What is the environmental impact of plant protection in European pomefruit orchards?

RA3.3 – Environmental risk and benefit assessment

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FOOD QUALITY AND SAFETY

SIXTH FRAMEWORK PROGRAMME

Integrated Pest Management in Europe

Paris, November 2010

endure diversifying crop protection

Contents

Objective

To assess the environmental impact of plant protection in four orchard regions on landscape level

Risk assessment was conducted with SYNOPS

Risk assessment on field level

Risk assessment on landscape level

GIS Database in the orchard regions

Application of SYNOPS in the orchard regions

Results of different scenarios

in the three orchard regions

SYNOPS

Exposure

Soil

surface water

non target plants

Toxicity

earthworm

daphnia, algae, fish, lemna

bee

active ingredient database

a.i.1 LC50 ;NOEC

a.i.2 LC50 ;NOEC

.....

$$\text{Risk (ETR)} = \frac{\text{calculated Exposure}}{\text{Toxicity}}$$

model application within ENDURE

SYNOPS (SustainOS)

region specific worst cases scenarios
application calendars from :
orchard system definitions (BS,AS,IS)

SYNOPS-GIS

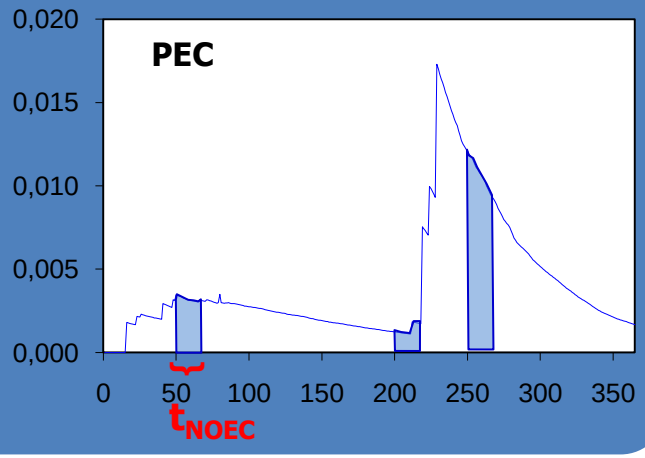
field specific GIS-data
application calendars form:
field based surveys
orchard system definitions (BS,AS,IS)

Risk assessment of application strategies

chronic aquatic risk

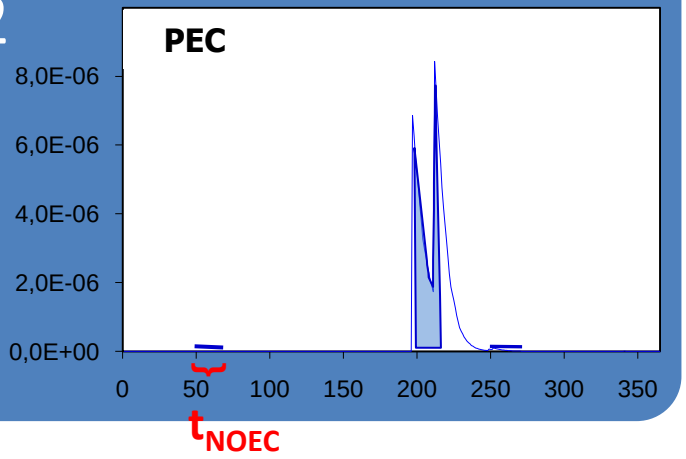
ingredient 1

- application 1
- application 2
- application 3



ingredient 2

- application 1
- application 2



Risk assessment of application strategies

chronic aquatic risk

ingredient 1

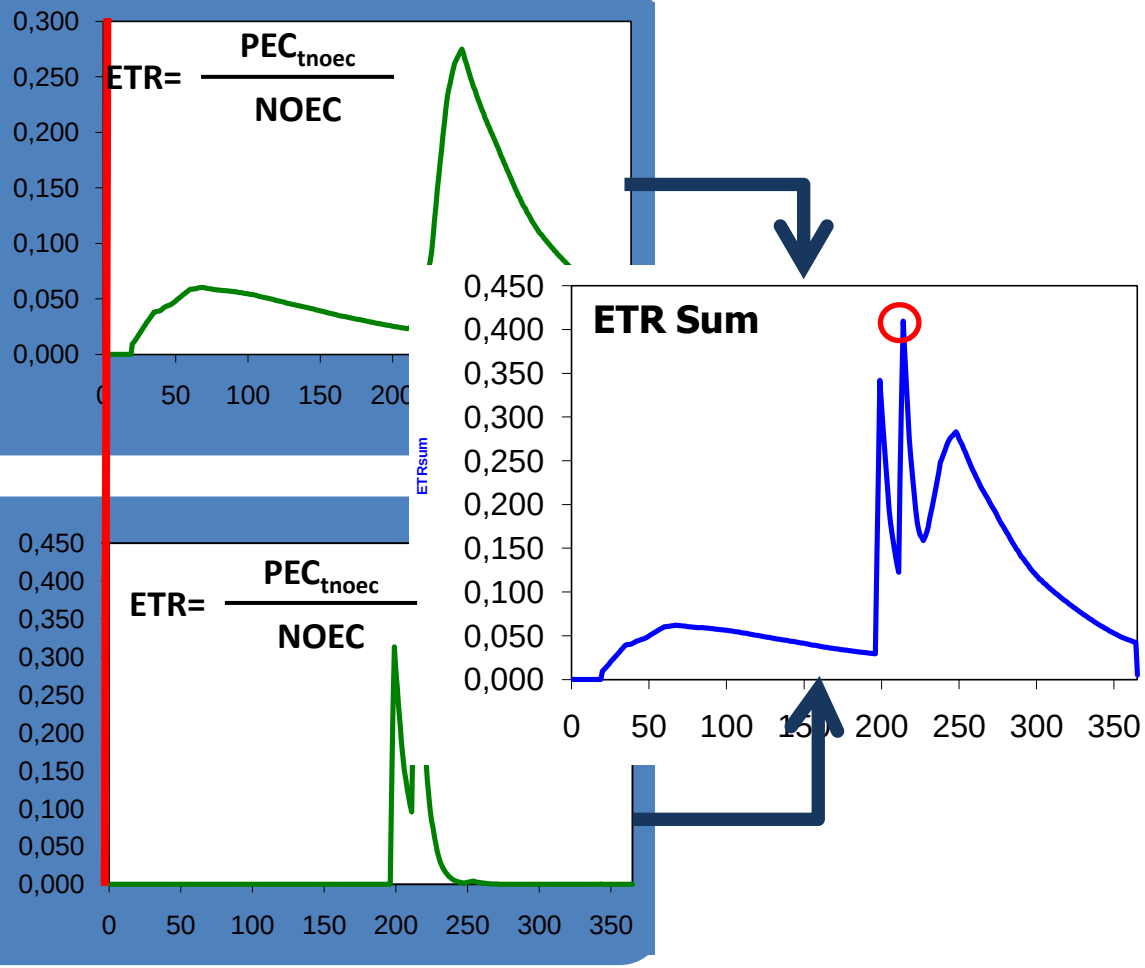
- application 1
- application 2
- application 3

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

ingredient 2

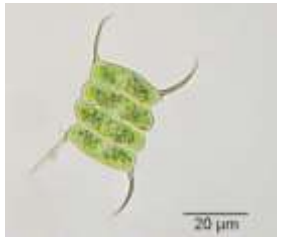
- application 1
- application 2

$NOEC_{daphnia}$ = 0.00002 mg l^{-1}



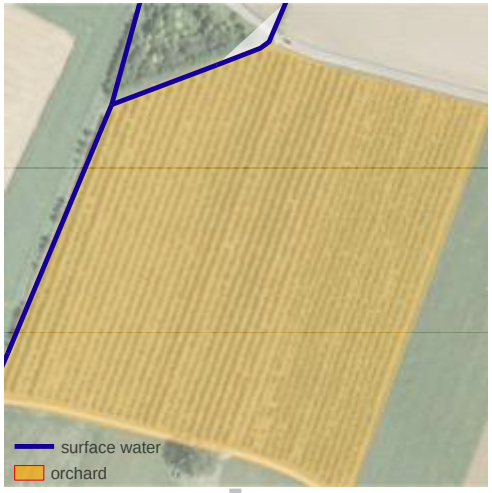
Aquatic risk

$$ETR_{aquatic} = \max(ETR_{algae}, ETR_{daphnia}, ETR_{fish}, ETR_{lemna})$$





GIS-based risk assessment with SYNOPS

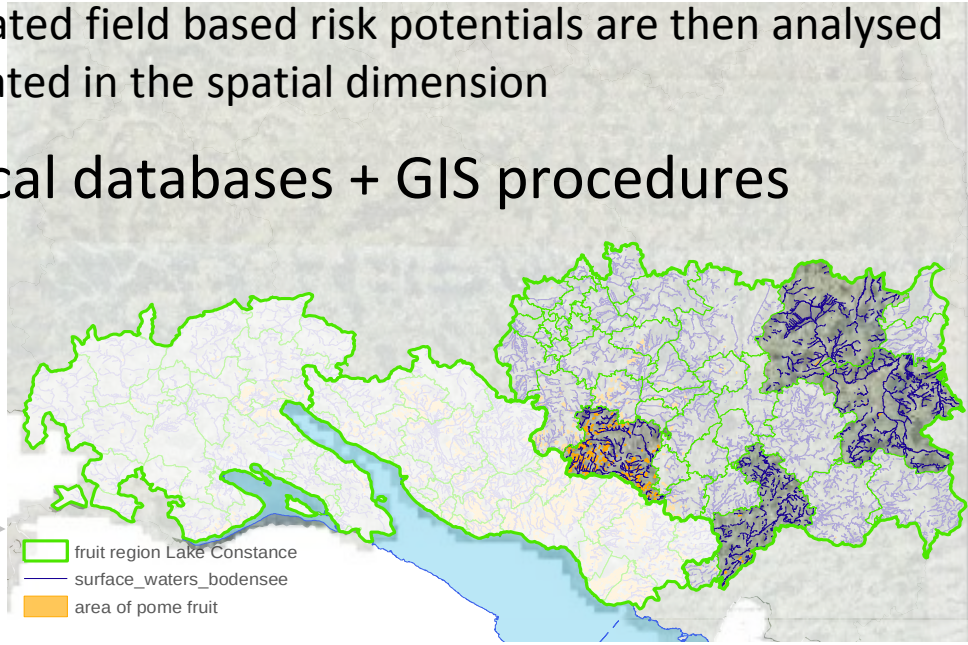


SYNOPS calculates the risk potential of all orchards within the considered region.

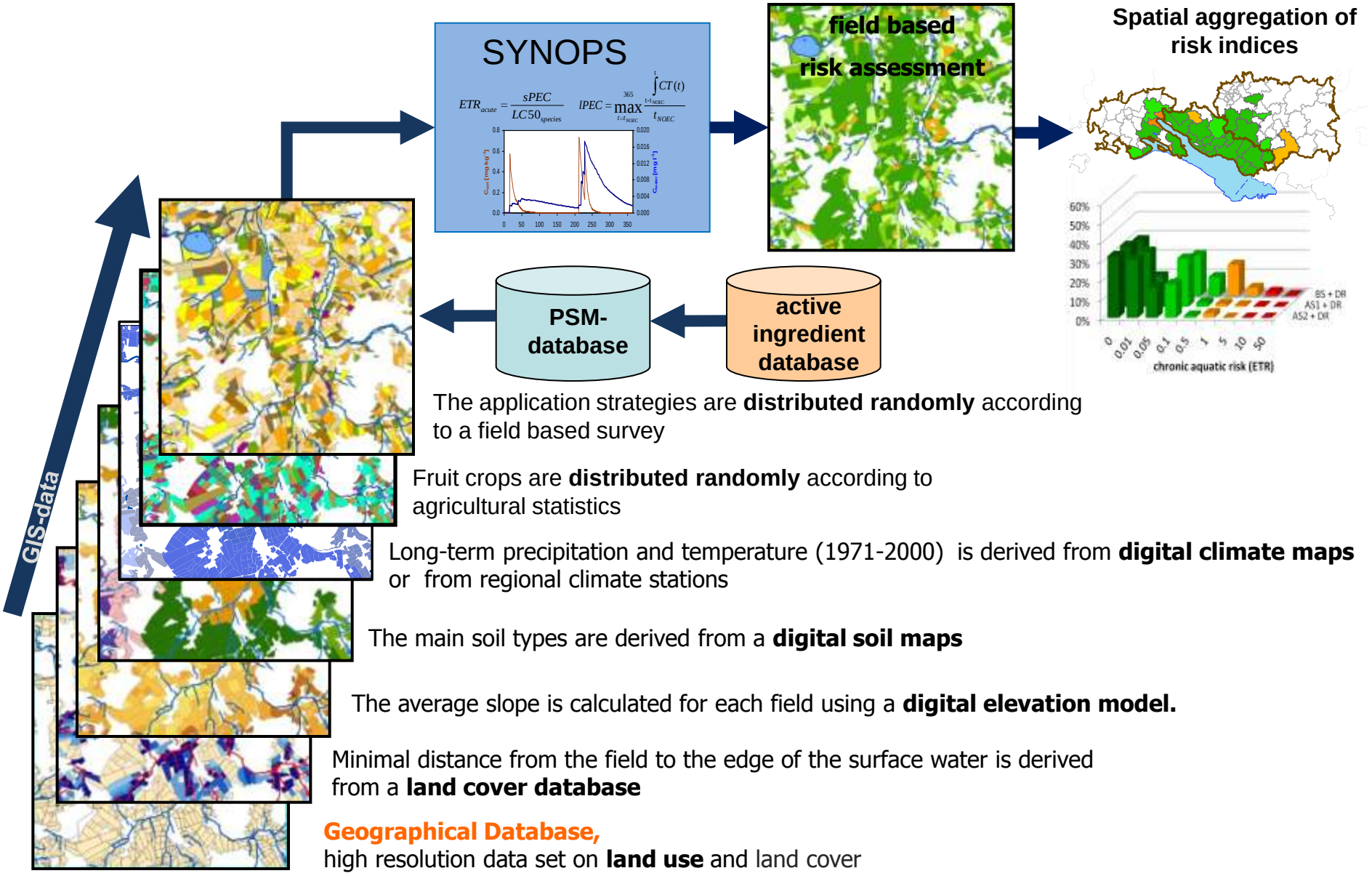
→ regional approach

- input data for all fields in the considered region have to be available on field level
- the calculated field based risk potentials are then analysed or aggregated in the spatial dimension

→ geographical databases + GIS procedures



GIS-based risk assessment with SYNOPS



The application strategies are **distributed randomly** according to a field based survey

Fruit crops are **distributed randomly** according to agricultural statistics

Long-term precipitation and temperature (1971-2000) is derived from **digital climate maps** or from regional climate stations

The main soil types are derived from a **digital soil maps**

The average slope is calculated for each field using a **digital elevation model.**

Minimal distance from the field to the edge of the surface water is derived from a **land cover database**

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

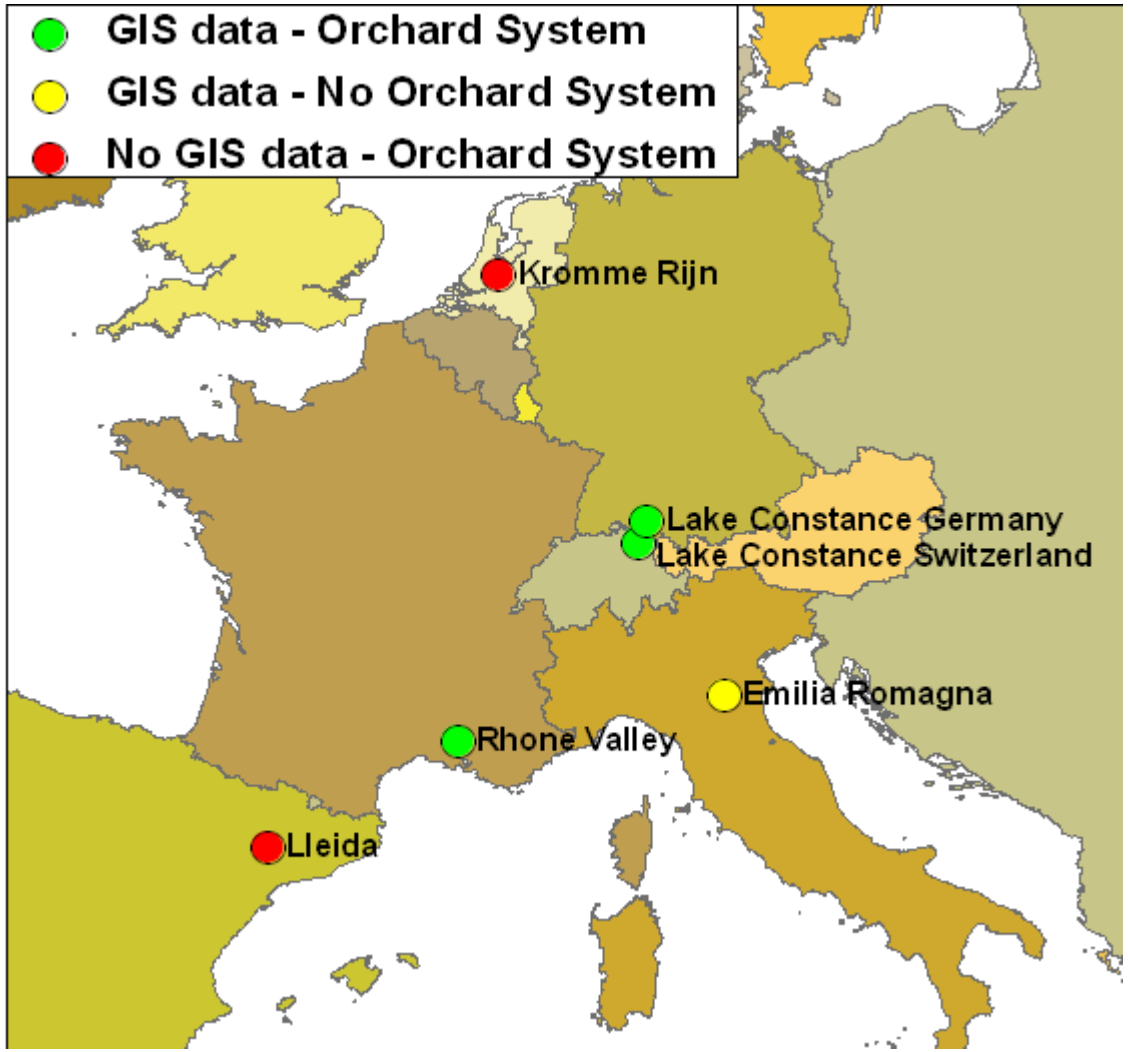
available spatial databases

country region	land cover data and surface water	slope	climate	soil
Germany **Lake Constance**	**ATKIS** area=10248 ha orchards=4232	digital elevation model (25m)	regional climate data (5 stations)	digital soil map
Switzerland **Lake Constance**	**Swisstopo** area=6370 ha orchards=6230	digital elevation model (2m)	regional climate data (1 station)	
France **Rhone Valley**	**digitalized from areal photos** area=1871 ha orchards=3157	Hair database (10*10 km average values)	regional climate data (1 station)	Hair database (10*10 km)
Italy **Emilia-Romagna** (part Ferrara)	**3rd level of Corine Land cover classification** area= 10135 ha orchards (artificial)=5561	digital elevation model (10m)	regional climate data (interpolated)	digital soil map
Netherlands Kromme Rijn	No GIS data	-	-	
Spain Lleida	No GIS data	-	-	

available pesticide use data

country / region	Survey	years	number of application schedules per year	defined systems (RA. 2.5)
Germany **Lake Constance**	NEPTUN field based	01, 04, 07,	>50	BS, AS1, AS2, IS
Switzerland **Lake Constance**	field based (not available for publication)	01, 02, 03, 04, 05	>250	BS, AS1, AS2, IS
France **Rhone Valley**	"zone 13" field based	06, 07, 08	>70	BS, AS1, AS2, IS
Italy **Emilia-Romagna**	recommendations from advisor	09	>15	-

Orchard regions

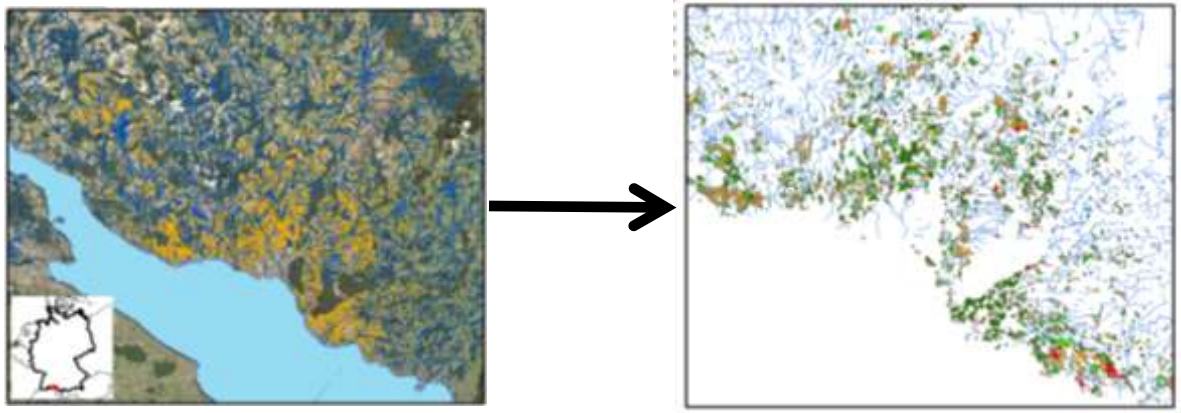


Rating of chronic aquatic risk

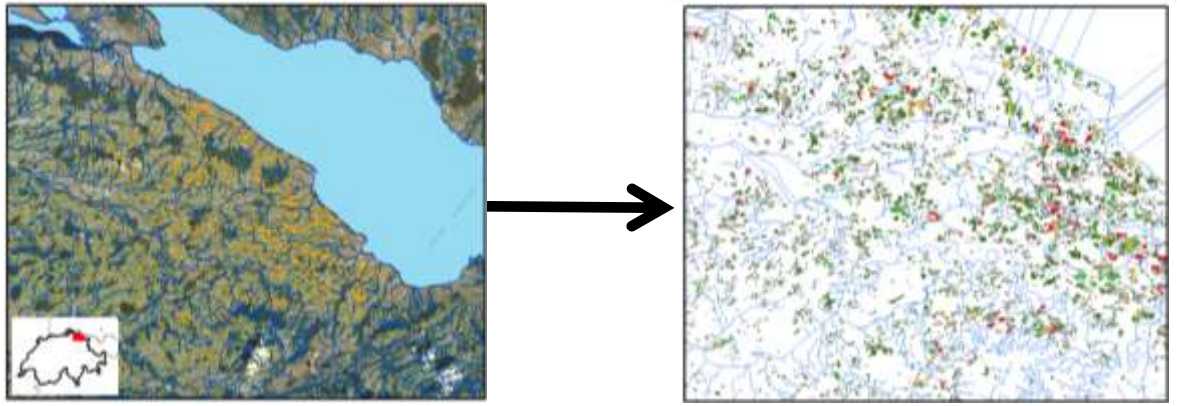
Four risk categories for SYNOPS results	chronic risk
very low risk	ETR<0.1
low risk	0.1< ETR<1
medium risk	1< ETR<10
high risk	ETR >10

chronic aquatic risk asessed with SYNOPS

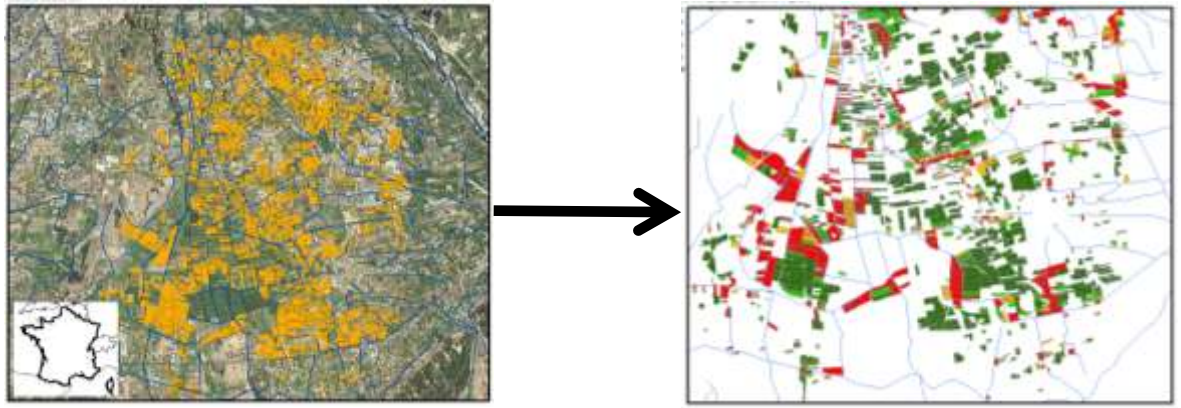
Lake Constance
Germany



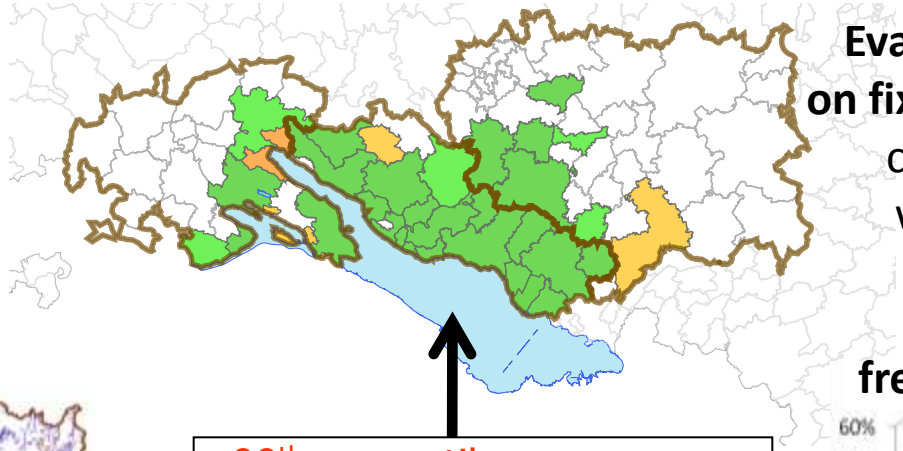
Lake Constance
Switzerland



Rhone Valley
France

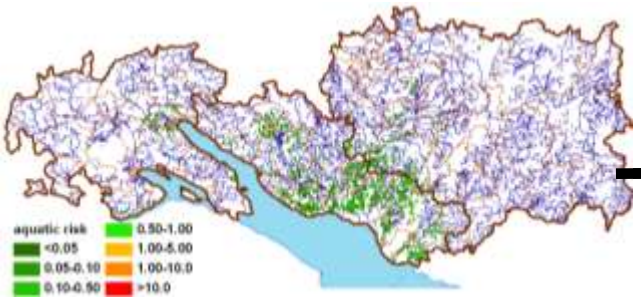


Spatial aggregation of the risk potential



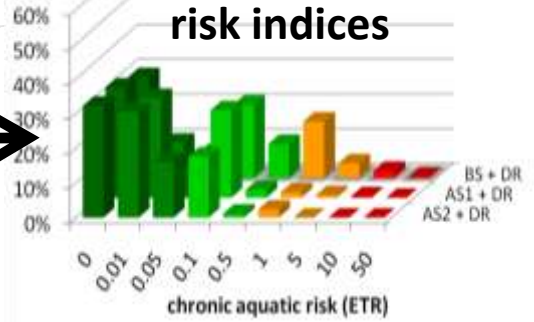
Evaluation based on fixed spatial units

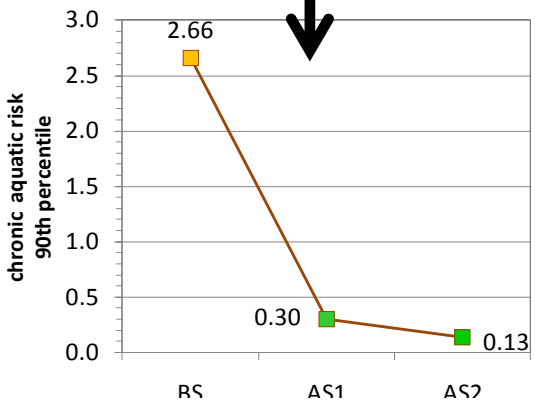
communities
water sheds
counties



- 90th percentile
- fraction orchard area with medium and high risk
- mean + std
- xth percentile

frequency distribution of risk indices





Evaluation for the whole orchard region

on statistical value representing the regional risk

aquatic risk on landscape level:
impact of product specific drift mitigation requirements

- Region: Lake Constance, Germany
- Pesticide applications from field based surveys (NEPTUN) in the year 2001, 2004, 2007
- random distribution of the application calendars (n= 42-112)

Scenario 1: **No (0%) producer follows the product specific drift mitigation requirements**

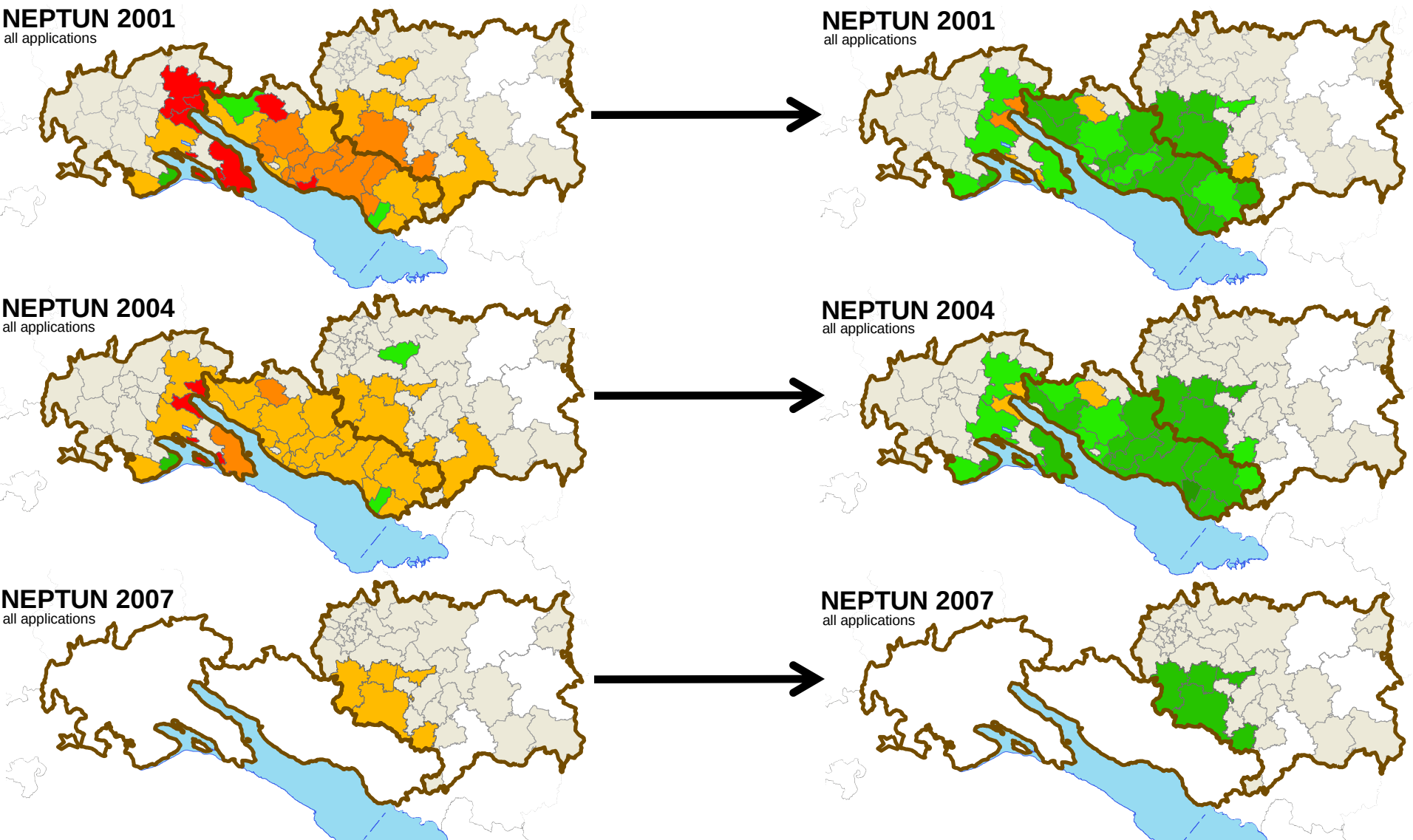
Scenario 2 **All (100%) producers follow the product specific drift mitigation requirements**

aquatic risk potential: Lake Constance

product specific drift mitigation requirements

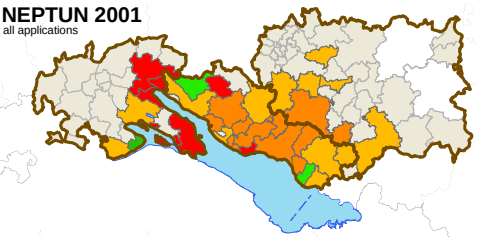
No (0%) producer follows the product specific drift mitigation measures

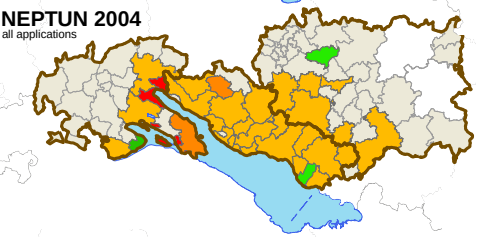
All (100%) producer follow the product specific drift mitigation measures

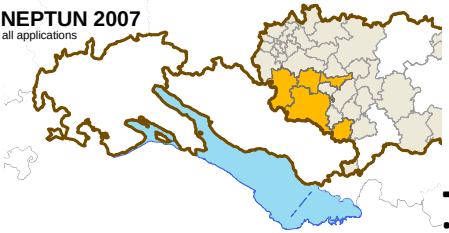


aquatic risk potential: Lake Constance

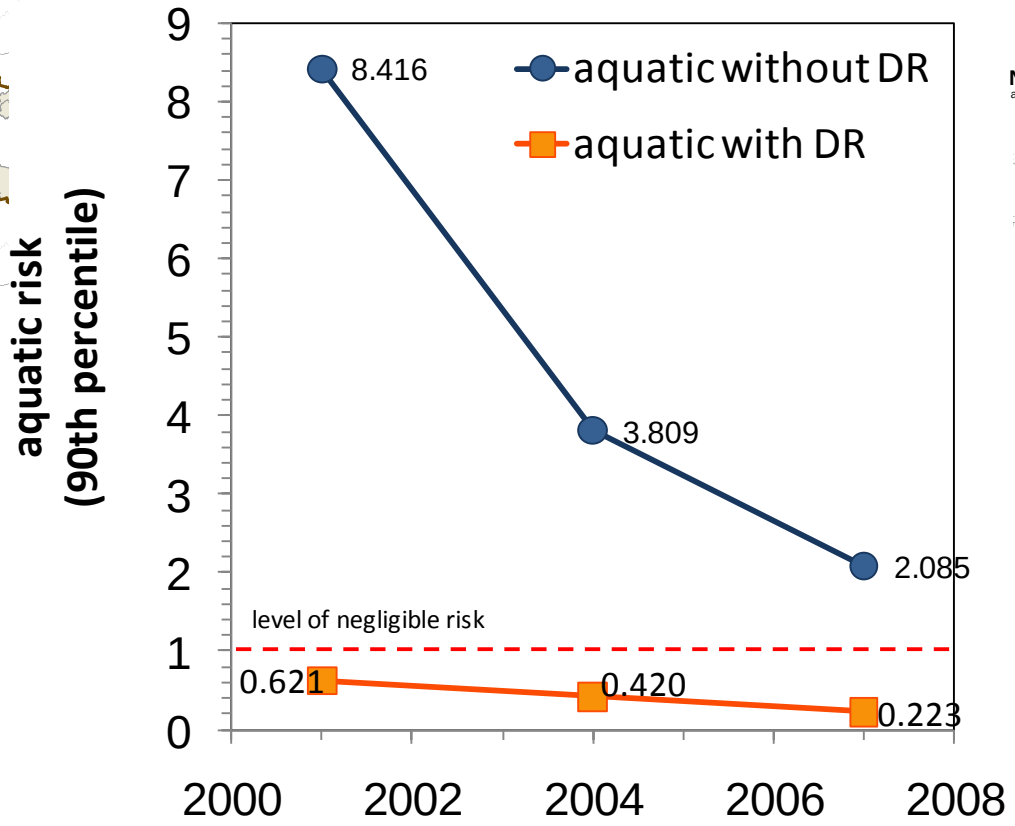
product specific drift mitigation requirements

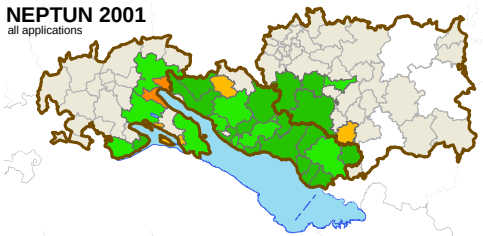


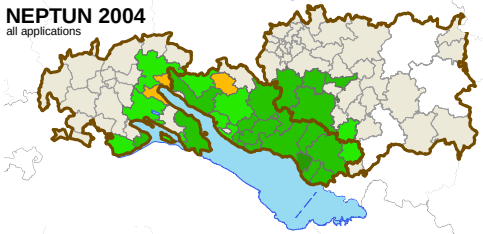


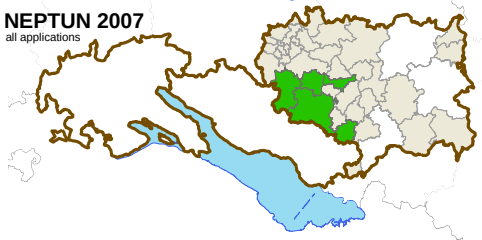


		Risk reduction
2001 vs.2007	no DR	-75.2%
	DR	-64.0%
no DR vs. DR	2001	**-92.6%**
	2004	**-89.0%**
	2007	**-89.3%**



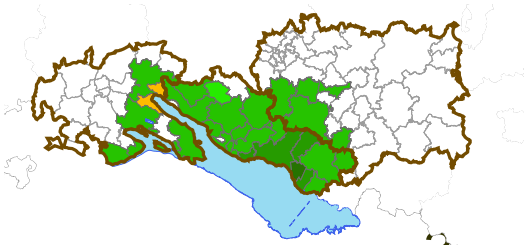


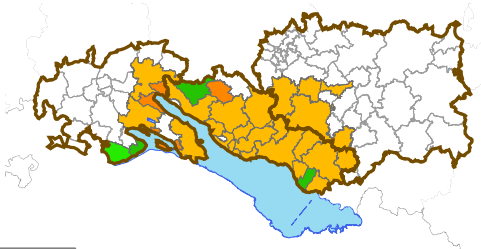


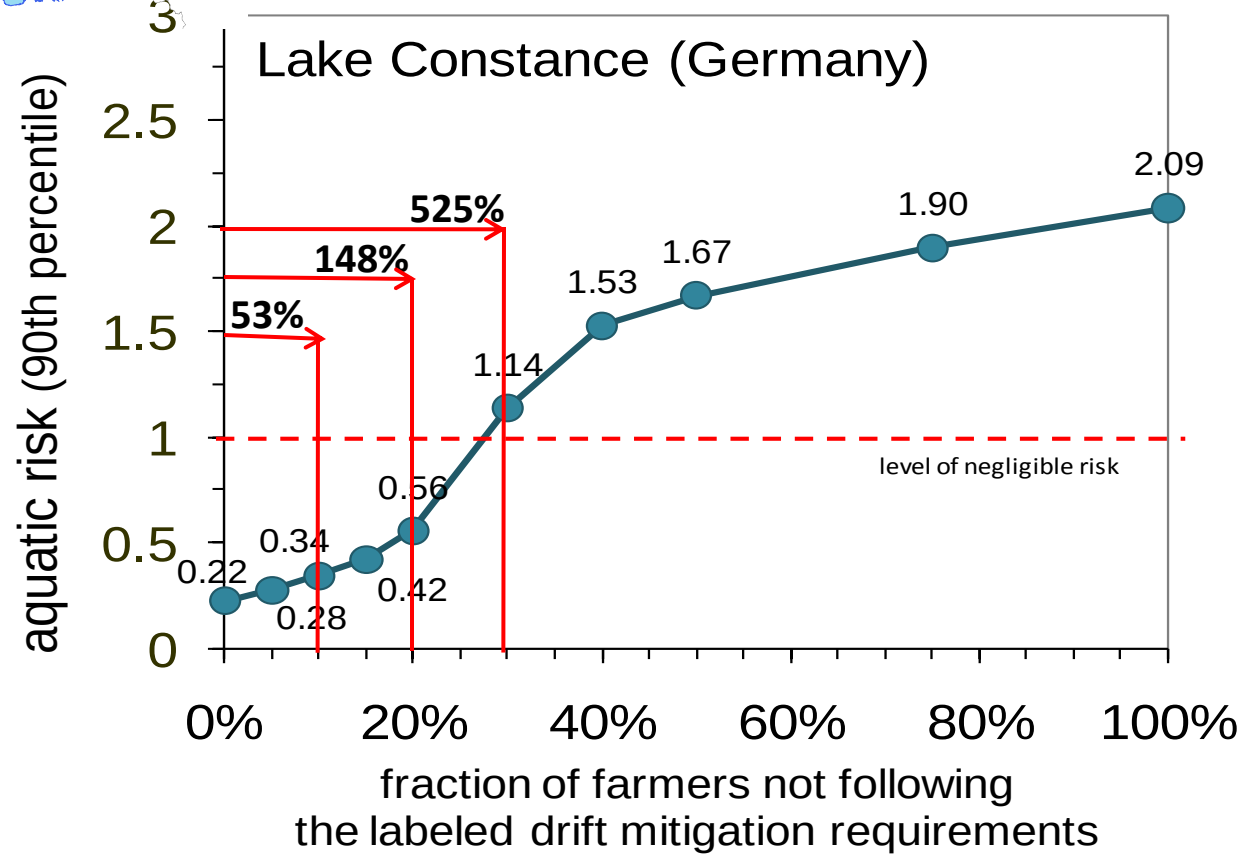


aquatic risk potential: Lake Constance

product specific drift mitigation requirements







aquatic risk on landscape level:

application calendars form defined orchard systems

- Regions: Lake Constance-GER, Lake Constance-CH, Rhone valley
- Pesticide applications from orchard system definitions
  BS, AS-1, AS-2
- random distribution of the application calendars
  of each system (n= 4-10)
- random distribution of the defined drift mitigation measures

Scenario 1: Baseline System (BS) is applied on all orchards (100%)

Scenario 2: Advanced System 1 (AS-1) is applied on all orchards (100%)

Scenario 3: Advanced System 2 (AS-2) is applied on all orchards (100%)

aquatic risk on landscape level:

definition of drift mitigation measures for orchard systems

hail nets
50% reduction

hedges
50% reduction

Sprayers
50, 75 or 90% reduction

Lake Constance
Germany

	0% drift reduction	50% drift reduction	75% drift reduction	90% drift reduction
BS	18%	25%	43%	15%
AS1	0%	9%	32%	59%
AS2	0%	0%	11%	89%

Lake Constance
Switzerland

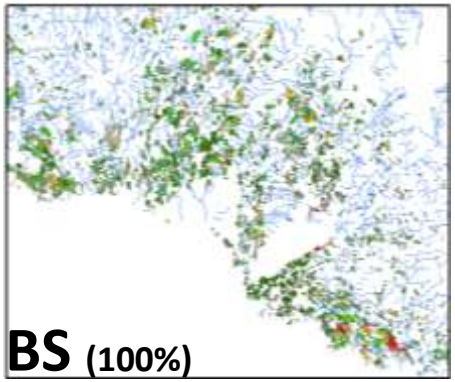
	0% drift reduction	50% drift reduction	75% drift reduction	90% drift reduction
BS	50%	50%	0%	0%
AS1	0%	25%	50%	25%
AS2	0%	0%	25%	75%

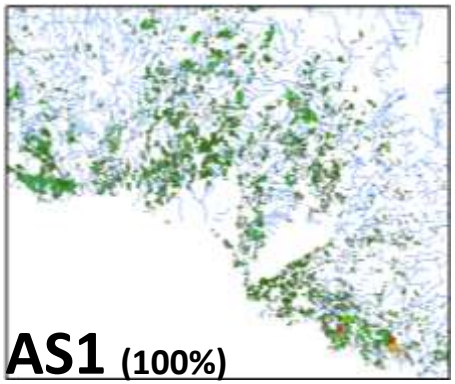
Rhone Valley
France

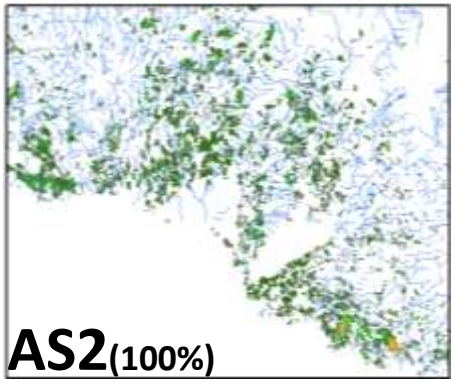
	0% drift reduction	50% drift reduction	75% drift reduction	90% drift reduction
BS	54%	42%	4%	0%
AS1	0%	9%	46%	45%
AS2	0%	0%	18%	82%

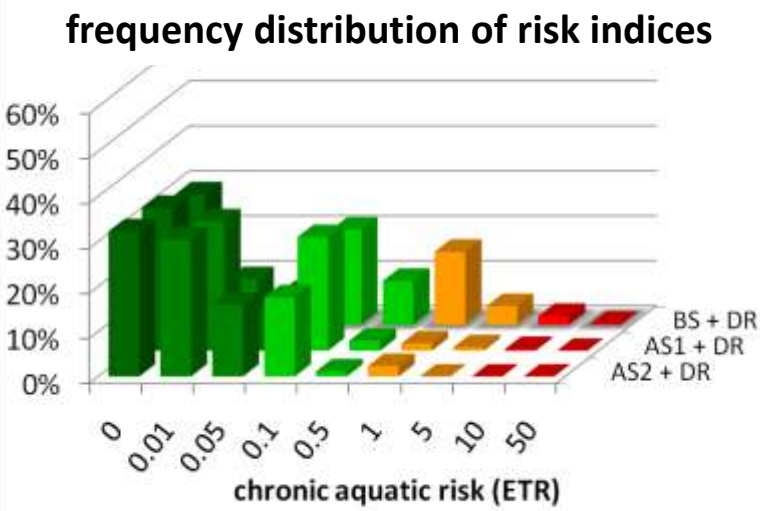
aquatic risk potential: Lake Constance (GER)

application calendars form orchard system definitions

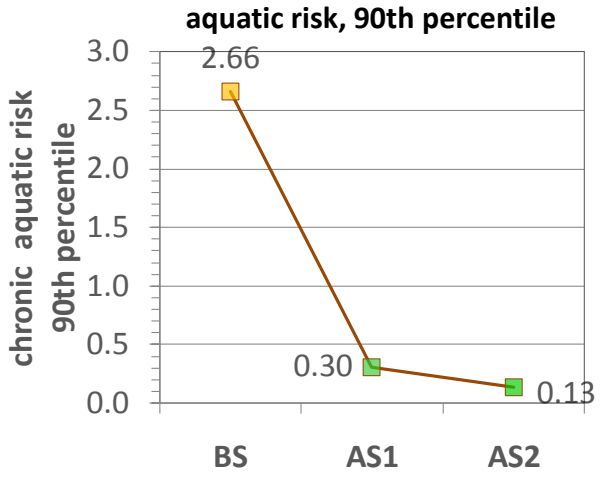


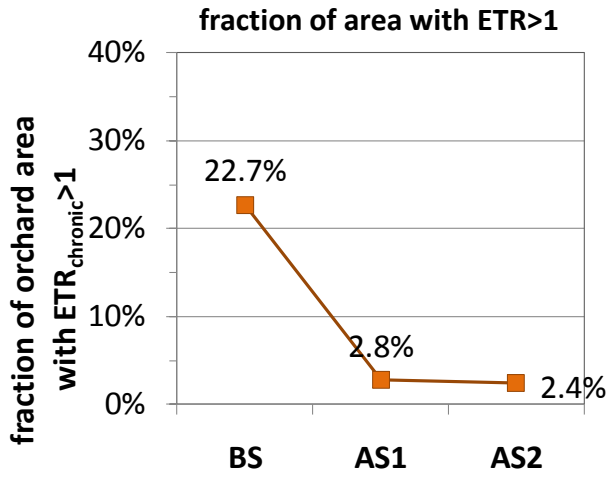






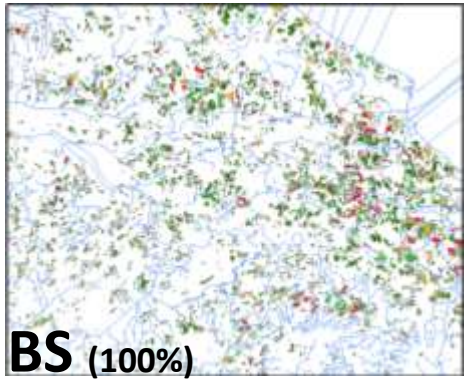
	Reduction compared to BS	
	aquatic risk, 90th percentile	fraction of area with ETR>1
AS1	-88.7%	-87.8%
AS2	-95.0%	-89.5%

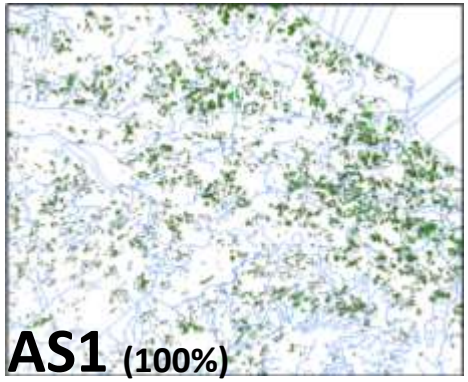


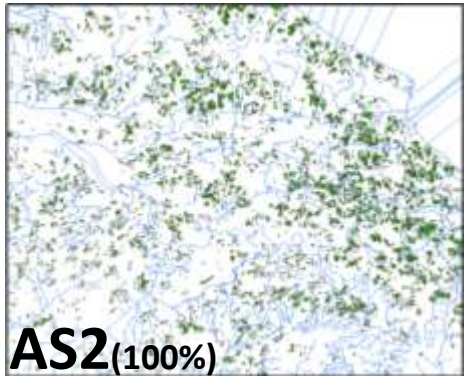


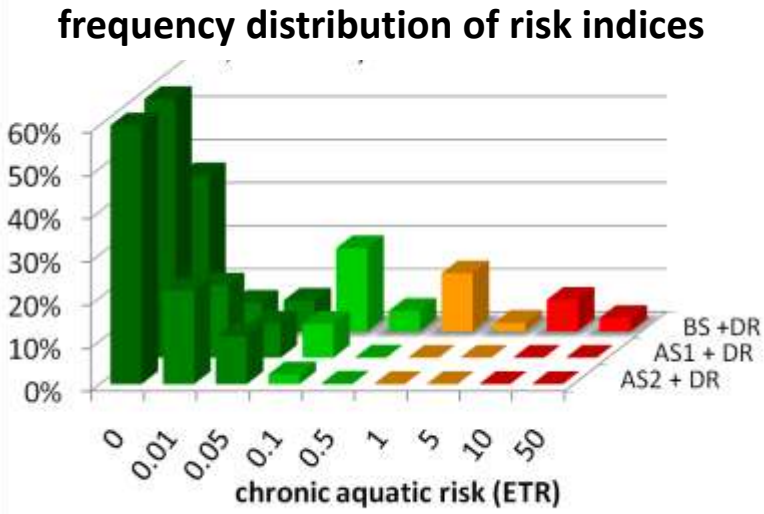
aquatic risk potential: Lake Constance (CH)

application calendars form orchard system definitions

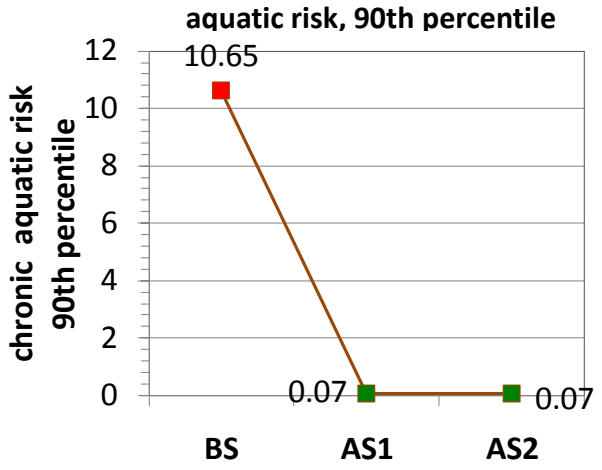


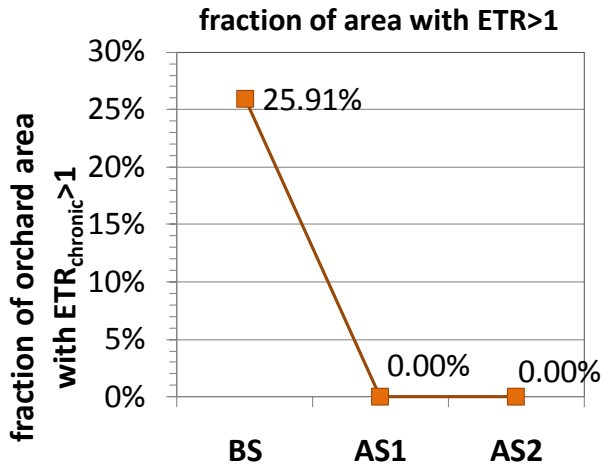






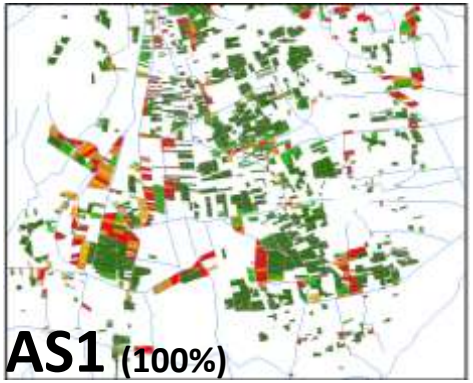
	Reduction compared to BS	
	aquatic risk, 90th percentile	fraction of area with ETR>1
AS1	-99.3%	-100%
AS2	-99.4%	-100%

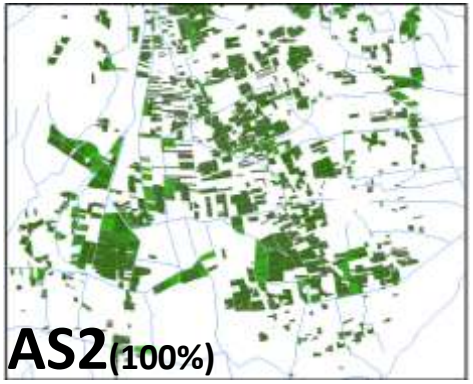


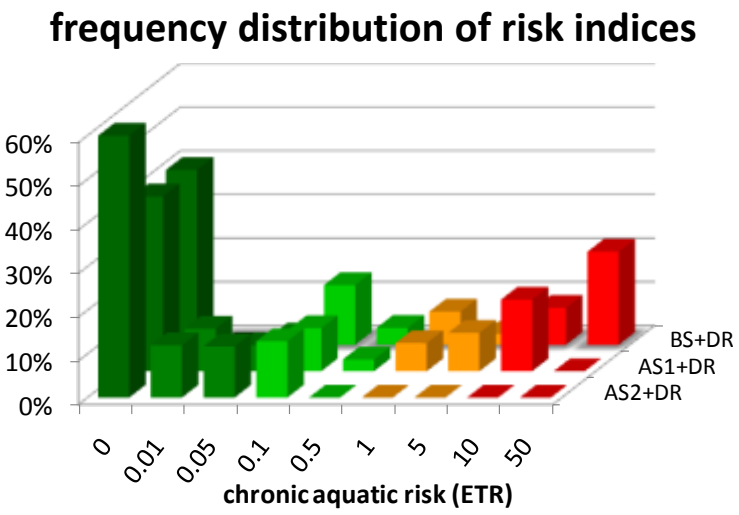


aquatic risk potential: Rhone Valley (FR)

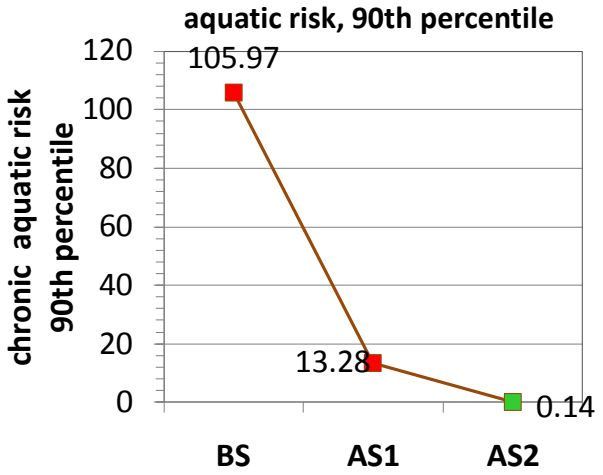
application calendars form orchard system definitions

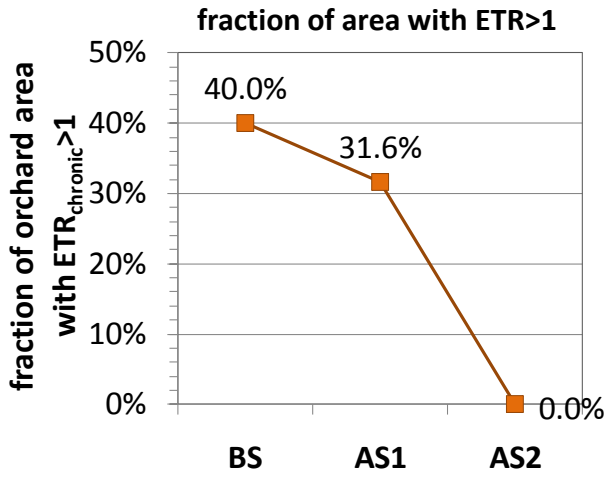






	Reduction compared to BS	
	aquatic risk, 90th percentile	fraction of area with ETR>1
AS1	-87.5%	-21.1%
AS2	-99.9%	-100.0%





aquatic risk on landscape level:

successive introduction of the defined orchard systems

- Regions: Lake Constance-GER, Lake Constance-GER, Rhone valley
- The 100% scenarios are not realistic.
- A mixture of available scenarios depending on the **availability** and **acceptance** of the orchard systems is more realistic .
- random distribution of the defined systems according to the following scenarios:

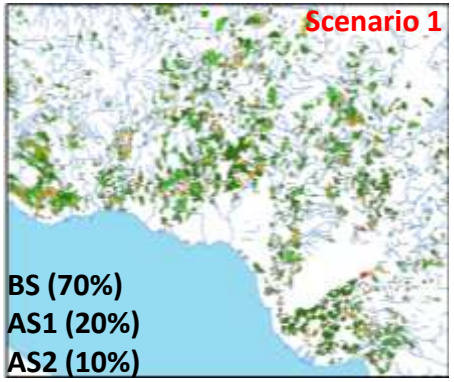
Scenario 1 **in 0-2 years: 70% BS, 20% AS-1 and 10% AS-2**

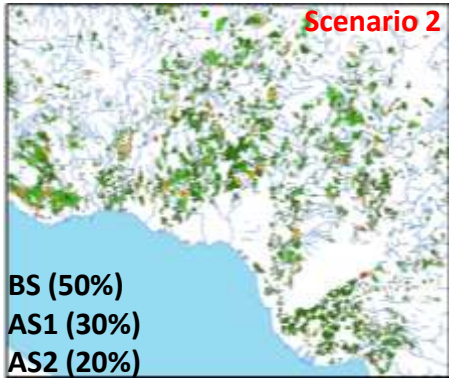
Scenario 2 **in 2-5 years: 50% BS, 30% AS-1 and 20% AS-2**

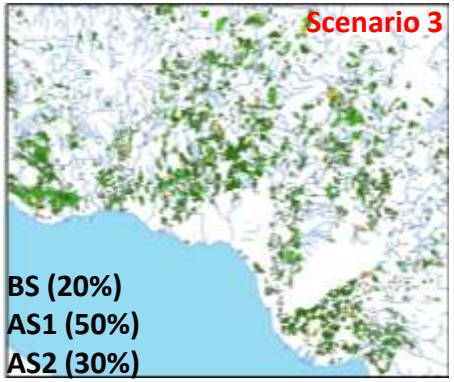
Scenario 3 **in 5-10 years: 20% BS, 50% AS-1 and 30% AS-2**

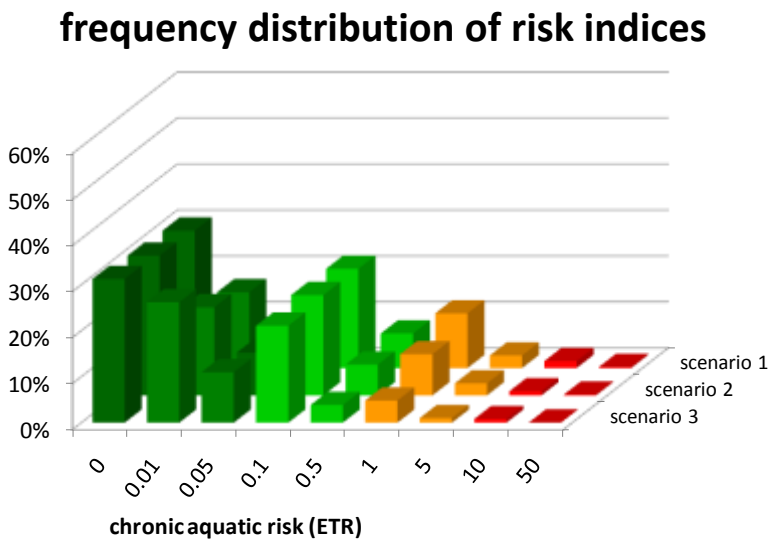
aquatic risk potential: Lake Constance (GER)

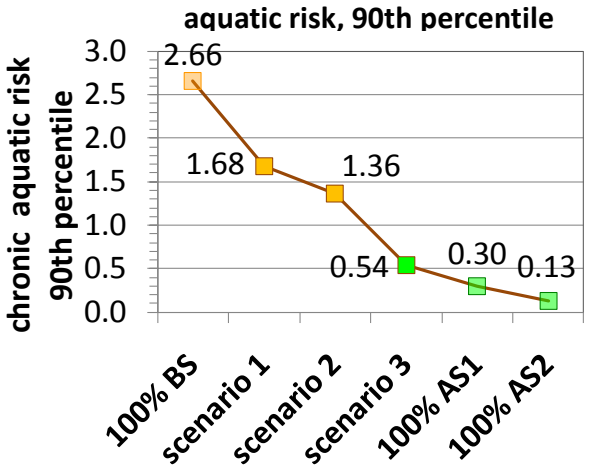
successive introduction of the defined orchard systems

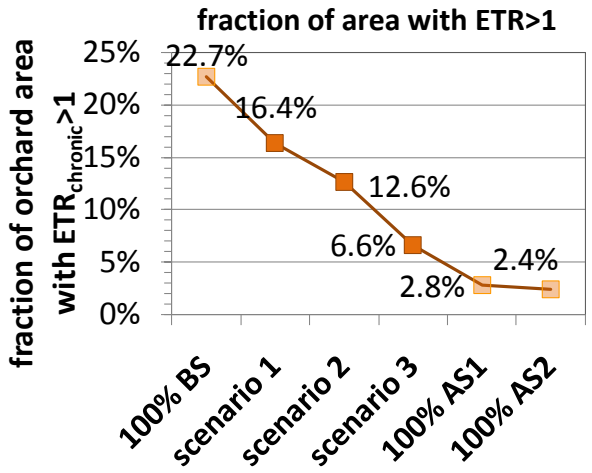








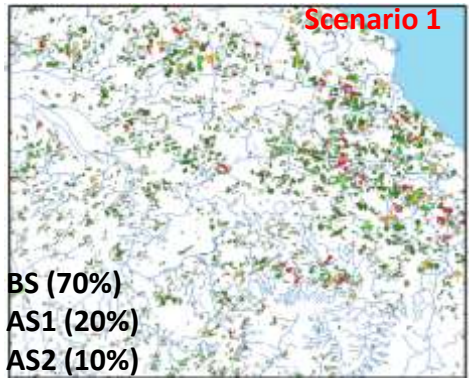


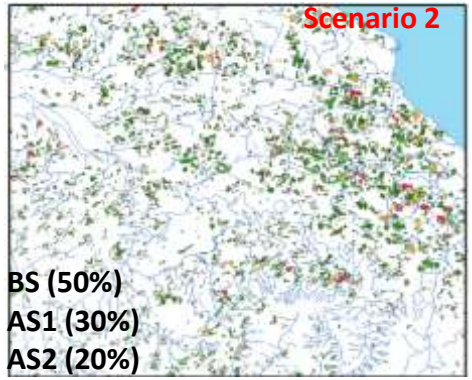


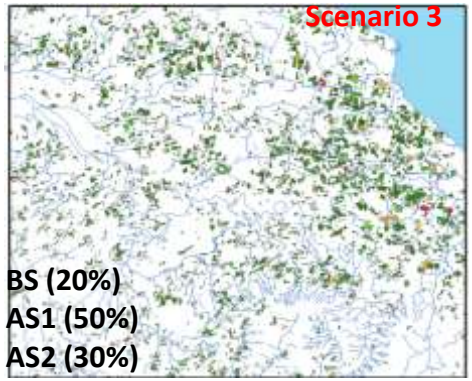
	Reduction compared to BS	
	aquatic risk, 90th percentile	fraction of area with ETR>1
Scenario 1	-36.98%	-27.78%
Scenario 2	-48.69%	-44.43%
Scenario 3	-79.69%	-70.81%

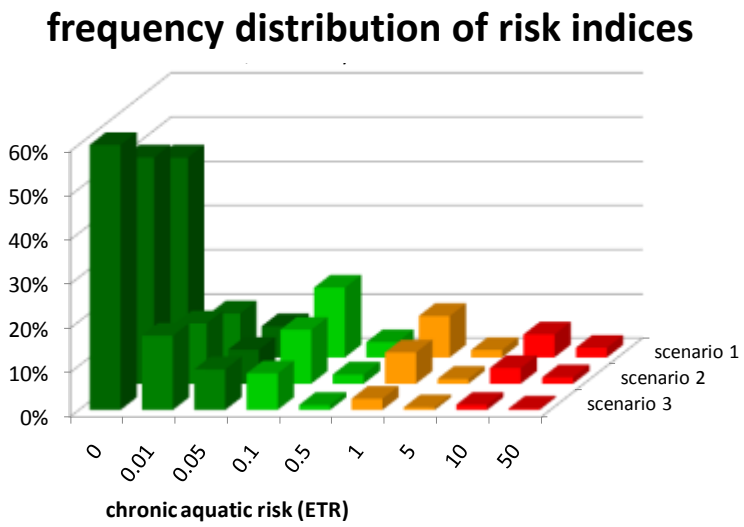
aquatic risk potential: Lake Constance (CH)

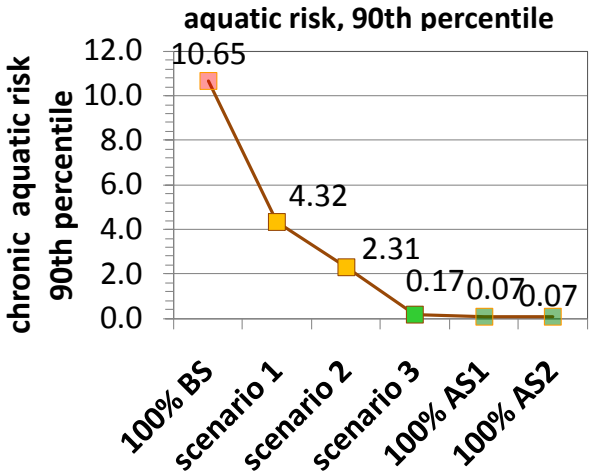
successive introduction of the defined orchard systems

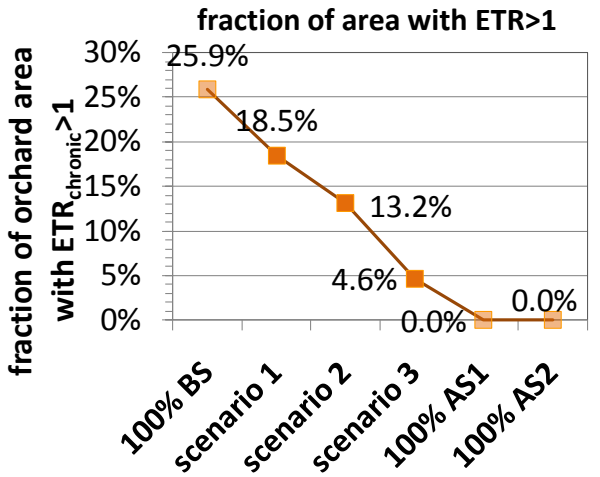








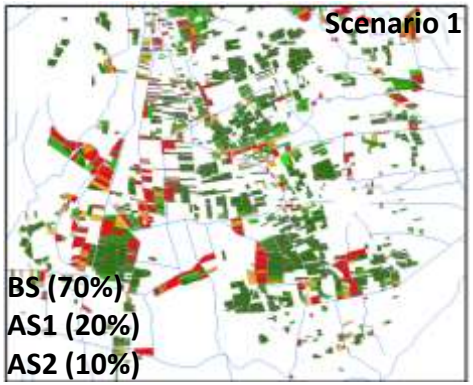


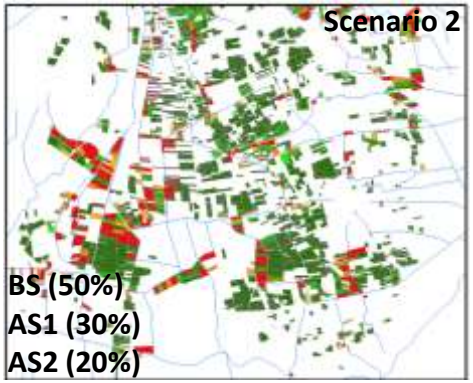


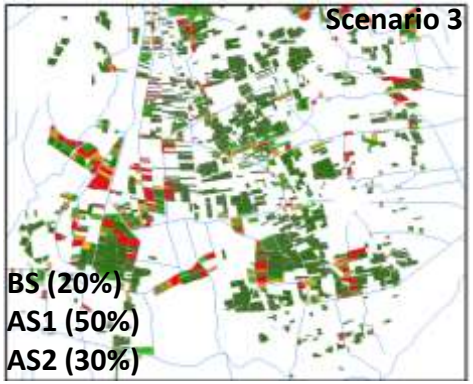
	Reduction compared to BS	
	aquatic risk, 90th percentile	fraction of area with ETR>1
Scenario 1	-59.38%	-28.66%
Scenario 2	-78.27%	-49.07%
Scenario 3	-98.37%	-82.09%

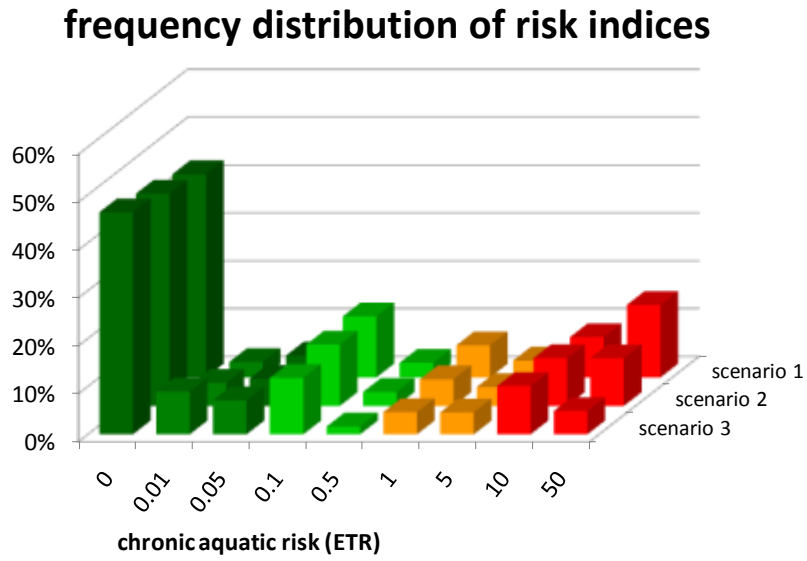
aquatic risk potential: Rhone Valley (FR)

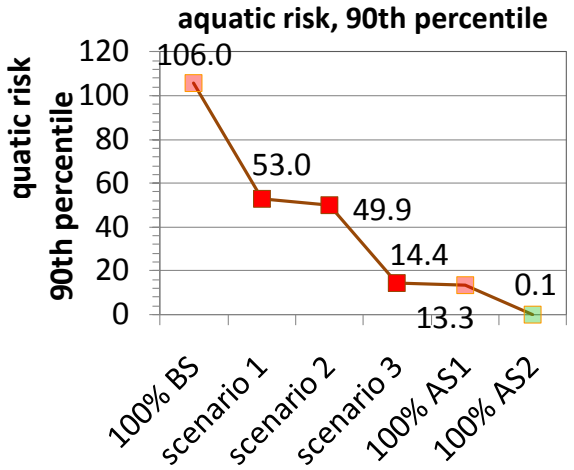
successive introduction of the defined orchard systems

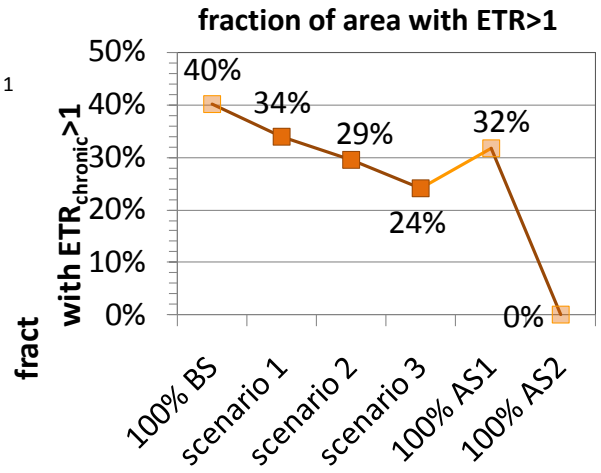












	Reduction compared to BS	
	aquatic risk, 90th percentile	fraction of area with ETR>1
Scenario 1	-49.99%	-15.38%
Scenario 2	-52.92%	-26.43%
Scenario 3	-86.38%	-39.61%

Summary

- A detailed spatial risk analysis can be conducted with SYNOPS-GIS
- The best case of data availability are geo-referenced environmental databases on field level in combination with field based information on pesticide use
- By using successively conducted surveys for pesticide use it is possible to show temporal changes in the regional risk
- The regional impact of drift mitigation measures can be evaluated by comparing different scenarios
- Drift mitigation measures have an substantial impact on the aquatic risk
- Both Advanced Systems AS1and AS2 show a clear improvement of the environmental risk compared to the Baseline System with a reduction of >87% for AS1 and >95% for AS2.
- Within a timeframe of 5-10 years (scenario 3) a reduction of the environmental risk by 70-89% is realistic. The orchard area with medium and high risk is reduced by 40-80%.

Thank you for your attention

FOOD QUALITY AND SAFETY

SIXTH FRAMEWORK PROGRAMME

endure diversifying crop protection