 131m². The protected soil area around the house is in the enlarged compartment 25m².

In reality this soil area is covered by a terrace, a pavement, a splash guard for the wall, cellar windows, stairs, etc.

Foto: Metten Stein+Design, Overath

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Environmental Risk Assessment
Protection Goal Soil

Foto: Metten Stein+Design, Overath

Foto: Metten Stein+Design, Overath

Very often the soil area around a house is covered

Environmental Risk Assessment
Protection Goal Soil

Further examples to cover the soil area around a house

Environmental Risk Assessment
PEC / PNEC

Predicted Environmental Concentration (PEC)

The PEC is e. g. based on parameters from the emission szenario and experimental or calculated leaching data

Predicted No Effect Concentration (PNEC)

The PNEC is based on ecotox data of the active substance

No risk for the environment if PEC / PNEC < 1

Tiered Approach
Leaching Data

Depending on the ecotox data of the active substance different approaches are possible to generate leaching data

Tier 1: Calculation of the emission over e. g. 5 years
Tier 2: Laboratory leaching over 9 emission days
Tier 3: Semi-field leaching e. g. up to 3 years
Tier 4: Field leaching on real objects

It is known from PT 8 that lab leaching tests lead to a significant overestimation. It has to be pointed out that also for PT 7 and 10 lab leaching tests lead to an overestimation and astonishingly semi-field tests too

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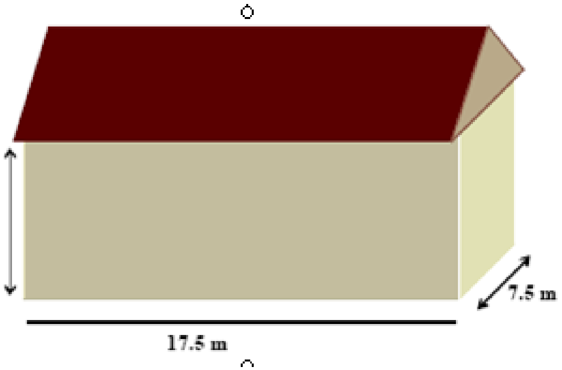
Tiered Approach
Transfer of data from model to model

Transfer from lab or semi-field

to the emission scenario house



Overestimation: Labor > Semi Field Weather Side

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Tiered Approach
Comparison lab / semi field

method	lab	semi field small samples
styrene acrylate paint	on glas	on render
paint quantity [g/m^2]	market relevant	market relevant
a. s. content [ppm]	medium	medium
a. s. quantity [mg/m2]	medium	medium
procedure	2 x 1h	weather side
duration of experiment	9 days	9 months / 21 months
leaching [mg/m^{2}xd]	determined	determined

extrapolation of the leaching quantity of one further year in relation to the original a. s. quantity

leaching quantity* [%]	> 100	ca. 2 / ca. 1

overestimation of the leaching quantity with lab data in comparison with the weather side in the semi field

Overestimation* > 100/2 = **> 50 fold** > 100/1 = > **100 fold**

*active substance is confidential

Semi-field
Influence of the weather

The main difference between laboratory and semi-field tests is the natural weather which cannot be simulated in the lab.

Weather consists of precipitation, wind speed, wind direction and temperature. Precipitation above 0°C in combination with wind speed causes the driving rain which forms the runoff from the facade. Without runoff there is no leaching. The more runoff the more leaching.

The runoff is the most important parameter which we have to study in order to understand how much overestimation comes from classic semi-field tests and in order to transfer data in a more realistic way on the emission scenario house in a environmental risk assessment

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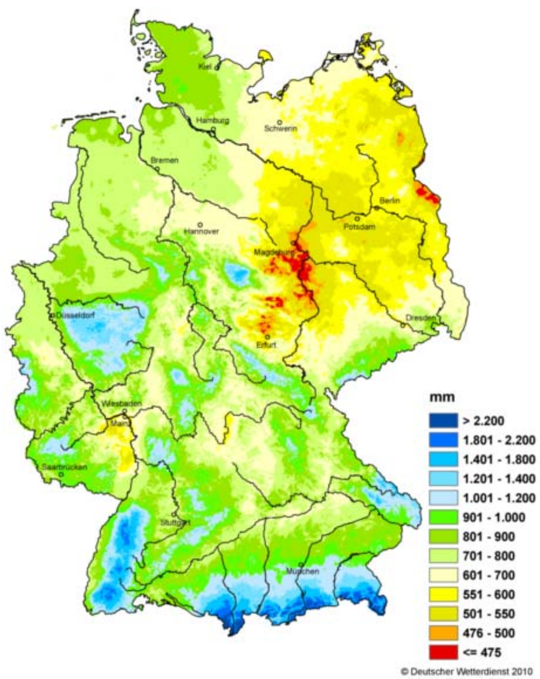
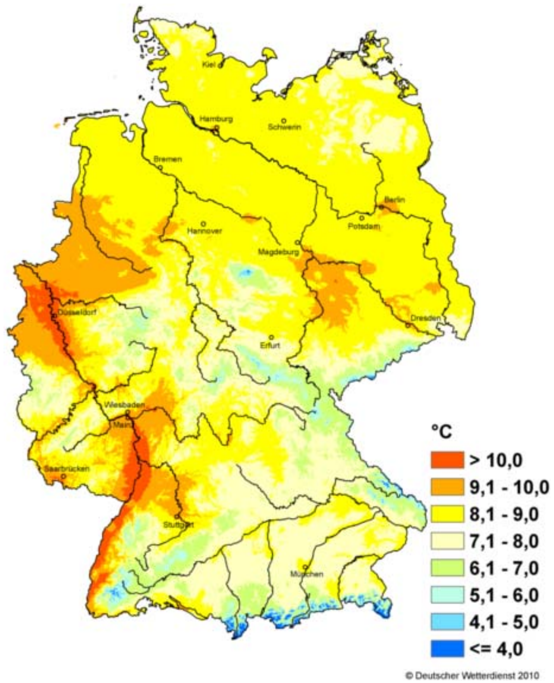
Semi Field
Weather Data in Germany

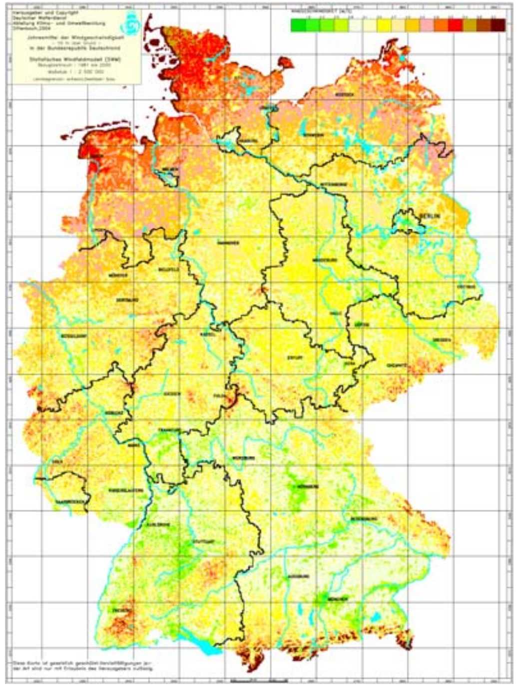
Precipitation



Temperature



Windspeed



Precipitation & Temperature in Germany per Year in the period from 1961 – 1990 (Source DWD)

Driving rain and runoff maps are not available

Annual Average Wind Speed in Germany in the period from 1981 – 2000 (Source DWD)

Semi-field
Parameters influencing the runoff

Data were determined with the following test houses in order to study runoff depending on orientation and size. Comparing the data from different locations we also found the influence of the location.

Fraunhofer IME
Schmallenberg
$0{,}3\text{x}0{,}6 = 0{,}18\text{m}^2$
4 orientations

Fraunhofer IME
Schmallenberg
$2{,}5\text{x}1{,}5 = 3{,}75\text{m}^2$
4 orientations

EMPA
Dübendorf
$1{,}75\text{x}0{,}75 = 1{,}31\text{m}^2$
1 orientation

Semi-field
Experimental Data Orientation & Size

Schmallenberg with a total precipitation of 901 l/m²
Test duration 9 cw 2010 – 4 cw 2011 (48 weeks)

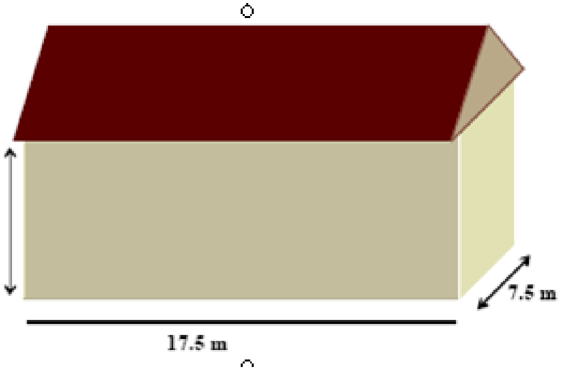
runoff [l/m²]	north	east	south	west
large samples	118	15	69	208
small samples	207	50	129	332

runoff [%] of total precipitation

runoff [%]	north	east	south	west
large samples	13	2	8	23
small samples	23	6	14	37

The runoff is significantly depending on orientation and size of the sample

Semi-field
Transfer of data & house factor



Average runoff from the emission szenario house facade

runoff [l/m2]	small samples	large samples
westorientation	332	208
n/e/s/w orientation	184	106

house factor	small samples	large samples
west orientation	1	0.62
n/e/s/w orientation	0.55	0.32

Proposal: use house factor for the refinement of leaching data

Semi-field
Size & location

Comparison of samples in west orientation

Schmallenberg	Dübendorf	Schmallenberg
$0{,}3 \times 0{,}6 = 0{,}18 m^2$	$1{,}75 \times 0{,}75 = 1{,}31 m^2$	$2{,}5 \times 1{,}5 = 3{,}75 m^2$
runoff [l/m2]		
332	61	208
Total precipitation [l/m²]		
901	815	901
runoff [%] of total precipitation		
37	8	23

The runoff depend in addition to orientation & size also on the location of the sample. The difference between locations come from the weather, especially from the driving rain which is influenced by rain and wind speed and also from the environment

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Semi-field
Calculation with ISO/FDIS 15927-3:2008(E)

Hygrothermal performance of buildings

— Calculation and presentation of climatic data —

Part 3: Calculation of a driving rain index for vertical surfaces from hourly wind and rain data

This part of ISO 15927 specifies two procedures for analysing data derived from hourly observations of wind and rainfall so as to provide an estimate in terms of both an annual average and short-term spells of the quantity of water likely to impact on a wall of any given orientation.

The first method, which uses hourly observations of wind and rainfall and which is based closely on BS 8104 (UK) is used for the following calculations.

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Semi-field
Experiment vs. Calculation

Comparison of experimental runoff and calculated potential runoff for samples in Schmallenberg with a total precipitation of 545 l/m²
9 cw – 38 cw 2010 (29 weeks)

large samples	north	east	south	west
experimental [l/m2]	69	9	31	107
calculated [l/m2]	71	11	37	115

small samples	north	east	south	west
experimental [l/m2]	116	26	36	151
calculated [l/m2]	119	18	61	191

Calculation is very close to the experiment

The calculations are done by Timothy Wangler, PhD, Postdoctoral Researcher
ETH Zürich, Institute for Technology in Architecture

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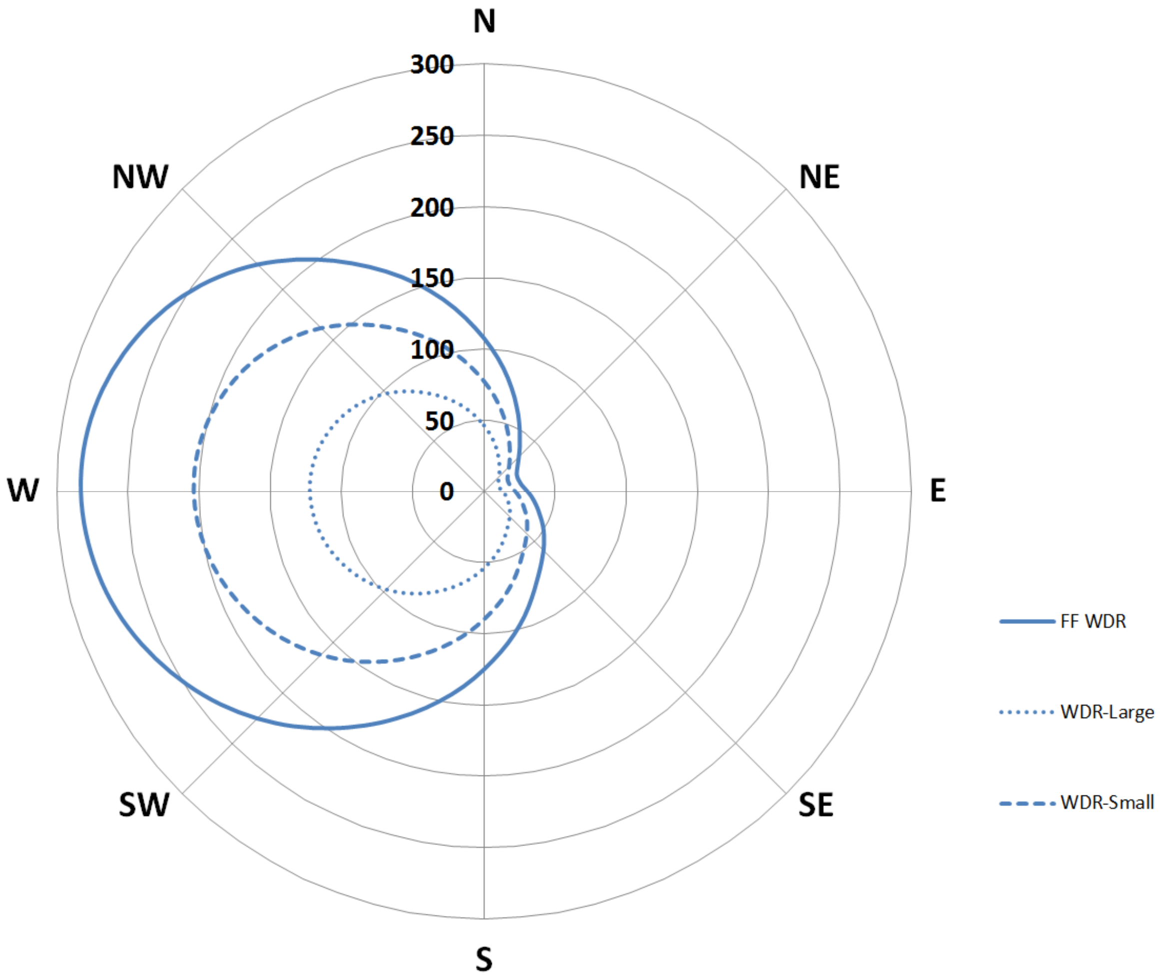
Semi-field
Wind Driven Rain vs. Orientation



FF WDR =
Free Field Wind
Driven Rain at 10m

WDR small =
Potential runoff
from small samples

WDR large =
Potential runoff
from large samples

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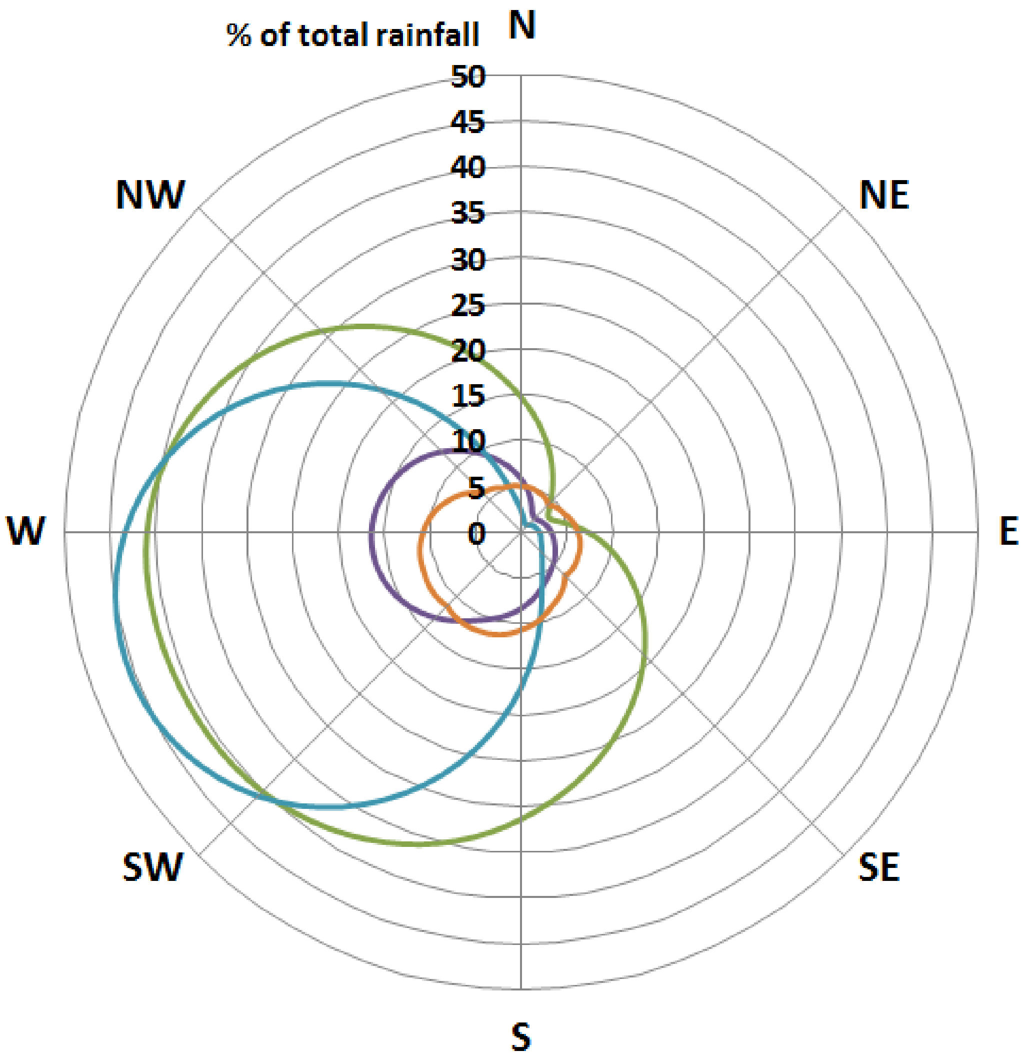
Semi-field
FF WDR [%] of total rainfall for 3.5m



The data (09/2008 – 12/2010) from the 10m weather stations of Schmallenberg, Holzkirchen and Dübendorf were downscaled to 3.5m weather data with log-law for comparison with Taastrup

Data thanks to Dr. M. Simon (IME), Dr. Chr. Scherer (IBP), Dr. T. Wangler (EMPA) and M. Klamer (DTI)

	North	East	Hight
Schmallenberg	51° 09‘	8° 18‘	486
Dübendorf	47° 24’	8° 36’	440
Holzkirchen	47° 51’	11° 44’	680
Taastrup	55° 66’	12° 27’	43

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Field
Calculation for the emission szenario house

Calculated potential runoff [%] of total precipitation for the emission szenario house length and width (17.5 x 7.5) and 4 different hights with weather data for the location Essen with a total precipitation of 918 l/m^2 and a wind speed of 3,5 m/sec in the Test Reference Year

potential runoff [%]	SW	NW	NE	SE
hight 3 m	18	9	7	11
hight 6 m	15	8	6	9
hight 9 m	11	6	4	7
hight 12 m	10	5	4	6

The runoff from a facade decreases with increasing hight due to the wind blocking effect. For comparison the runoff from small semi-field samples in Schmallenberg was 37%.

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Field
Experimental Runoff

Hight of building 10.5m

74 runoff events

runoff [%] from total precipitation

< 0.7%

Data from Dr. M. Burkhardt UMTEC
HSR Hochschule für Technik

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Summary

The current environmental risk assessment for active substances in facade coatings and wood protection lead to an overestimation of the emissions

The runoff from a facade is the driving force for the leaching of biocides and it could be shown that it depends on orientation, size and location and that from real facades the runoff is much lower than from semi-field samples

A house factor derived from runoff is proposed in order to do a first refinement of the environmental risk assessment

For a profound refinement future studies should clarify the correlation between runoff and leaching

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Closing Words
Benefit and Risk of Biocides

Biocides protect water based paints and plaster during storage (PT 6) and on facades (PT 7 & 10) and timber (PT 8) against the attack of bacteria, algae and fungi

protection of materials ➔ protection of resources ➔protection of environment & health

The benefit and risk of biocides should be evaluated in a balance

Sponsorship
Cooperation with Fraunhofer & EMPA/UMTEC

The runoff study at Fraunhofer IME, the runoff report from Dr. Burkhardt EMPA/UMTEC and the calculation from Dr. Wangler EMPA is sponsored by the following companies:

LANXESS Deutschland GmbH: torsten.groth@lanxess.com
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Troy Chemie GmbH: HeuerT@troycorp.com
ISP Biochema Schwaben GmbH: WLAnker@ispcorp.com
Schülke & Mayr GmbH: Bernd.Heinken@schuelke.com
The Dow Chemical Company: TKoehler@rohmhaas.com
Janssen PMP, Don McKenzie: DMCKENZ2@its.jnj.com

It is the intention of the companies to support with these studies the leaching and refinement discussion in the EU.

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Many Thanks for Your Attention.

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