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Pesticide Risk Indicators in Germany

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SYNOPS spatial level

Within the German NAP the risk indicator SYNOPS is used on different spatial levels

The same assessment procedures are used to analyze the impact of pesticide use on the environment

field/farm level
SYNOPS-WEB

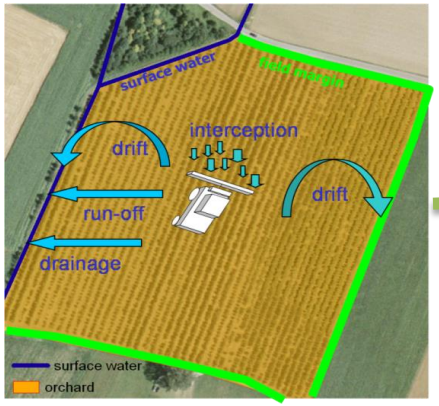
regional level
SYNOPS-GIS

national level
SYNOPS-TREND

Risk indicator: SYNOPS with different approaches

SYNOPS Type	Purpose	Environmental data	Pesticide use data	Assessment of IPM impact
TREND 	▪ tracking of the risk trends ▪ risks for pesti-cide groups on national level	▪ realistic worst case scenario	▪ sales data or aggregated use data (no realistic application)	▪ **difficult**, since active ingredients are analyzed separately ▪ mitigation measures ARE NOT considered
GIS 	▪ identification of hotspots ▪ regional analysis of risk	▪ field based input for soil, climate and crop data from GIS databases	▪ real application scenarios from field based surveys ▪ random distribution	▪ **possible**, since application strategies on field level are evaluated ▪ mitigation measures CAN BE considered
WEB 	▪ comparison of pesticide use strategies under environmental conditions	▪ field based input for soil, climate and crop data from real field data or GIS data-bases	▪ real application scenarios from demonstration farms, station experiments of single farmers	▪ **possible**, since application strategies on field level are evaluated ▪ mitigation measures CAN BE considered

SYNOPS - Risk assessment



PPP-Database (BVL)

PSM 1
Wirkst. Formulierung Auflagen...
PSM 2
Wirkst. Formulierung Auflagen...
.....

acitve ingredients (JKI)

Wirkstoff 1
Koc, DT50 LC50 ;NOEC
Wirkstoff 2
Koc, DT50 LC50 ;NOEC
.....

Exposure

soil

surface water

off crop areas

Toxicity

earthworm, collembolae

daphnie, algea, duck weed, fish, chironomus

Honeybee,

NTA, non target plants

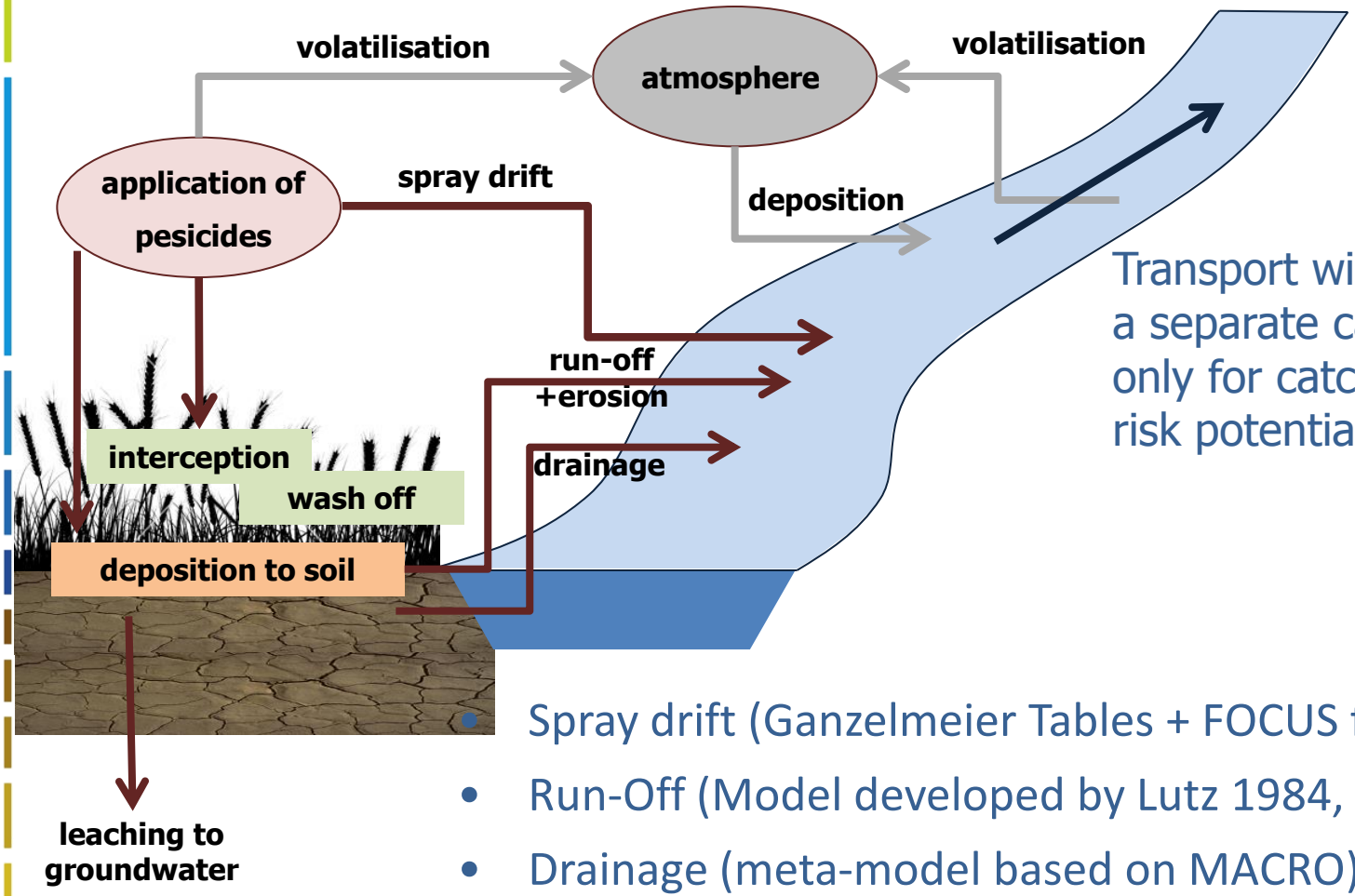
$$Risk\ (ETR) = \frac{Exposure\ (PEC)}{Toxicity\ (NOEC\ /LC50)}$$

SYNOPS-WEB
field

SYNOPS-GIS
regional

SYNOPS-TREND
national

modeled exposition pathways in SYNOPS

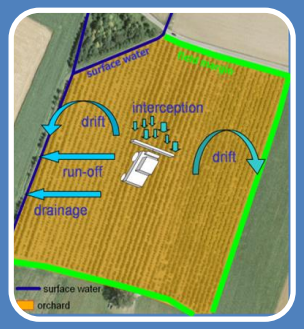


Transport will be assessed with a separate catchment model only for catchments with high risk potentials (hot spots)

- Spray drift (Ganzelmeier Tables + FOCUS functions)
- Run-Off (Model developed by Lutz 1984, REXTOX)
- Drainage (meta-model based on MACRO)
- Erosion (united soil loss equation according to FOCUS)
- Leaching to Groundwater (GeoPearl as implemented in HAIR)

Risk assessment of application patterns

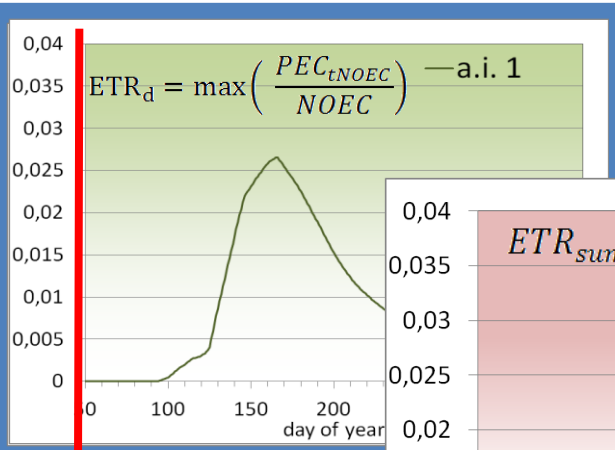
Addition of risk indices on daily basis

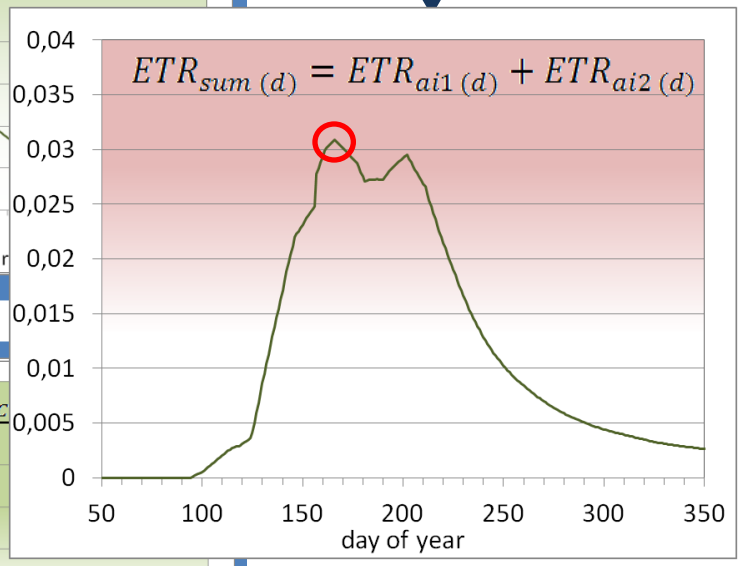


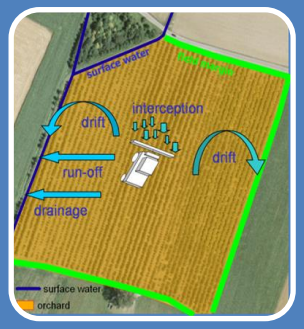
a.i. 1

- application 1
- application 2
- application 3
- application 4

$NOEC_{daphnia}$= *0.52* mg l^{-1}



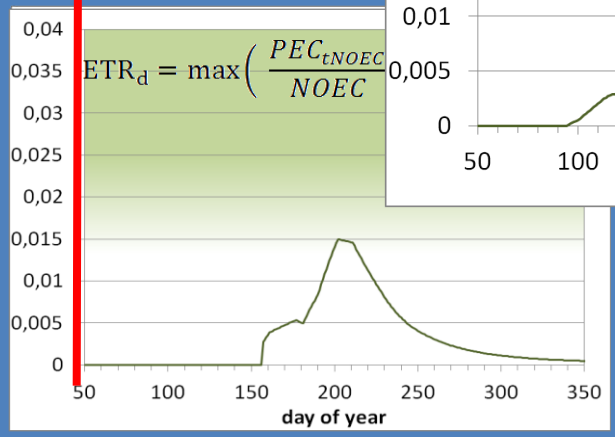




a.i. 2

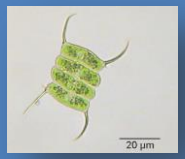
- application 1
- application 2
- application 3

$NOEC_{daphnia}$= 0.002 mg l^{-1}



Aggregation for aquatic and terrestrial compartments

$$\mathbf{ETR}_{\mathbf{aquatic}} = \max(\mathrm{ETR}_{algae}, \mathrm{ETR}_{daphnia}, \mathrm{ETR}_{fish}, \mathrm{ETR}_{lemna}, \mathrm{ETR}_{chironomus})$$






$$\mathbf{ETR}_{\mathbf{soil}} = \max(\mathrm{ETR}_{earthworm}, \mathrm{ETR}_{collembolae})$$


$$\mathbf{ETR}_{\mathbf{soil}} = \max(\mathrm{ETR}_{bee}, \mathrm{ETR}_{NTA})$$

Four risk categories for SYNOPS results

	acute risk	chronic risk
very low risk	ETR<0.01	ETR<0.1
low risk	0.01< ETR<0.1	0.1< ETR<1
medium risk	0.1< ETR<1.0	1< ETR<10
high risk	ETR >1.0	ETR >10

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SYNOPS-TREND

Tracking risk trends - the database

Sales data on the annual volume of active ingredients in kg

1996, 1998, 1999, 2000, 2001, 2002, 2004, 2005
(serve as base line – years)

2006 – 2013
(years following the baseline)

step 1

a. Compilation of the relevant (registered) potential uses of all active ingredients (>1 t /year) based on the German product database
b. Calculation of their application area in the corresponding year according to the procedure of Gutsche & Rossberg (OECD, 1999)

> 19.000 potential uses

Tracking risk trends - SYNOPS processing

step 2

For each potential use SYNOPS calculates a set of risk indices:

5 risk indices for aquatic organisms

algea, duck weed, daphnia, fish, chironomus

2 risk indices for terrestrial organisms

earthworm, honey bee+ (in prep. collembole, NTA)

Aggregated risk indices for 2 environmental compartments

aquatic: maximum der 5 aquatic organisms

terrestrial: maximum of 2 terrestrial organisms

SYNOPS uses the registered dose rate

SYNOPS runs under „worst case“ environmental conditions:

the application site is adjacent to a ditch with **depth of 0.3** m and **width of 1.5 m**

three days after application a **strong rainfall of 30 mm** happen

the application site has **a slope of 3%**

the soil of the application site is **loamy** with organic **carbon content of 1.5%**

Aggregation of SYNOPS assessments

step 3

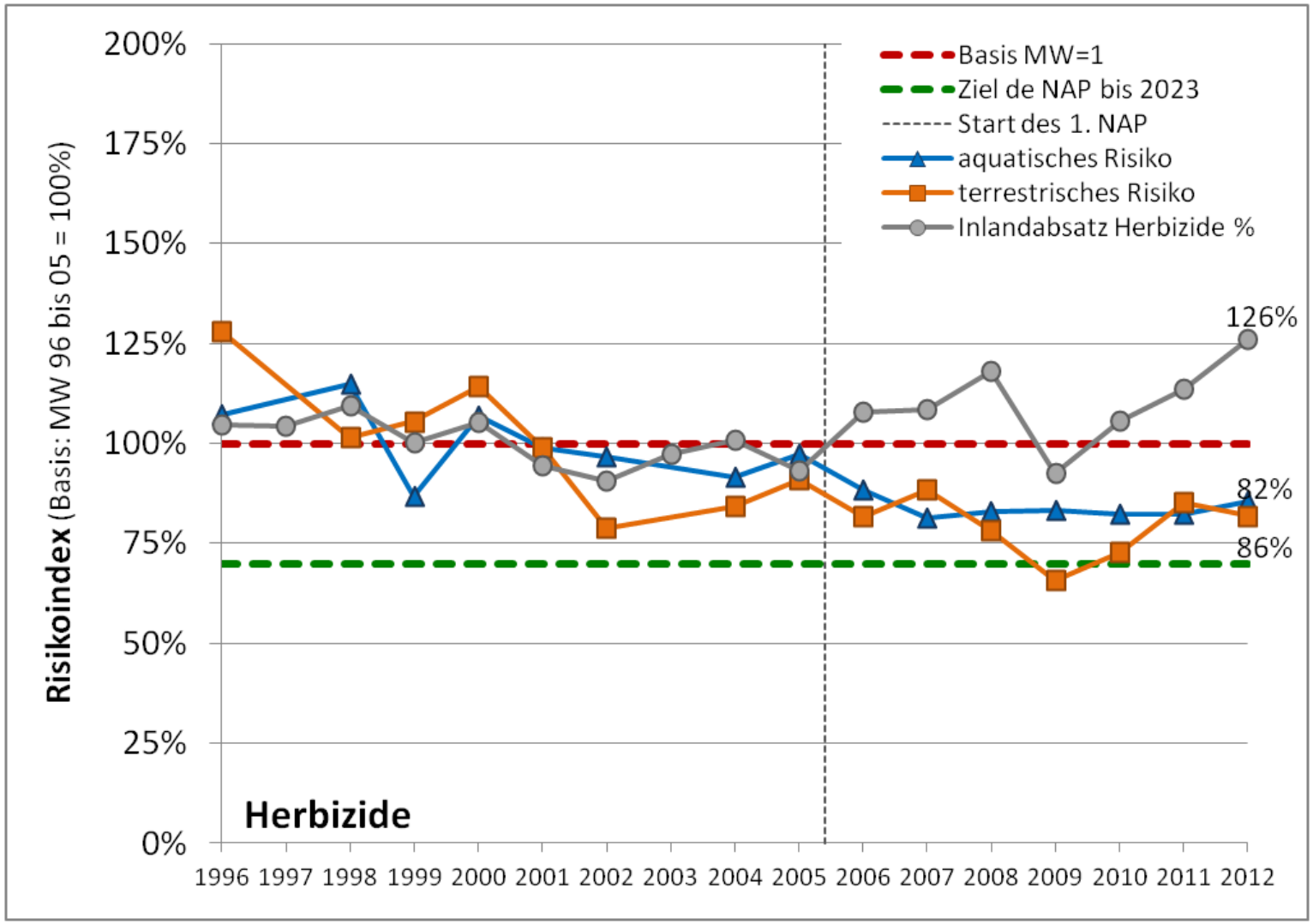
Weighted mean values per year are calculated separately for **herbicides, fungicides** and **insecticides**

The applied weights are the **estimated application areas of each use**

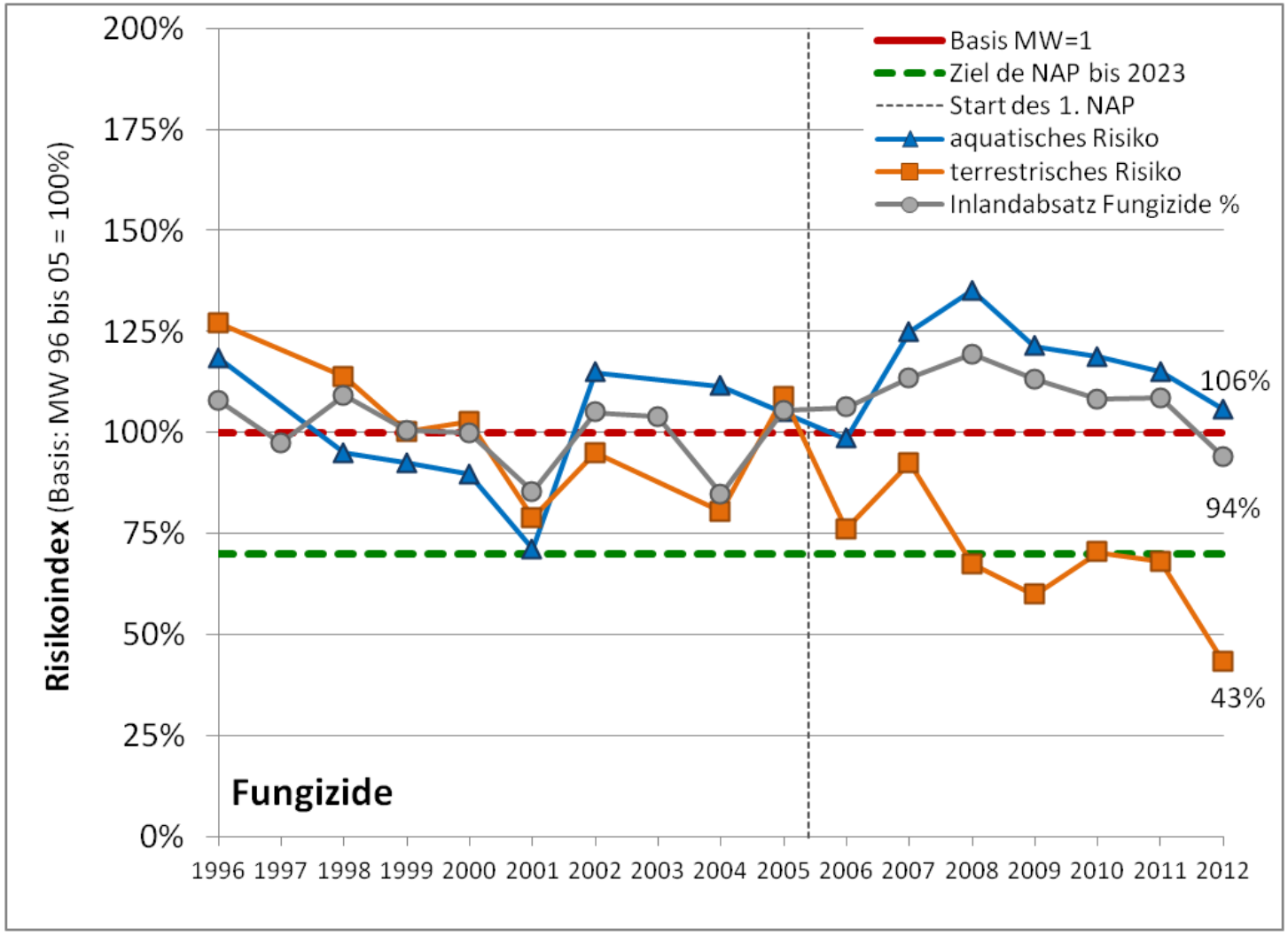
Additionally, weighted means of all 9 risk indices for the period 1996 – 2005 were calculated for herbicides, fungicides and insecticides. **They form the base line**

Mean values per year are related to the values obtained for the base line period (base line = 100%).

SYNOPS-Trend: risk development for herbicides

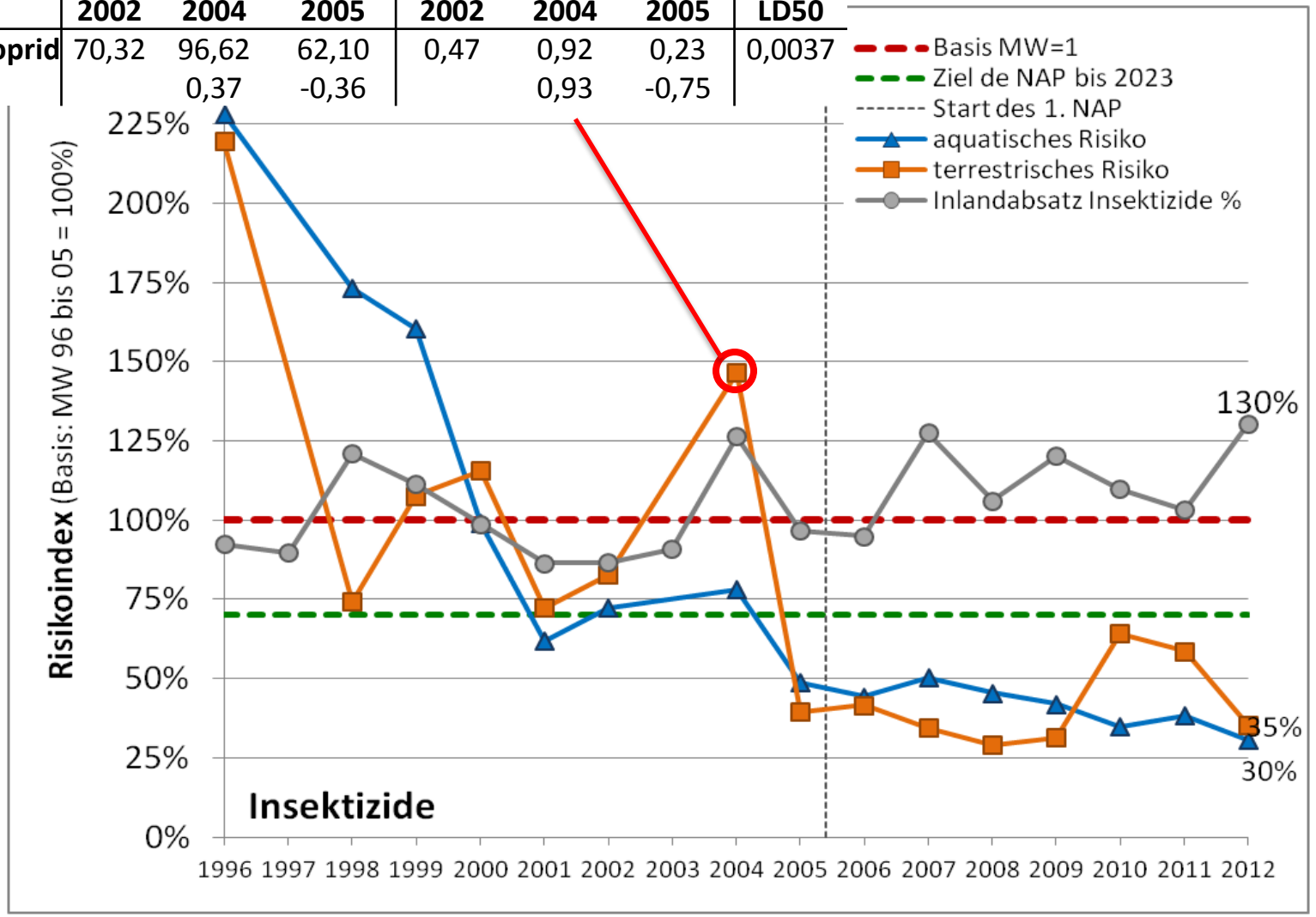


SYNOPS-Trend: risk development for fungicides



SYNOPS-Trend: risk development for insecticides

	Absatz [t]			Gew. Risikoindex			
	2002	2004	2005	2002	2004	2005	LD50
Imidacloprid	70,32	96,62	62,10	0,47	0,92	0,23	0,0037
		0,37	-0,36		0,93	-0,75	



SYNOPS-Trend:

Relativer Risikoindex in Prozent je Jahr						
	Insektizide		Fungizide		Herbizide	
	aquat.	terrest.	aquat.	terrest.	aquat.	terrest.
Basis (96-05)	100%	100%	100%	100%	100%	100%
2006	44%	42%	99%	76%	88%	82%
2007	50%	35%	125%	92%	81%	89%
2008	45%	29%	135%	67%	83%	78%
2009	42%	31%	121%	60%	83%	66%
2010	35%	64%	119%	70%	82%	73%
2011	38%	59%	115%	68%	82%	85%
2012	30%	35%	106%	43%	86%	82%

Future steps

- Integration of further reference organisms
- Separation of the terrestrial index into two indices for soil and off field areas
- Include further environmental scenarios based on a spatial analysis of slope maps, soil maps, climate maps and crop statistics
- Comparison of risk trends with other indicators as HAIR or the „Pesticide Load Indicator“ from Denmark

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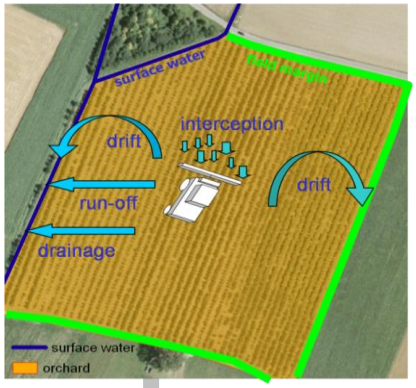
SYNOPS-GIS

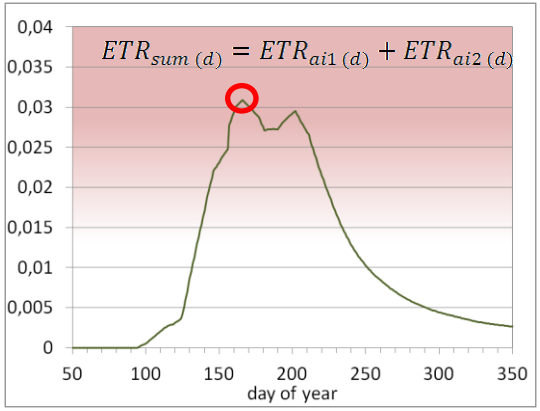
GIS based risk assessment with SYNOPS



SYNOPS calculates the risk indices for all active ingedients and reference organisms on **field basis**.

$$\textit{Risk (ETR)} = \frac{\textit{Exposure (PEC)}}{\textit{Toxicity (NOEC /LC50)}}$$

Aggregation for a complete application strategy by **addition of risk indices on daily basis**

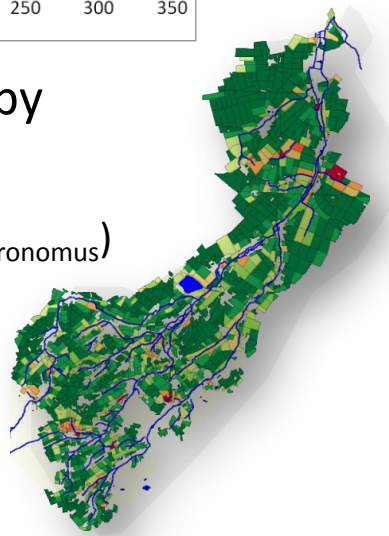


Aggregation for environmental compartments by selecting the **maximum ETR**

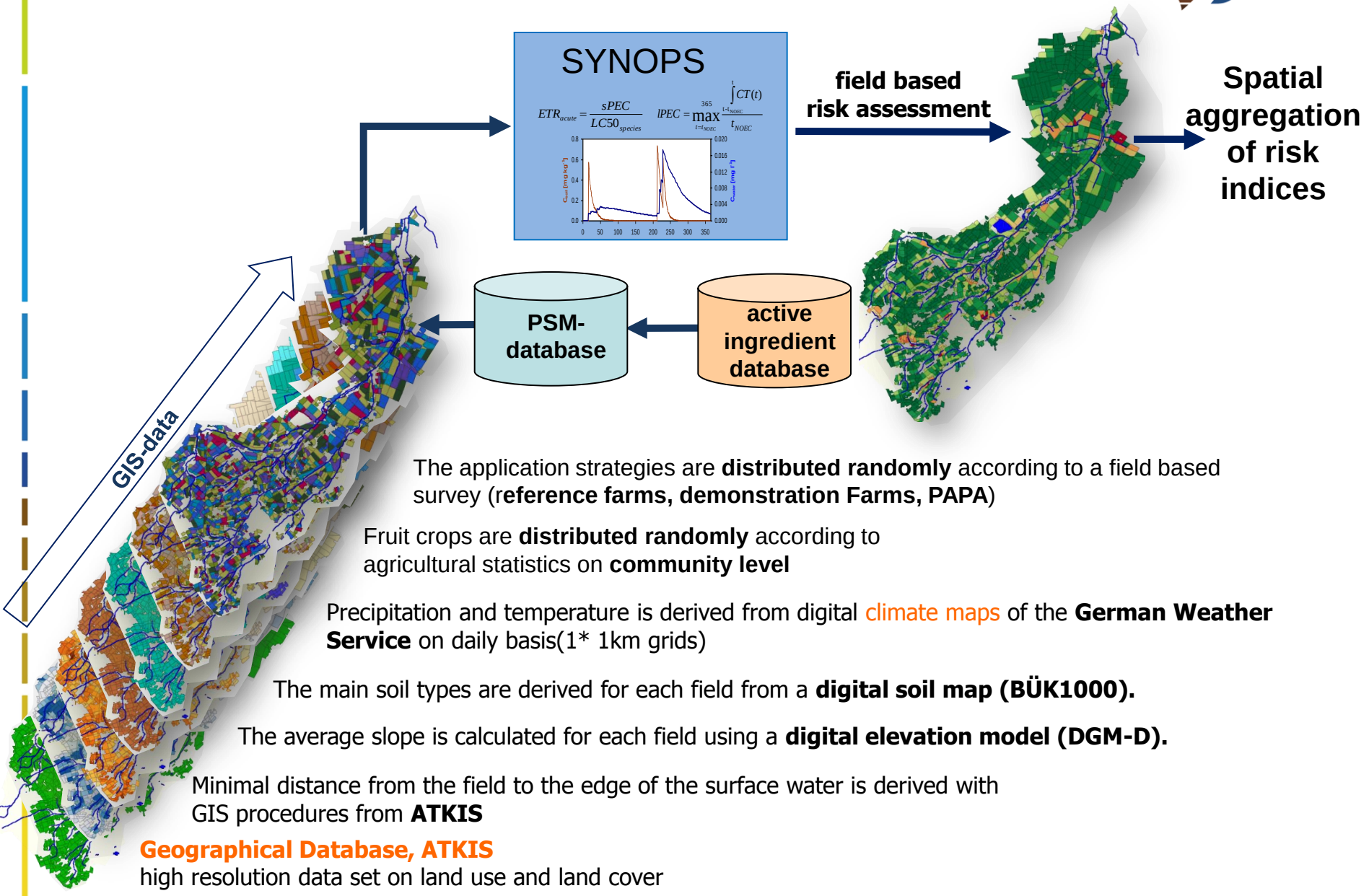
ETR $_{\textbf{aquatic}}$ = max(ETR_{algae}, $ETR_{daphnia}$, ETR_{fish}, ETR_{lemna} , $ETR_{chironomus}$)

all fields within the considered region

geographical databases + GIS procedures



GIS based risk assessment with SYNOPS



The application strategies are **distributed randomly** according to a field based survey (r**eference farms, demonstration Farms, PAPA**)

Fruit crops are **distributed randomly** according to agricultural statistics on **community level**

Precipitation and temperature is derived from digital climate maps of the **German Weather Service** on daily basis(1* 1km grids)

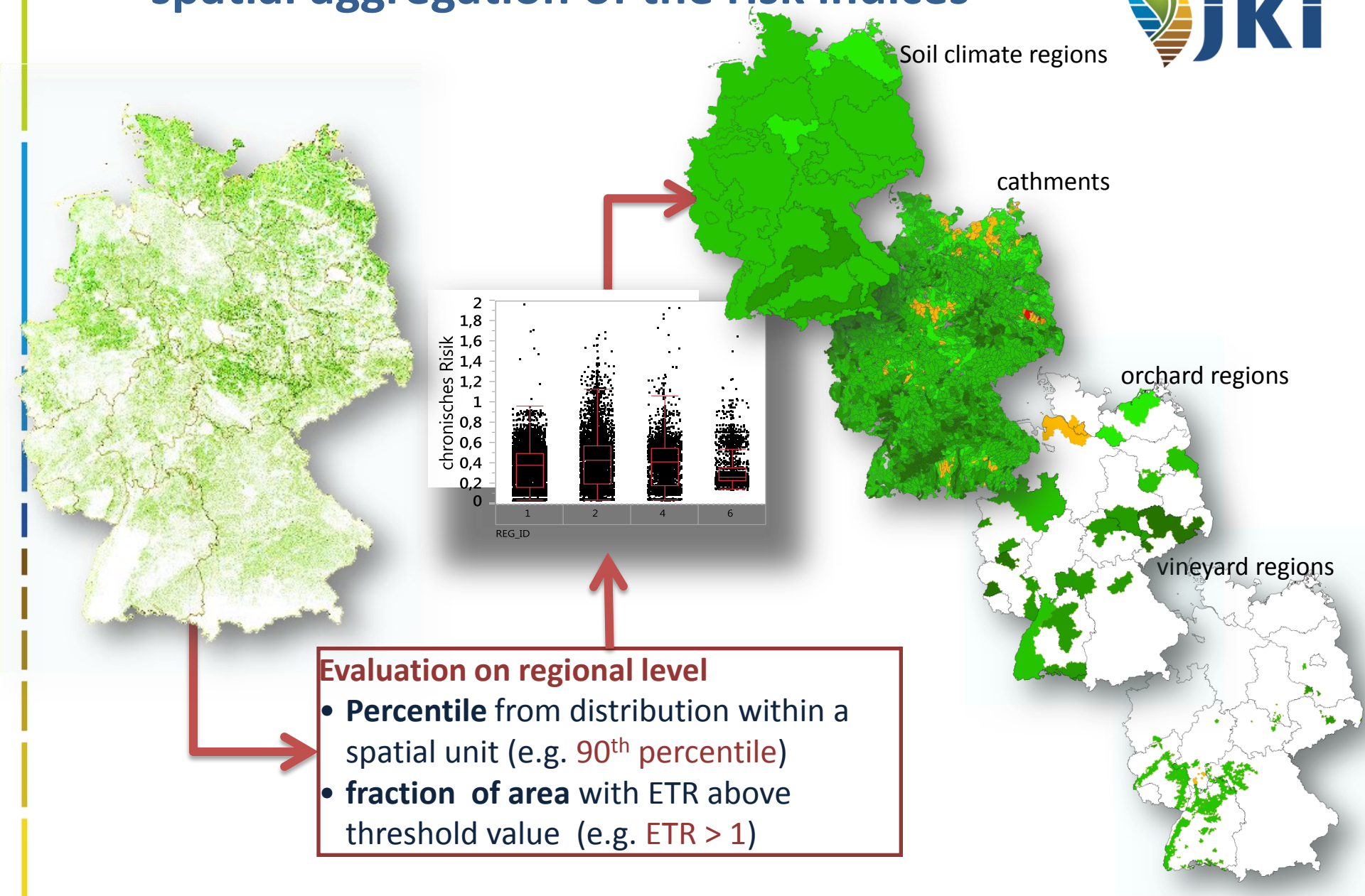
The main soil types are derived for each field from a **digital soil map (BÜK1000).**

The average slope is calculated for each field using a **digital elevation model (DGM-D).**

Minimal distance from the field to the edge of the surface water is derived with GIS procedures from **ATKIS**

Geographical Database, ATKIS
high resolution data set on land use and land cover

spatial aggregation of the risk indices



Evaluation on regional level

- **Percentile** from distribution within a spatial unit (e.g. 90th percentile)
- **fraction of area** with ETR above threshold value (e.g. ETR > 1)

Evaluate the impact of risk mitigation measures on the regional aquatic risk

- Region: **Germany**
- Crop: **Maize**
- Spatial unit of aggregation: **Catchment**
- Pesticide applications from reference farms in the year 2010
- random distribution of the application calendars (n= 196)

Scenario 1: **No (0%) farmer follow the product specific drift mitigation requirements**

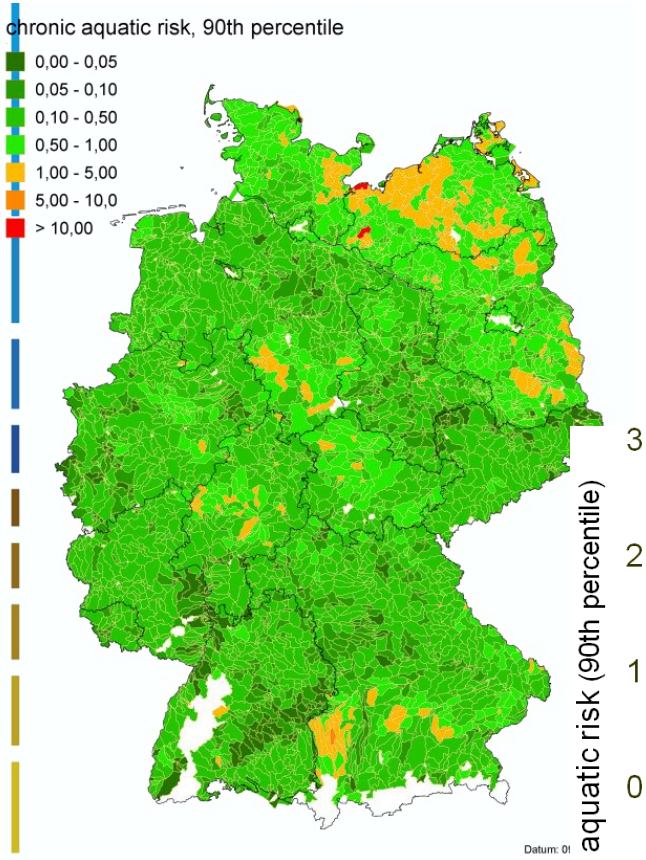
Scenario 2: **All (100%) farmers follow the product specific drift mitigation requirements**

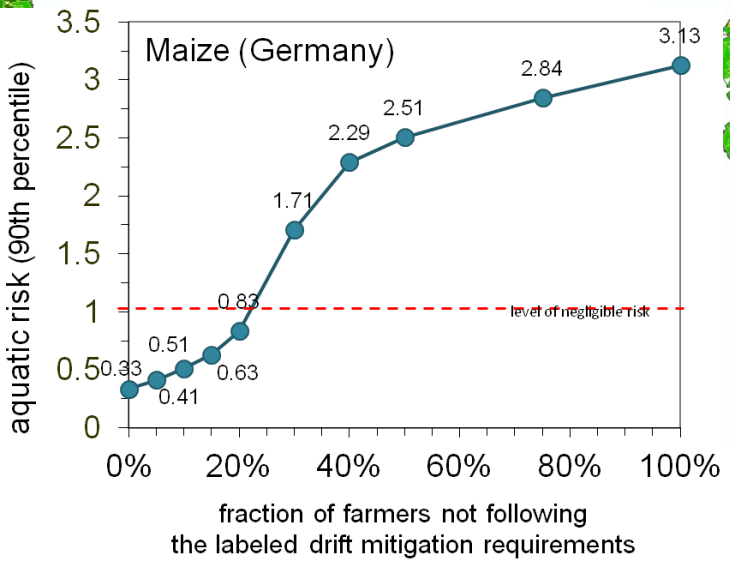
chronic aquatic risk

product specific drift mitigation requirements were considered

2010

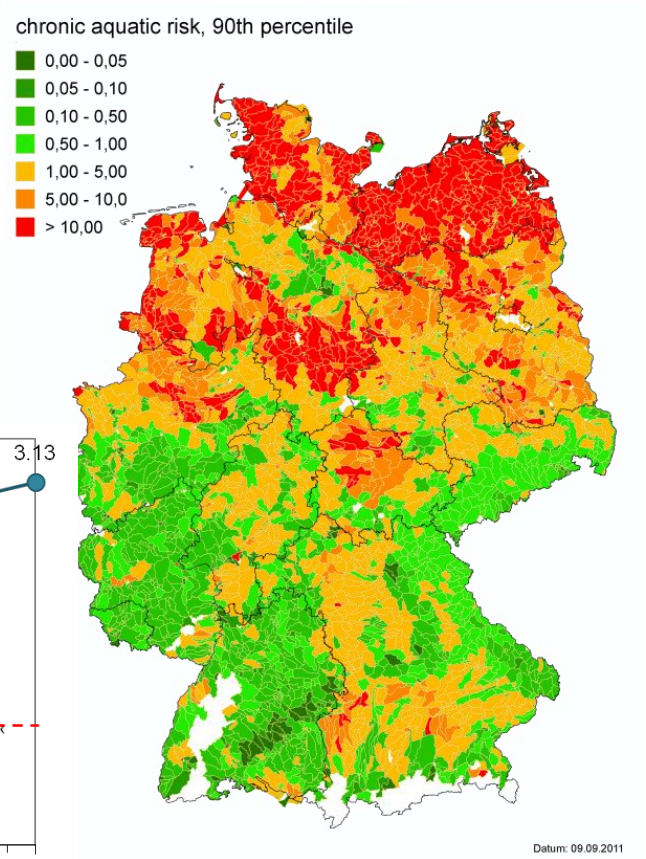
with 100% drift mitigation requirements



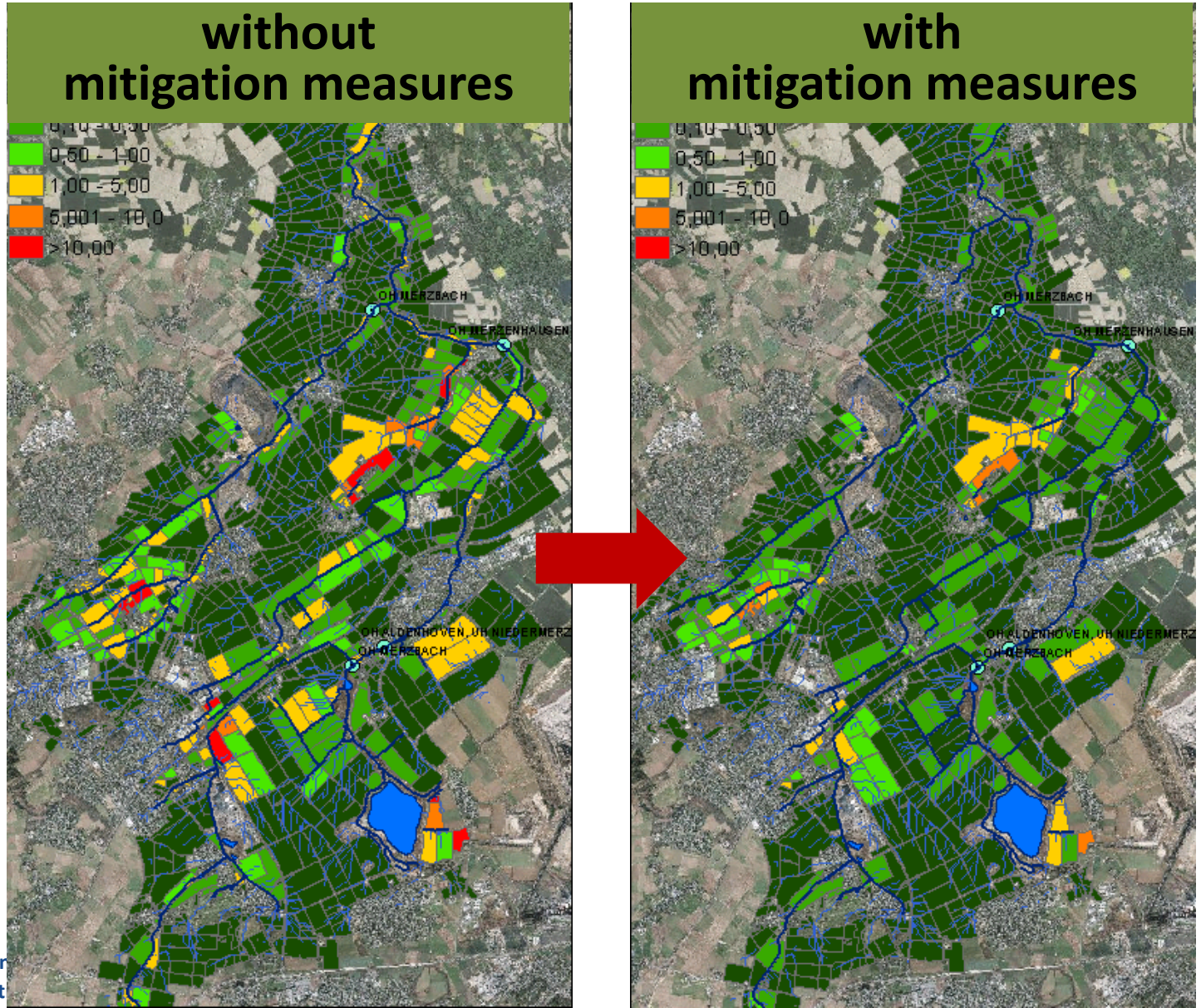


2010

without (0%) drift mitigation requirements



chronic aquatic risk potential on catchment level



Evaluate the impact of new and future IPM strategies on the regional aquatic risk

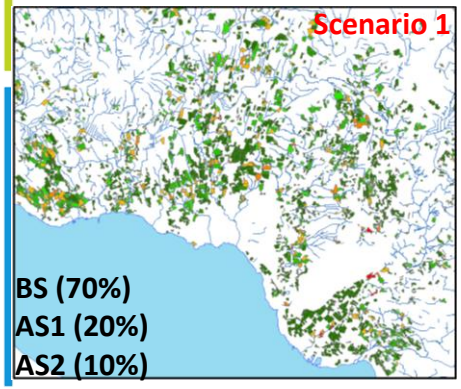
- Region: **Lake Constance-GER**
- Crop: **Apple**
- Spatial unit of aggregation: **Orchard region**
- The 100% base lines scenarios represents conventional production.
- A mixture of available scenarios depending on the **availability** and **acceptance** of the IPM systems is more realistic .
- random distribution of the defined systems according to the following scenarios:

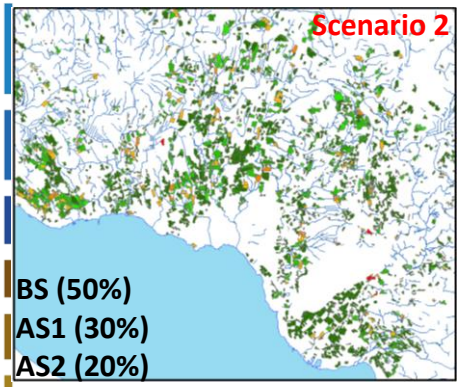
Scenario 1 **in 0-2 years: 70% BS, 20% IPM-1 and 10% IPM-2**

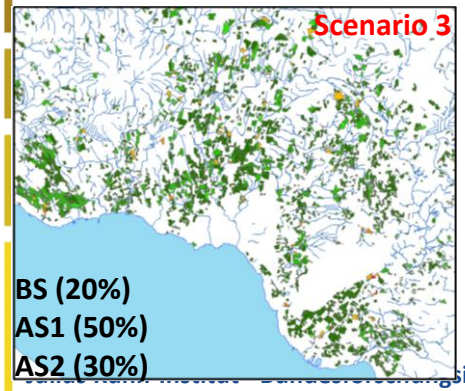
Scenario 2 **in 2-5 years: 50% BS, 30% IPM-1 and 20% IPM-2**

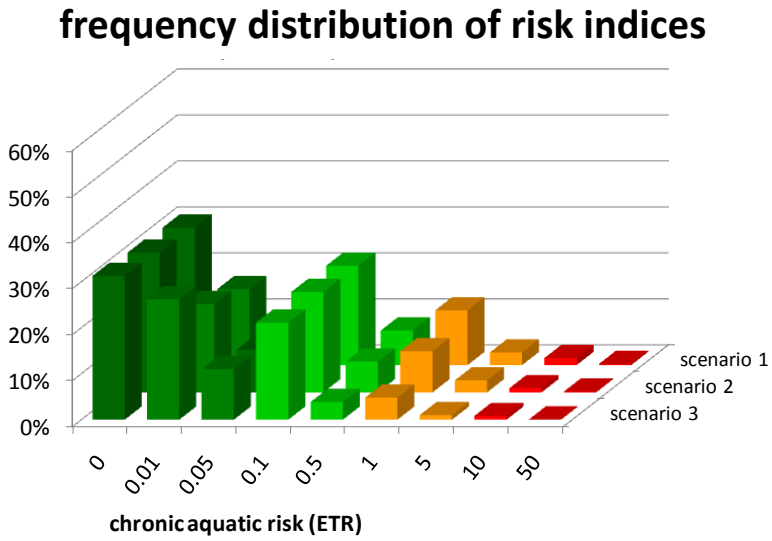
Scenario 3 **in 5-10 years: 20% BS, 50% IPM-1 and 30% IPM-2**

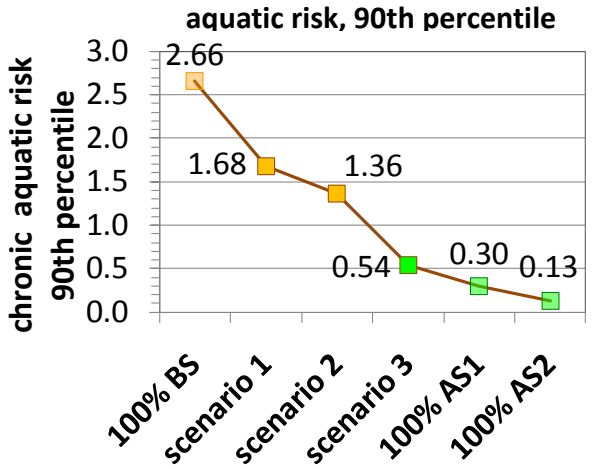
Evaluate the impact of new and future IPM strategies compared to a conventional base line strategy

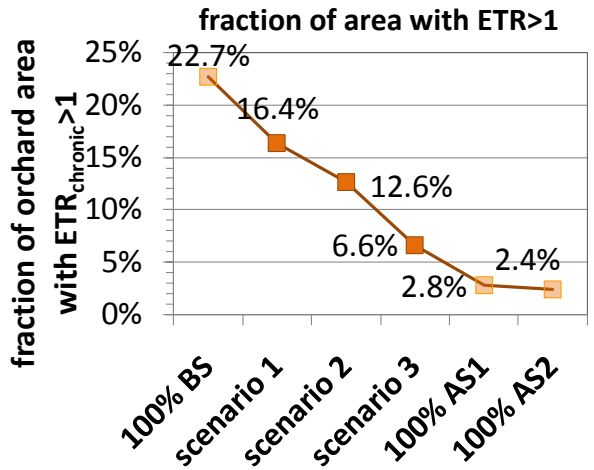












	Reduction compared to BS	
	aquatic risk, 90th percentile	fraction of area with ETR>1
Scenario 1	-36.98%	-27.78%
Scenario 2	-48.69%	-44.43%
Scenario 3	-79.69%	-70.81%

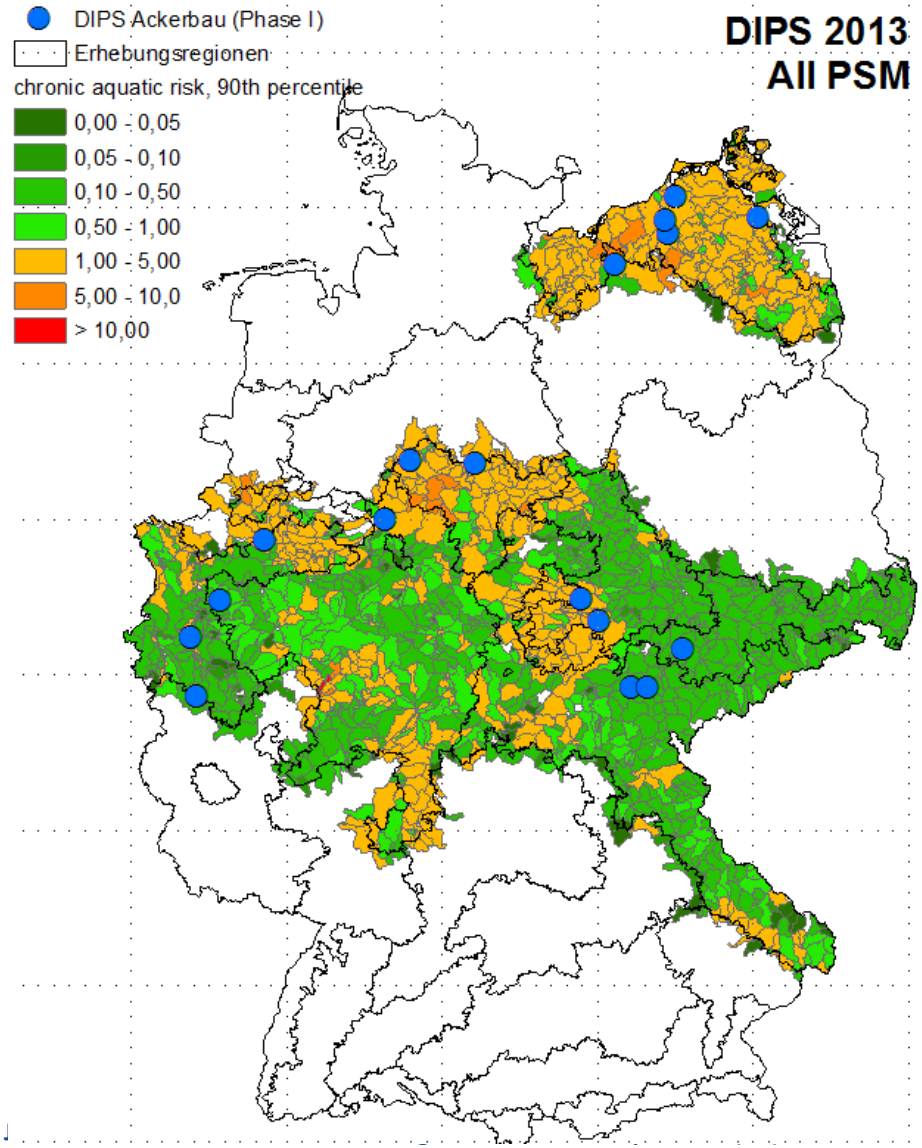
Comparison of demonstration farms with reference farms on regional level

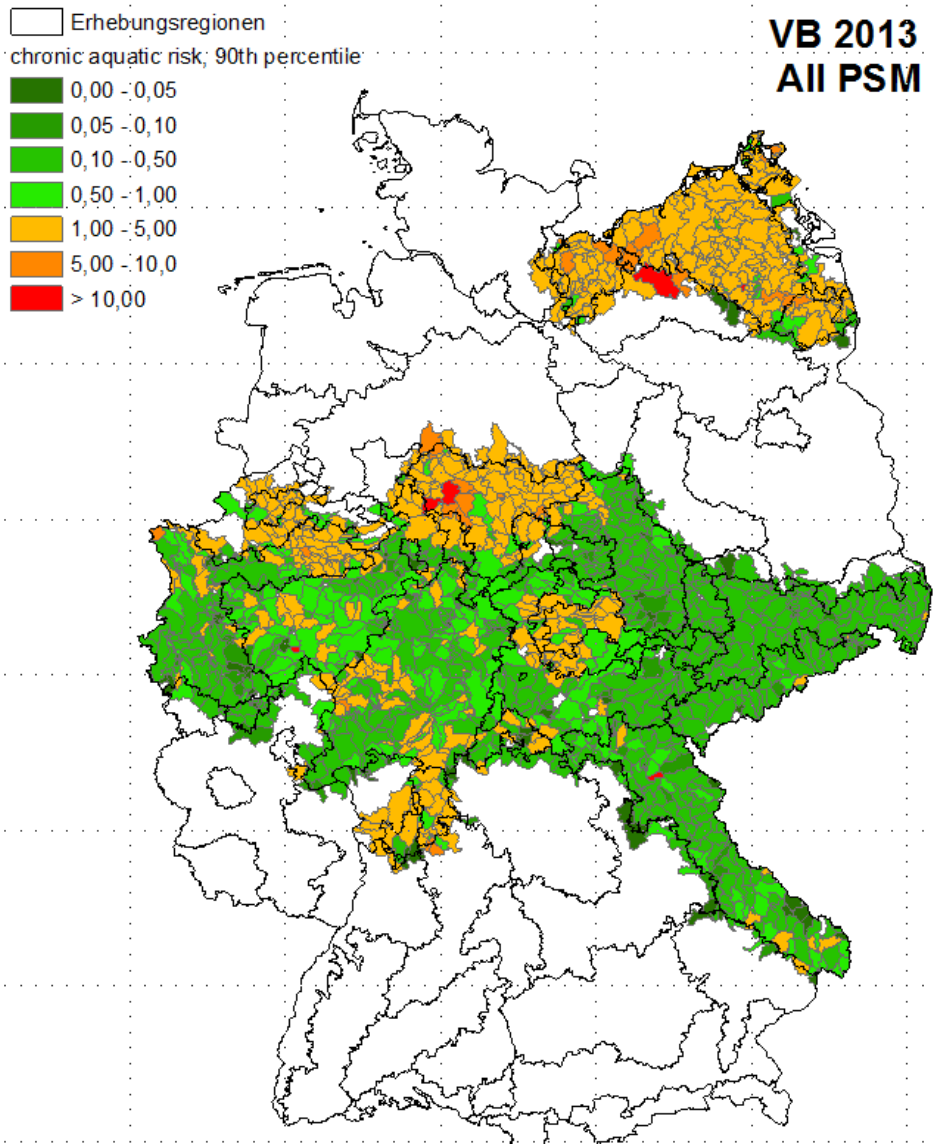
- Region: **Germany**
- Crop: **winter rye**
- Spatial unit of aggregation: **catchment**
- Pesticide applications from reference and demonstration farms in the year 2012
- random distribution of the application calendars (n= 34/35)

Scenario 1: **(100%) demonstration farms**

Scenario 2: **(100%) reference farms**

Regionales chronisches aquatisches Risiko der PSM Strategien der DIPS und VB im Ackerbau (WG)





Ackerbau (WG), BRD gesamt
Aggregierte Risikoindizes als 90. Perzentile

Ackerbau (WG)		DIPS 2011	DIPS 2012	DIPS 2013	VB 2011	VB 2012	VB 2013	Diff in % 2011	Diff in % 2012	Diff in % 2013
Anzahl Betriebe		.	10	16	.	10	13			
Anzahl Appl.-Muster		.	35	55	.	30	43			
Flächen			34679	82889		34679	82889			
Alle PSM	**chronisch aquatisch**		**0,885**	**1,264**		**1,272**	**1,570**		**0,70**	**0,81**
Insektizide			0,136	0,396		0,390	0,488			
Fungizide			0,049	0,046		0,037	0,041			
Herbizide			0,626	0,984		0,826	1,184			
Alle PSM	**akut aquatisch**		**0,451**	**0,686**		**0,539**	**0,796**		**0,84**	**0,86**
Insektizide			0,011	0,094		0,016	0,023			
Fungizide			0,025	0,013		0,016	0,026			
Herbizide			0,448	0,682		0,539	0,796			

Thank you for your attention!

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