ÖKOLOGIE BÜRO
HOFMANN

TIEM
Integrated Environmental Monitoring

Exposure and Selection of Aquatic Ecosystems for an Environmental Risk Assessment of Bt-Maize

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Content

1. Introduction
2. Exposure pathways
3. Selection method
4. Result: Top priority stream types
5. Conclusions and further tasks

Environmental risks of Bt-maize cultivation on aquatic ecosystems

The aspect of aquatic ecosystems had been ignored for long time in the EIA / risk assessment of Bt-maize

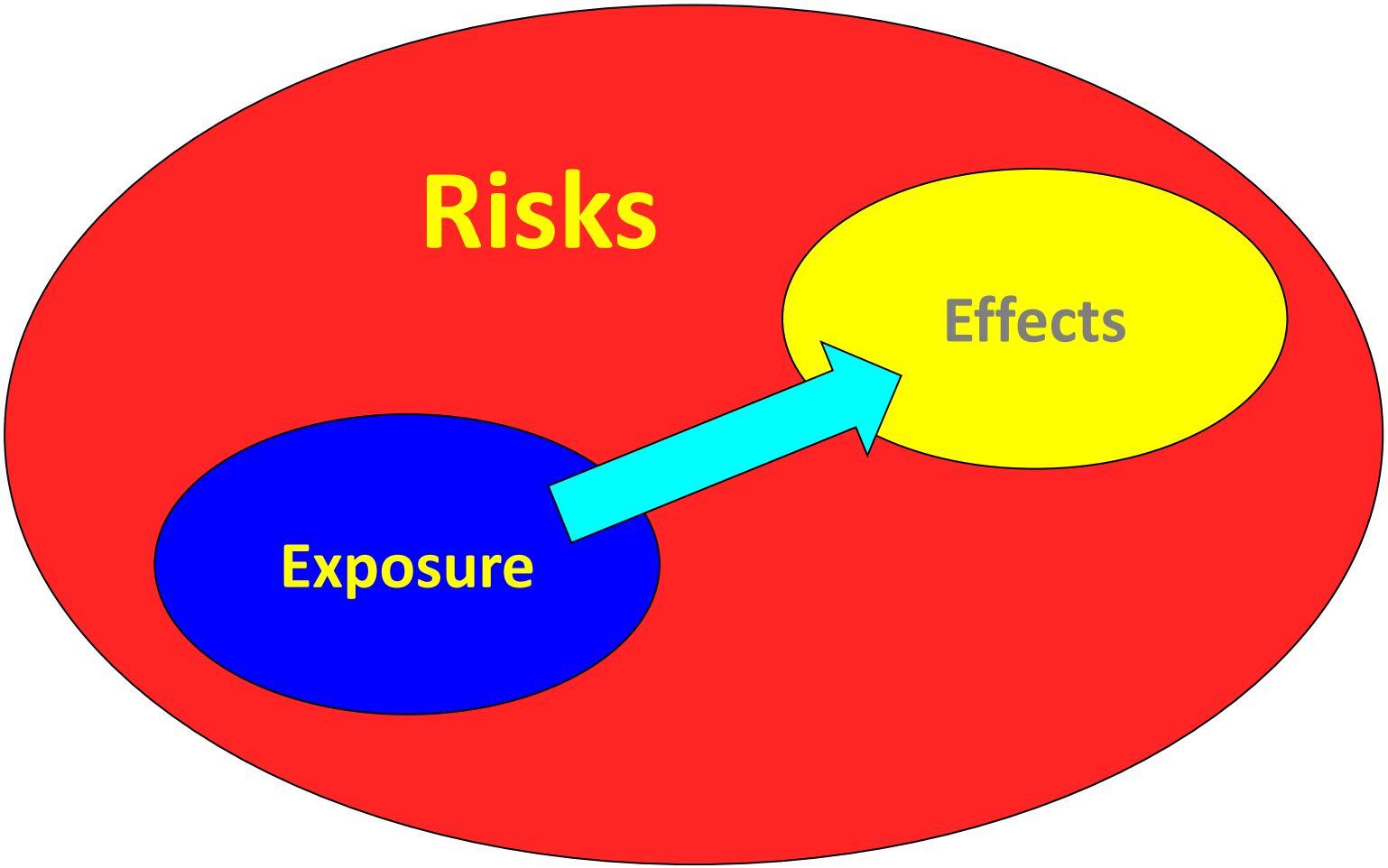
Recent studies showed that there are potential risks that cannot be excluded without further investigations

Rosi-Marshall et al. 2007

Bohn et al. 2008

Douville et al. 2008

Environmental Risk Assessment



Exposure is the base for any effects

Exposure of aquatic ecosystems to pollen and harvest residues

Pollen

Input by wind drift /deposition

→ Exposure mainly during maize bloom in Juli/August

Harvest residues

Input by wind drift and run-off

→ Exposure from harvest in autumn until spring

Drift in streams / deposition

Transport, decomposition, deposition, accumulation

Depending on water regime (heavy rains, floods, snow melt etc)

Soil passage / drainage

Input all over the year

Special aspect of freshwater ecosystems

- Collection of drifted material from headwater streams in the watershed area to downstream waterbodies
- Accumulation at sites / sinks far away downstreams and in higher concentrations compared to input sites

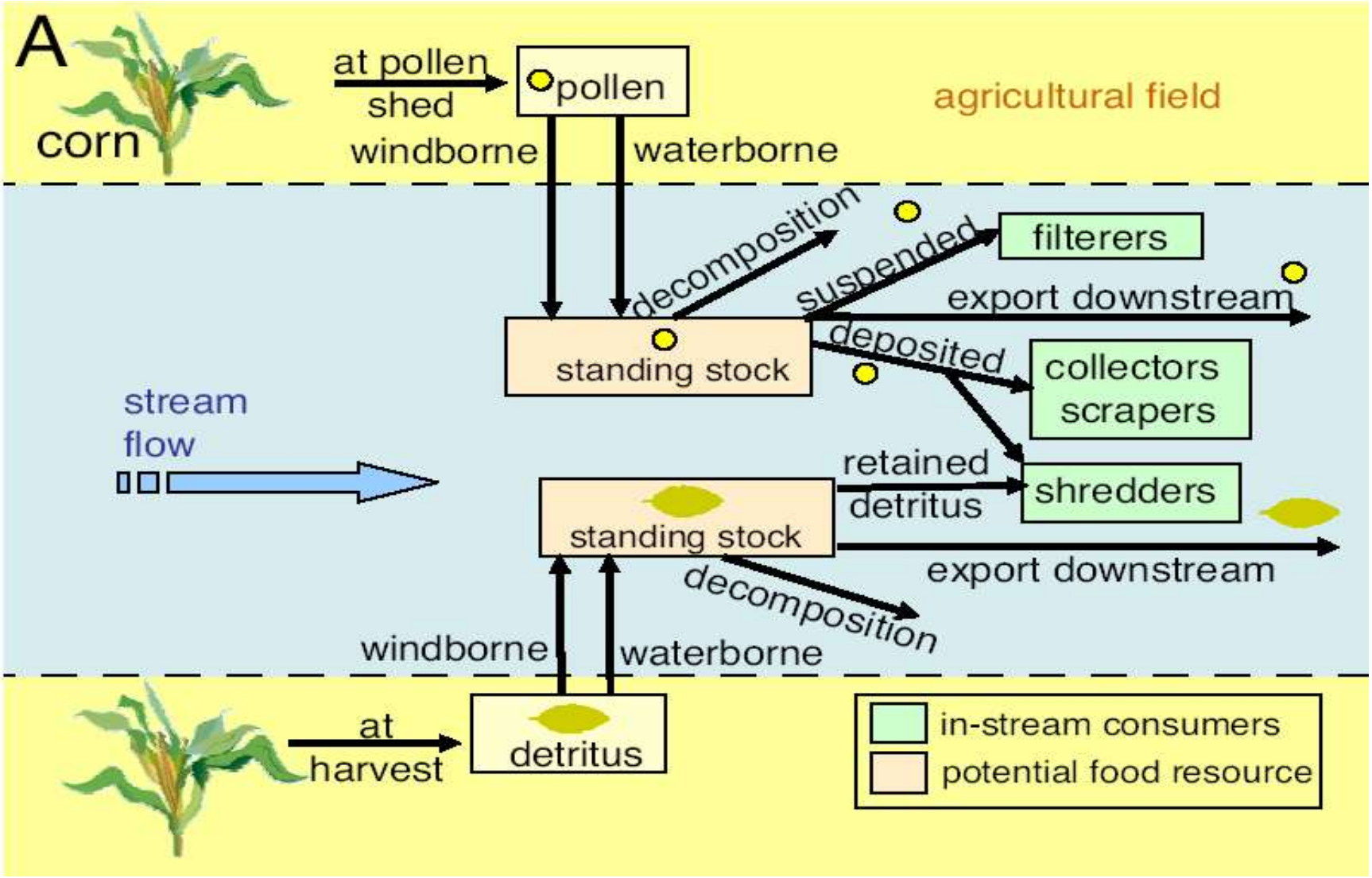







Bilder: Rosi-Marshall, Kuhn, Hofmann, BfN

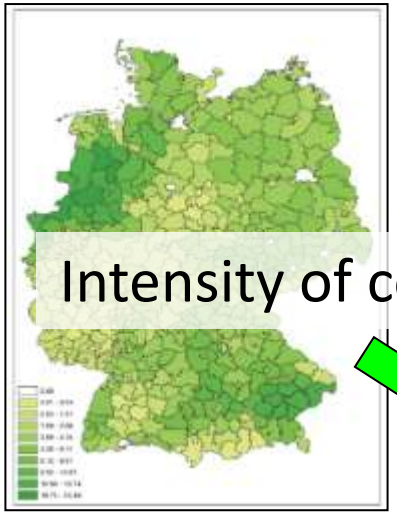
Modells of exposure pathways and potential effects



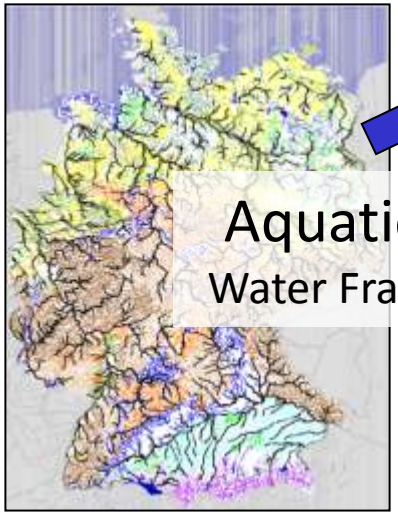
Rosi-Marshall et al 2007

Selection method
of exposed & sensitive aquatic ecosystems

Streams



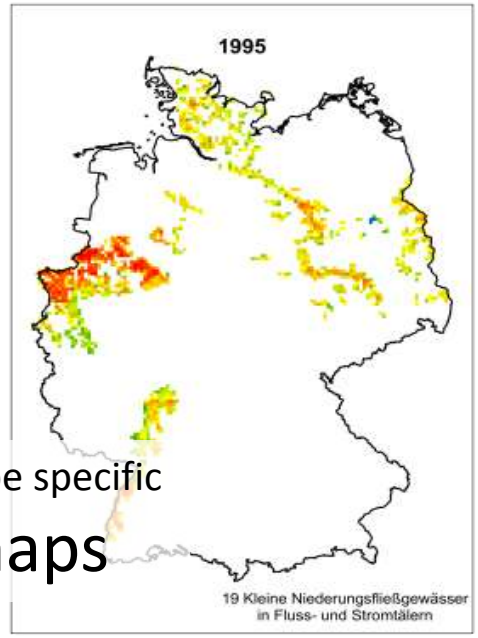
Intensity of corn cultivation



Aquatic ecosystems
Water Framework Directory

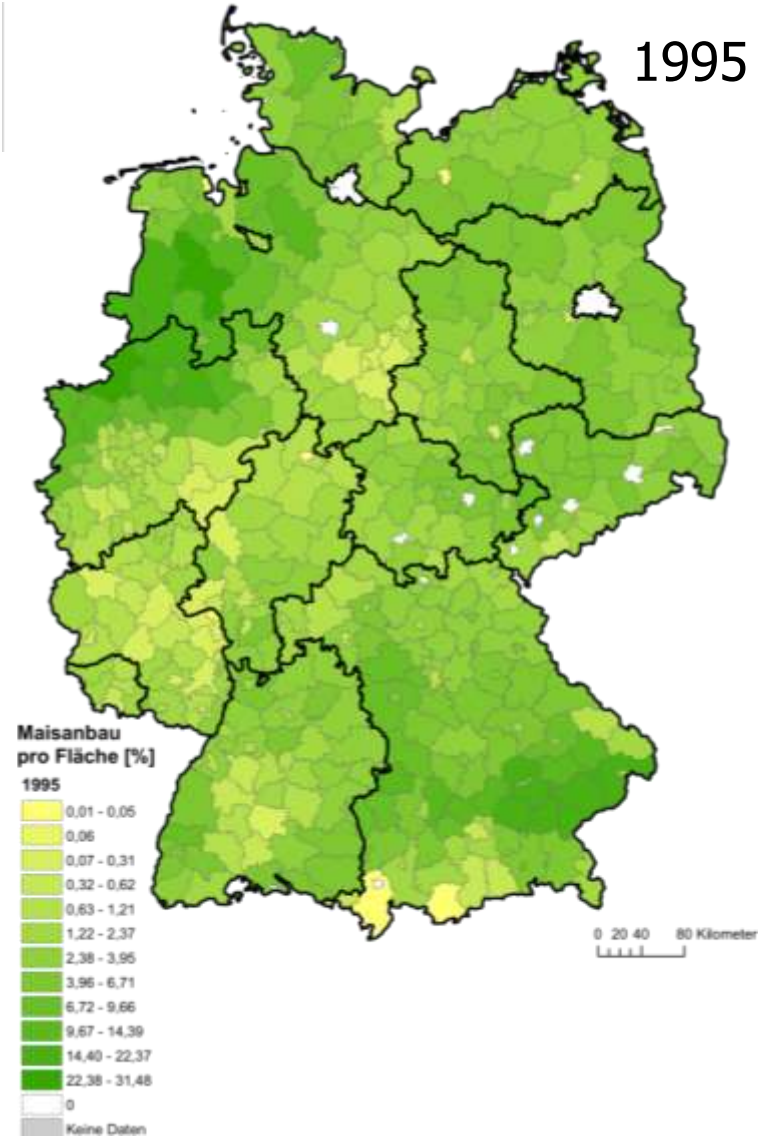
GMO
Exposure
assessment

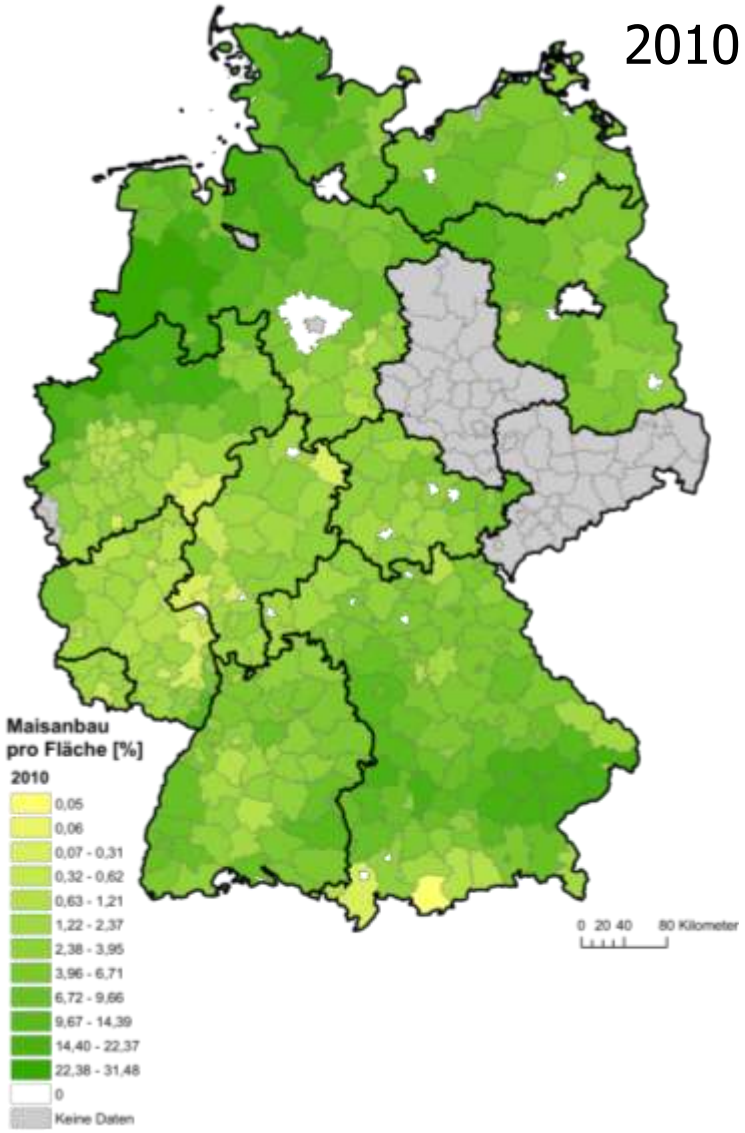
Ecosystem type specific
Risk maps



Selection
Top priority streams

Database 1: Maize cultivation





Statistical data on density of corn production
[regionalized data base, in % area of district] (Source: Stat. Bundesamt)

Data base 2: EU-Water Framework Directory (WFD)

European Union directive:
Directive 2000/60/EC
Water Framework Directive
Made by: European Parliament & Council
Made under: Article 175(1)
Journal: OJL 327, 22 December 2000,

Actual WFD includes:

- **Streams >10 km² watershed area**
- **Lakes >50 ha**
- **Transitional water bodies**
- **Coastal water bodies**
- **Groundwater bodies**

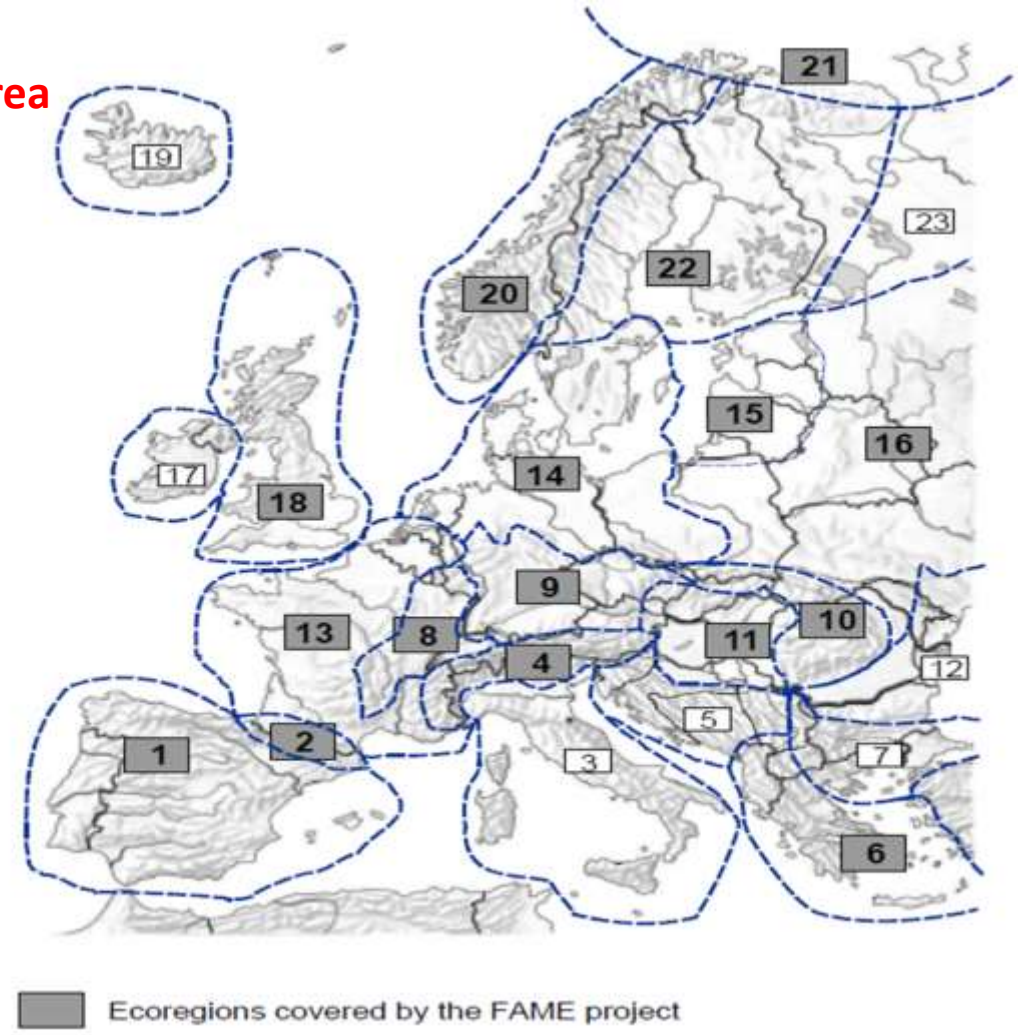
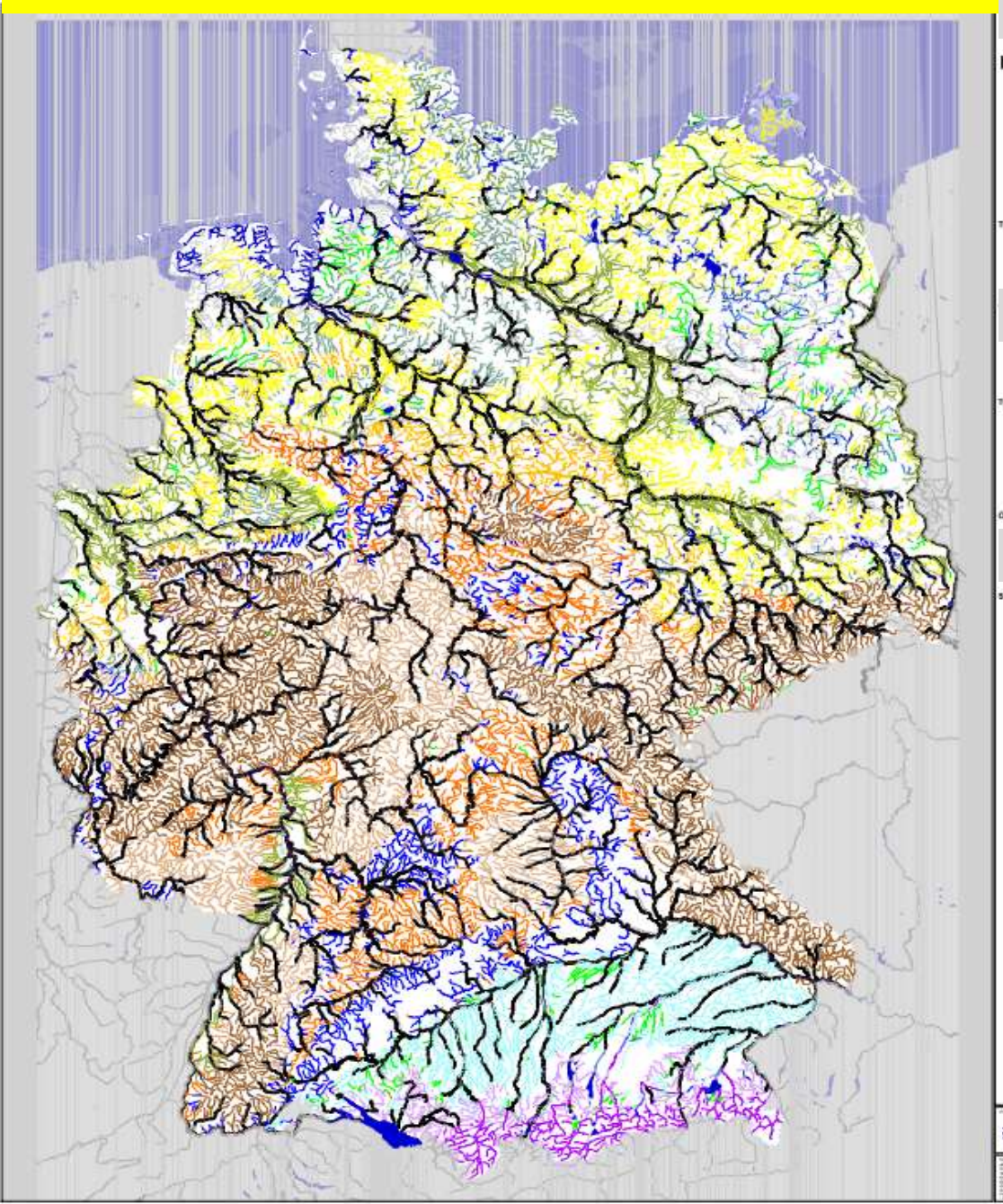


Figure 1 Map of ecoregions in Europe as defined by WFD

WFD: Stream typology of Germany



Types in the Alps and Alpine foothills

Typen der Alpen und des Alpenvorlandes

- Typ 1: Fließgewässer der Alpen (Subtyp 1.1)
- Typ 1: Fließgewässer der Alpen (Subtyp 1.2)
- Typ 2: Fließgewässer des Alpenvorlandes (Subtyp 2.1)
- Typ 2: Fließgewässer des Alpenvorlandes (Subtyp 2.2)
- Typ 3: Fließgewässer der Jungmoräne des Alpenvorlandes (Subtyp 3.1)
- Typ 3: Fließgewässer der Jungmoräne des Alpenvorlandes (Subtyp 3.3)
- Typ 4: Große Flüsse des Alpenvorlandes

Typen des Mittelgebirges

Types in the central highlands

- Typ 5.1: Feinmaterialreiche, silikatische Mittelgebirgsbäche
- Typ 6: Feinmaterialreiche, karbonatische Mittelgebirgsbäche
- Typ 7: Grobmaterialreiche, karbonatische Mittelgebirgsbäche
- Typ 9: Silikatische, fein- bis grobmaterialreiche Mittelgebirgsflüsse
- Typ 9.1: Karbonatische, fein- bis grobmaterialreiche Mittelgebirgsflüsse
- Typ 9.2: Große Flüsse des Mittelgebirges
- Typ 10: Kiesgeprägte Ströme

Types in the central plains

- Typ 14: Sandgeprägte Tieflandbäche
- Typ 15: Sand- und lehmgeprägte Tieflandflüsse
- Typ 16: Kiesgeprägte Tieflandbäche
- Typ 17: Kiesgeprägte Tieflandflüsse
- Typ 18: Löss-lehmgeprägte Tieflandbäche
- Typ 20: Sandgeprägte Ströme
- Typ 22: Marschengewässer
- Typ 22: Marschengewässer
- Typ 22: Marschengewässer
- Typ 23: Rückstau- bzw. brackwasserbeeinflusste Ostseezuflüsse

Eco-region independant types

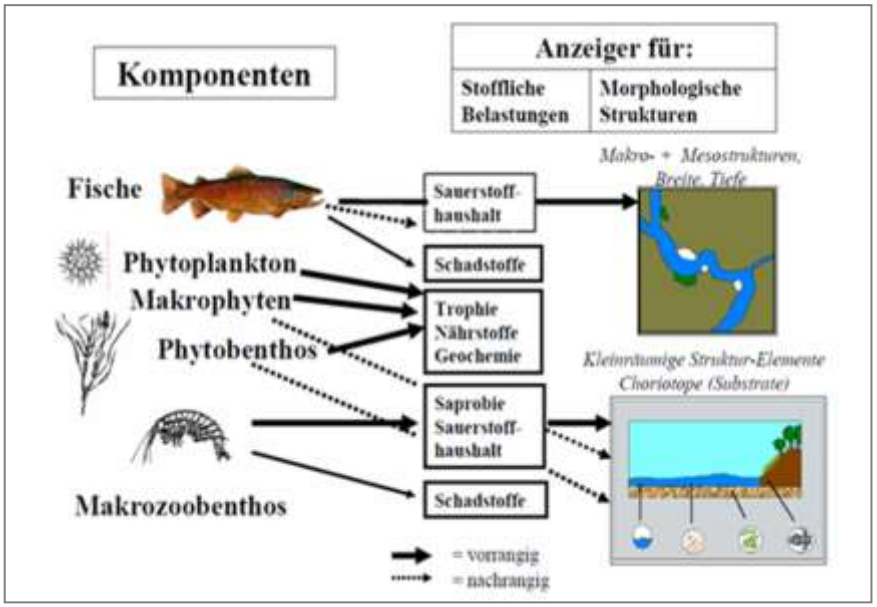
- Typ 11: Organisch geprägte Bäche
- Typ 12: Organisch geprägte Flüsse der Sander und sandigen Aufschüttungen
- Typ 19: Kleine Niederungsfließgewässer in Fluss- und Stromtälern
- Typ 21: Seeausflussgeprägte Fließgewässer

4 eco region classes
25 stream types
7 sub-types

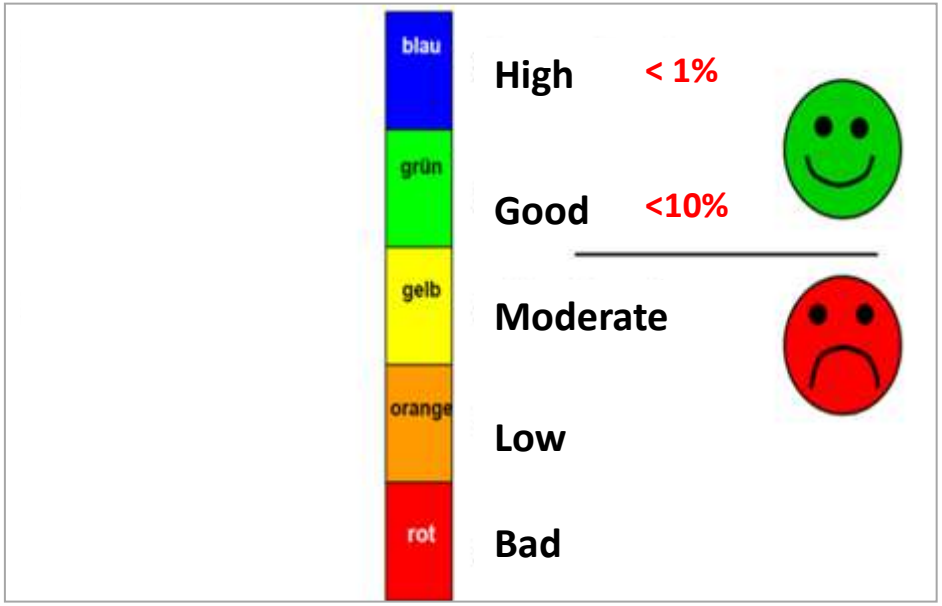
Advantages of WFD data base

- More than 10.000 monitoring sites for streams in Germany
- Detailed data on stream type, morphology, chemical and biological status and stressors
- Standardized assessment of ecological status
- Realization in all EU member states

Biological components



Assessment of ecological status



WFD: Profiles for each stream type

Selection of type-specific species

Type 2: Streams in the alpine foothills
(Sub types 2.1 and 2.2)

Distribution in river landscapes and regions according to Briem (2003):
Tertiary hills, old moraines (ground and terminal moraines) and river terraces, lower river terraces, occasionally in loess regions

Picture:

Kleine Laber (Bavaria). Photograph: Bavarian Water Management Agency (LfW)

Short description of morphology:
Stream type 2 „Streams in the alpine foothills" comprises both small rivers (sub type 2.1) and mid-sized rivers (sub type 2.2). Characteristic for these stream types is the winding and meandering channel form. Dominant substrates are cobble and depending on catchment geology gravel with varying shares of sand and loam. Cobble and gravel bars with some argyllal and valley peat intrusions are common. Slowly flowing pool sections are disrupted by fast flowing riffles.

Abiotic profile:

Size class:	10 - 1.000 km² catchment area (Sub type 2.1 small rivers: 10 - 100 km² catchment area) (Sub type 2.2 mid-sized rivers: 100 - 1.000 km² catchment area)
Slope of the valley floor:	> 0,5 ‰
Flow category:	slow flowing with fast flowing riffles sections
Channel substrates:	cobble, gravel, sand, clay, silt

Physico-chemical water conditions:
(slightly) calcareous or siliceous

Conductivity [µS/cm]: 300 - 400
pH-value: 7,9 - 8,4
Alkalinity [°dH]:
Total hardness [°dH]:

Flow regime & hydrology:
High fluctuations in discharge over the year, with very pronounced extreme discharge events.

Type 2: Streams in the alpine
(Sub types 2.1 and 2.2)

Characterisation of the macroinvertebrate community:

Functional Groups: The macroinvertebrate community is dominated by rheophilic stone-dwellers. Besides these, species inhabiting the small gravel and sand patches also occur. With respect to abiotic parameters (current velocity, oxygen supply and water temperature) demanding species are prevalent. In sub type 2.1 species of the epirhithral are abundant.

Selection of type-specific species in small rivers (sub type 2.1): Ephemeroptera: *Baetis muticus, B. niger, Electrogena ujhelyii, Habrophlebia lauta, Rhithrogena semicolorata.* Odonata: *Calopteryx virgo.* Plecoptera: *Siphonoperla torrentium, Brachyptera risi, Nemoura cambrica, Leuctra albida, Leuctra hippopus.* Heteroptera: *Sigara fossarum, S. hellensii, Velia caprai.* Neuroptera: *Osmylus fulvicephalus.* Coleoptera: *Brychius elevatus, Haliplus lineatocollis, Deronectes latus, Platambus maculatus, Hydraena belgica, H. gracilis, Elmis aenea, E. maugetii, Limnius volckmari.*Trichoptera: *Rhyacophila fasciata, Philopotamus montanus, Tinodes rostocki, Hydropsyche instabilis, H. saxonica, Silo nigricornis, S. pallipes, Potamophylax cingulatus, Odontocerum albicorne.*

Selection of type-specific species in mid-sized rivers (sub type 2.2): Ephemeroptera: *Baetis lutheri, Ecdyonurus insignis, Heptagenia flava, H. sulphurea, Potamanthus luteus, Caenis macrura.* Odonata: *Calopteryx splendens, C. virgo, Gomphus vulgatissimus.* Plecoptera: *Perlodes dispar, Perla burmeisteriana, Taeniopteryx nebulosa, Leuctra fusca, L. geniculata.* Heteroptera: *Micronecta griseola, M. minutissima, Aphelocheirus aestivalis.* Megaloptera: *Sialis nigripes.*Coleoptera: *Orechtochilus villosus, Bidessus delicatulus, Ochthebius bicolon, O. colveranus, Hydraena pulchella, Elmis maugetii, E. obscura, Oulimnius tuberculatus, Limnius volckmari, Macronychus quadrituberculatus, Heterocerus marginatus.* Trichoptera: *Rhyacophila dorsalis, Agapetus laniger, Cheumatopsyche lepida, Hydropsyche bulbifera, Hydropsyche exocellata, Brachycentrus subnubilus, Goera pilosa, Potamophylax rotundipennis, Athripsodes bilineatus, Ceraclea annulicornis.*

Characterisation of macrophyte and pyhtobenthos communities:

Selection of type-specific macrophyte species: *Callitriche obtusangula, Hygroamblystegium fluviatile, Brachythecium rivulare, Bryum argenteum, Cratoneuron filicinum, Callitriche hamulata.*

Selection of type-specific diatom species: *Achnanthes biasolettiana, Achnanthes minutissima, Cymbella microcephala.*

Characterisation of the fish fauna:
Small rivers offer suitable habitat for brook trout, bullhead, minnow and stone loach. Mid-sized rivers generally represent the grayling and barbel regions. In this stream type, gravel-spawning species like grayling, nase, barbel and indifferent species like chub and roach are common. Typical small fish species are schneider and gudgeon. Often the grayling region fauna is not developed. In temporary small rivers of this stream type, the fish fauna can be reduced or absent depending on the extent and length of dry periods.

Comments:
Stream type 2 „Streams in the alpine foothills" comprises two longitudinal sub types: small rivers (sub type 2.1) and mid-sized rivers (sub type 2.2). Longitudinal, biotic differentiation and local particularities should be considered in stream assessment.

Examples of typical streams
Macrophytes and phytobenthos: Baierzer Rot (Baden-Württemburg), Schrannenbach (Bavaria)

Comparative literature (selection):

Exposure index for stream ecosystems

Principle:

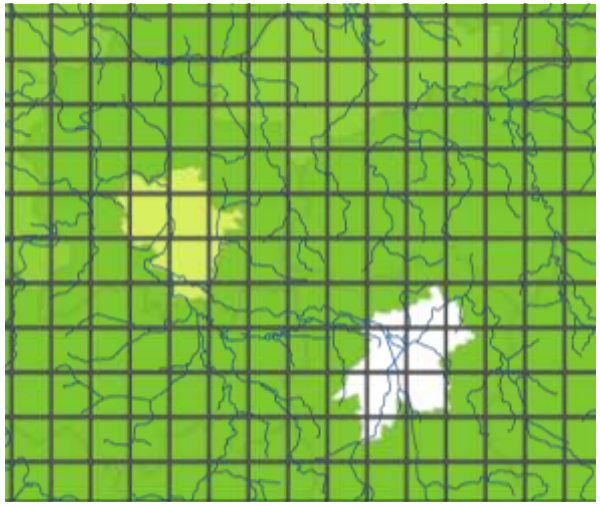
- Combining the data of WFD on stream ecosystems with data on maize cultivation using GIS
- Determination of an Exposure Index E

Technical problem:

- Data on maize cultivation are given as regionalised data in percentage of district area
- Stream data are given as vectorized data in the GIS

Solution:

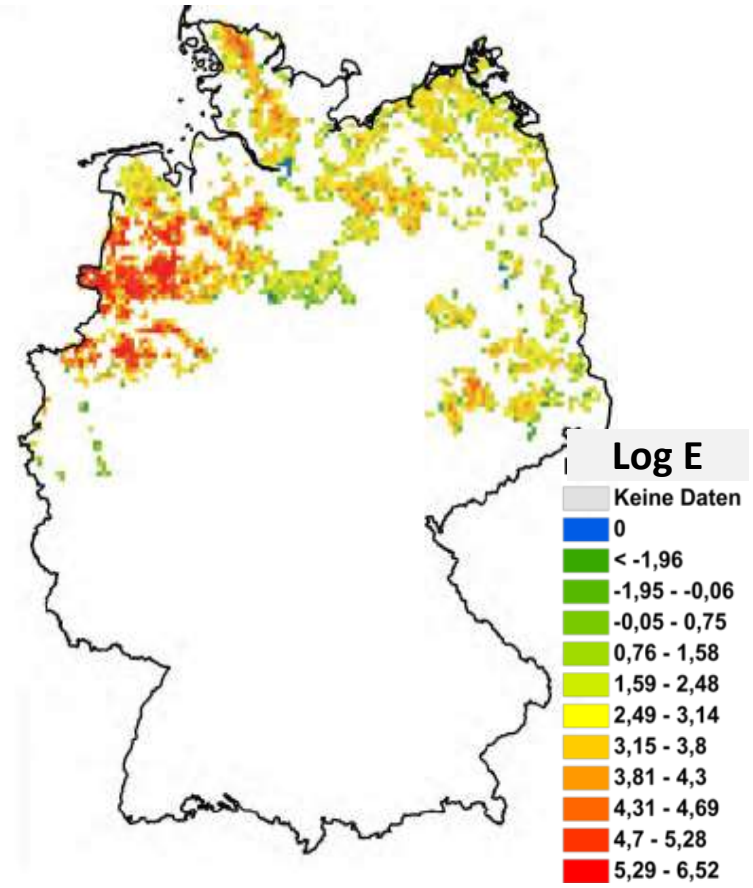
- We placed a grid over Germany with an optimized size of **5 km x 5 km** (n=14.931 grid cells)
- For each grid cell the length of water body per each stream type was determined
- An exposure index was calculated by multiplication of
  - + the lenght of the water body (km) with
  - + the density of maize cultivation [% area]



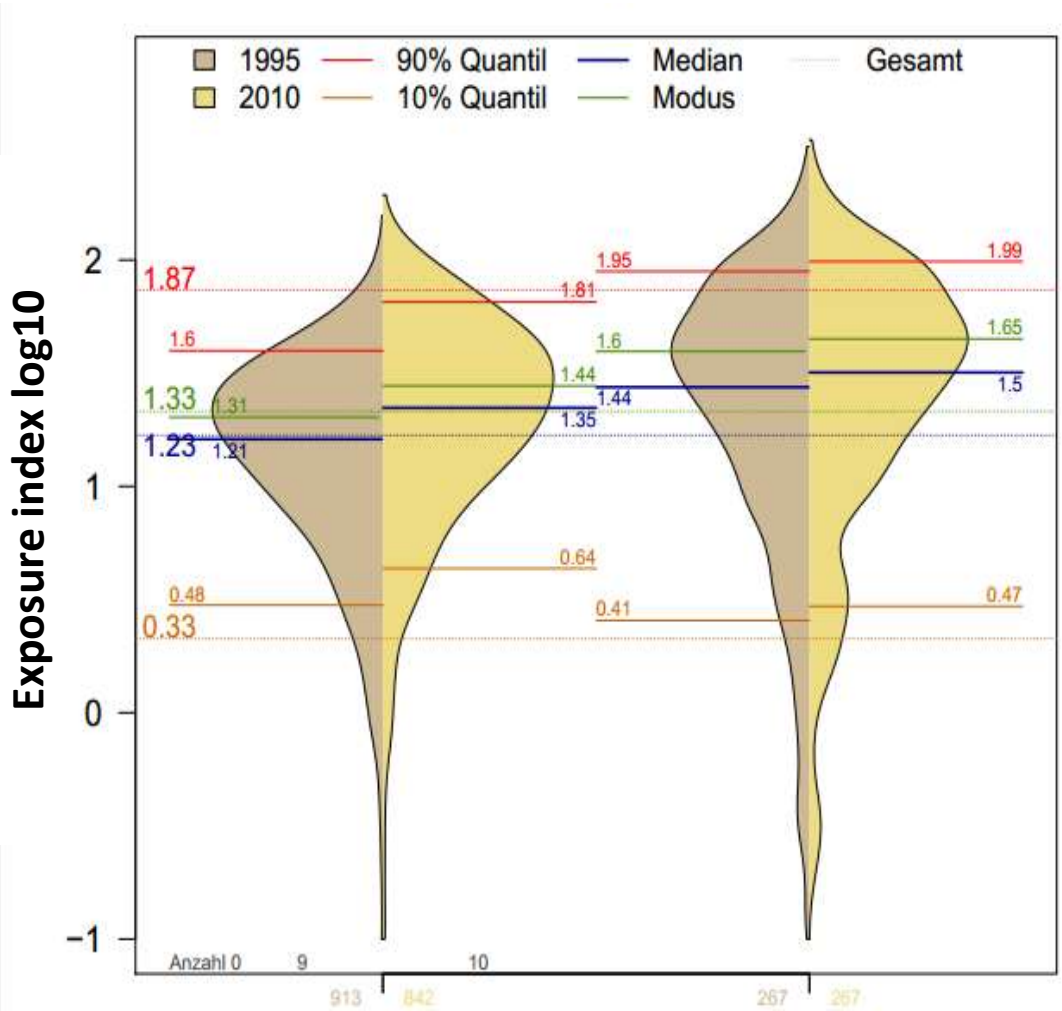
Exposure Index for streams

Exposure Index E =
lenght of stream type [km] x density of maize cultivation [%]

Risk map (visually)



Beams: Density distribution (statistically)



Selection Matrix: Top Priority Stream Types

Criteria

- **Exposure: Intensity (hot spots) and abundance**
- **Sensitivity (water bodies of high or at least good ecological status)**
- **Reference water bodies without or negligible maize cultivation**
- **Each eco-region should be represented with at least one stream type**

A **Rational classification by algorhythms based on the statistical density distribution of the parameters**

B **Visual plausibility check using the risk maps and beam graphs**

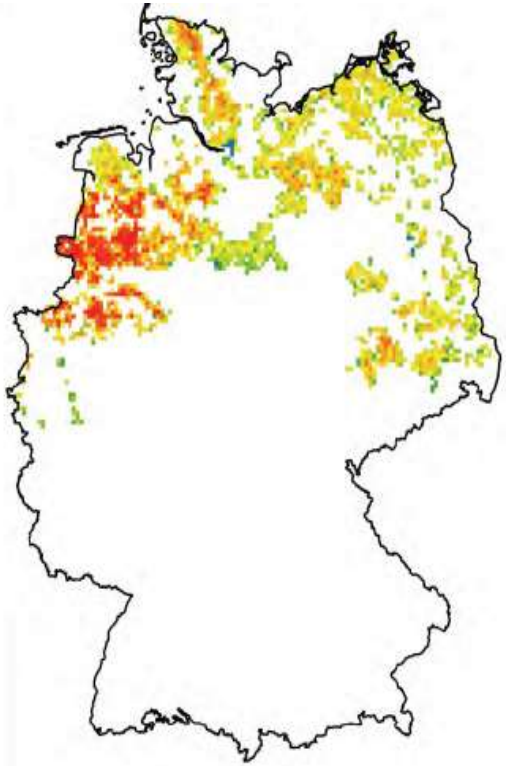
Exposure index

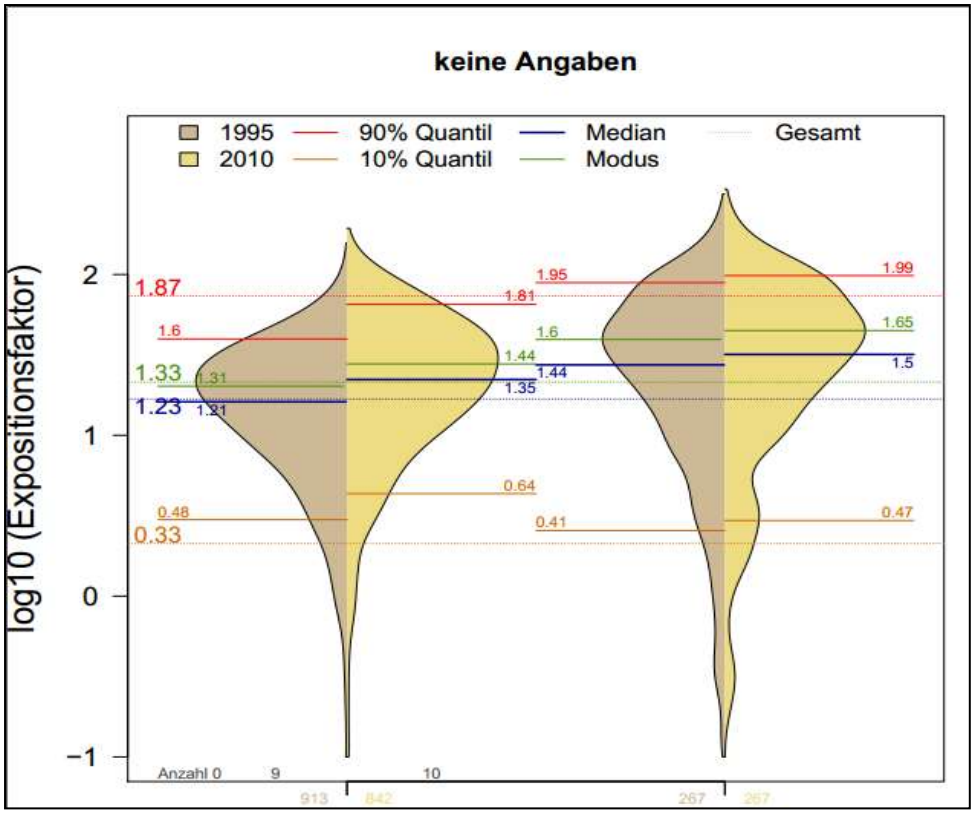
Exposure index E = stream length [km] x density of maize cultivation [%]

2 parameters:

Intensity EI: 95% quantile of exposure index (“hot spots“) → **5 classes 1-5**

Abundance EA: geometric mean of exposure index x frequency (number of grid cells) → **5 classes 0-4**





Sensitivity

Water bodies with at least ecological status “good“

Sensitivity index S =

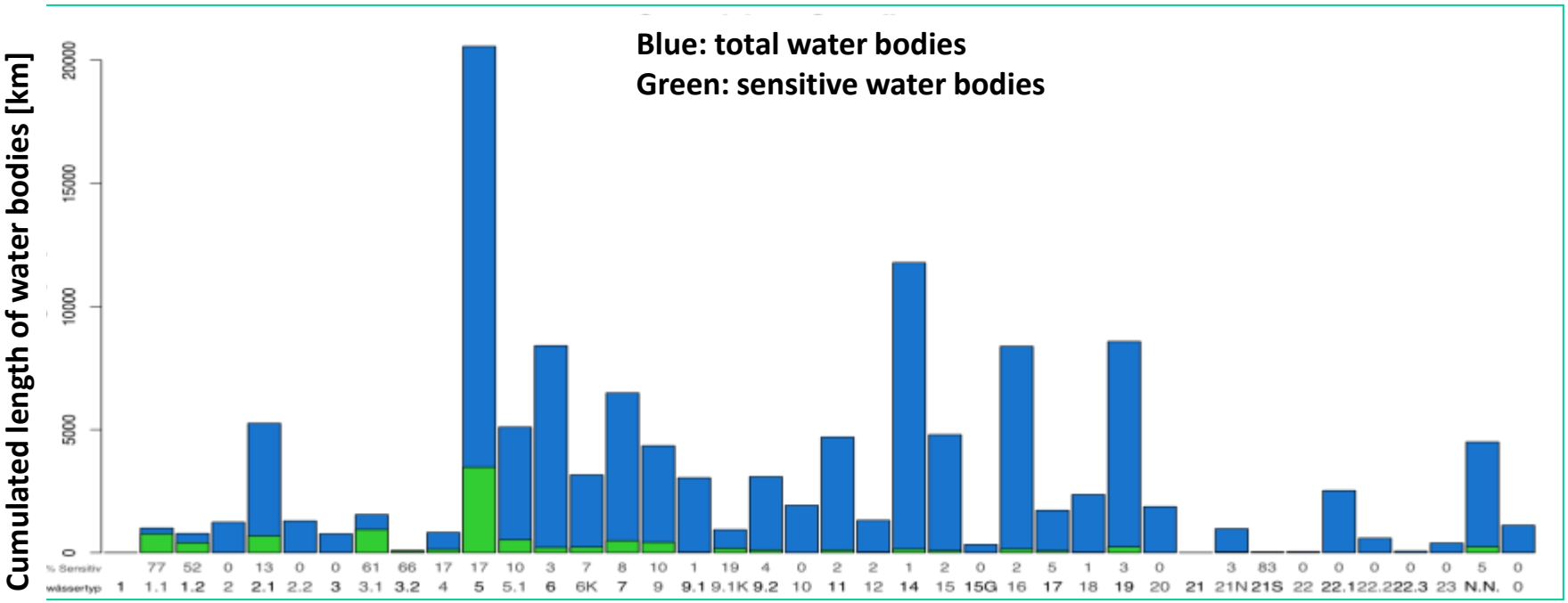
percentage of water bodies with at least ecological status “good“

→ 3 classes 0-2

Exposure index for sensitive streams ES =

length of streams with at least good ecological status [km]

x density of maize cultivation [%] **→ 3 classes 0-2**



Reference water bodies

Water bodies without or negligible maize cultivation

Reference index R =

percentage of grid cells for each stream type without or negligible maize cultivation

→ 3 classes 0-2

Priority Index and Priority Class

Numerical priority index PN = EI + EA + S + ES + R

Priority class PC → 5 classes

→Top Priority Stream Types: Class 4 + 5

Selection Matrix: Top Priority Stream Types

Stream type			Exposure			Sensitivity		Exposure sensitive streams		Reference water bodies		Priority	
			Intensity		Abundance							Index	Class
Stream type			EI	Class 1,2,3,4,5	EA	Class 0,1,2,3,4	S in %	Class 0,1,2	ES	Class 0,1,2	R in %	Class 0,1,2	Sum classes	1-5, U
		Types in the Alps and Alpine foothills												
F	1	Alpine streams												
F	1.1	Small and mid-sized rivers of the Calcareous Alps	32	1	0,2	0	77	2	1	1	0,00	0	4	2
F	1.2	Large rivers of the Calcareous Alps	56	2	1,1	1	52	2	2	1	0,00	0	6	3
F	2	Streams in the alpine foothills	80	3	3,6	1	0	0		0	0,00	0	4	2
F	2.1	Small rivers in the alpine foothills	172	5	19,1	3	12	2	16	1	0,00	0	11	5
F	2.2	Mid-sized rivers in the alpine foothills	135	5	6,1	2	0	0		0	0,00	0	7	3
F	3	Streams in the Pleistocene sediments of the alpine foothills	63	3	2,2	1	0	0		0	0,00	0	4	2
F	3.1	Small rivers in the Pleistocene sediments of the alpine foothills	68	3	3,1	1	59	2	3	1	0,00	0	7	3
F	3.2	Mid-sized rivers in the Pleistocene sediments of the alpine foothills	46	2	0,2	0	66	2	2	1	0,00	0	5	2
F	4	Large rivers in the alpine foothills	124	5	3,8	1	8,9	1	32	1	0,00	0	8	4
		Types in the central highlands												
F	5	Small coarse substrate dominated siliceous highland rivers	51	2	43,7	4	16	2	3	1	0,07	1	10	5
F	5.1	Small fine substrate dominated siliceous highland rivers	27	1	10,4	3	10	2	3	1	0,00	0	7	3
F	6	Small fine substrate dominated calcareous highland rivers	58	2	21,9	4	2,5	1	3	1	0,07	1	9	4
F	6_K	Small fine substrate dominated calcareous highland rivers in the Keuper	64	3	9,8	2	2,5	1	7	1	0,00	0	7	3
F	7	Small coarse substrate dominated calcareous highland rivers	46	2	17,2	3	7,4	1	6	1	0,00	0	7	3
F	9	Mid-sized fine to coarse substrate dominated siliceous highland rivers	35	1	10,6	3	8,4	1	4	1	0,10	1	7	3
F	9.1	Mid-sized fine to coarse substrate dominated calcareous highland rivers	45	2	8,0	2	0,6	1	5	1	0,00	0	6	3
F	9.1_K	Subtype in the Keuper	69						24	1	0,00	0	7	3
F	9.2	Large highland rivers	42						18	1	0,16	1	7	3
F	10	Very large gravel-dominated rivers	50							0	0,24	1	5	2
		Types in the central plains												
F	14	Small sand-dominated lowland rivers	135						8	1	0,39	1	12	5
F	15	Mid-sized and large sand and loam-dominated lowland rivers	128						12	1	1,27	1	11	5
F	15_g	Very large sand and loam-dominated lowland rivers	120							0	0,00	0	5	2
F	16	Small gravel-dominated lowland rivers	74						5	1	0,24	1	10	5
F	17	Mid-sized and large gravel-dominated lowland rivers	47	2	5,6	2	4,6	1	8	1	0,00	0	6	3
F	18	Small loess and loam-dominated lowland rivers	78	3	7,1	2	0,7	1	9	1	0,00	0	7	3
F	20	Very large sand-dominated rivers	60	3	6,3	2	0	0		0	1,75	1	6	3
F	22	Marshland streams of the coastal plains	17	1	0,1	0	0	0		0	0,00	0	1	1
F	22.1	Subtype small to mid-sized streams	62	3	7,7	2	0	0		0	1,42	1	6	3
F	22.2	Subtype large rivers	132	5	2,5	1	0	0		0	0,00	0	6	3
F	22.3	Subtype very large rivers	29	1	0,3	0	0	0		0	0,00	0	1	1
F	23	Backwater and brackish water influenced Baltic Sea tributaries	29	1	1,4	1	0	0		0	0,00	0	2	1
		Ecoregion independent stream types												
F	11	Small organic substrate-dominated rivers	76	3	18,6	3	2,1	1	2	1	0,36	1	8	4
F	12	Mid-sized and large organic substrate-dominated rivers	66	3	5,6	2	2,0	1	15	1	0,32	1	8	4
F	19	Small streams in riverine floodplains	146	5	29,5	4	1,7	1	10	1	0,19	1	12	5
F	21	Lake outflows												
F	21_N	Subtype in the Northern Plains (North)	29	1	4,3	1	2,4	1	5	1	0,91	1	5	2
F	21_S	Subtype in the Alpine foothills (South)	39	1	0,1	0	83	2	3	1	0,00	0	4	2

Each eco-region is represented with at least 2 stream types

Type 2: Streams in the alpine foothills

(Sub types 2.1 and 2.2)

Distribution in river landscapes and regions according to Briem (2003):

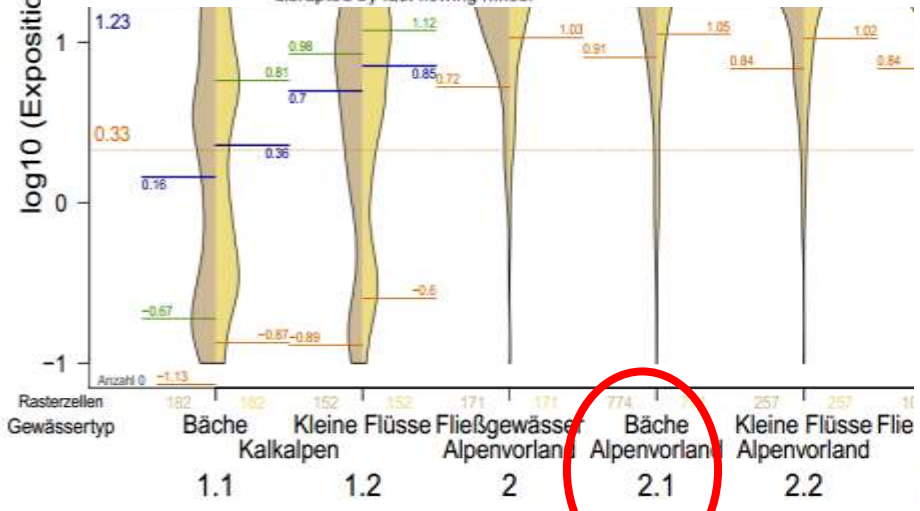
Tertiary hills, old moraines (ground and terminal moraines) and river terraces, lower river terraces, occasionally in loess regions

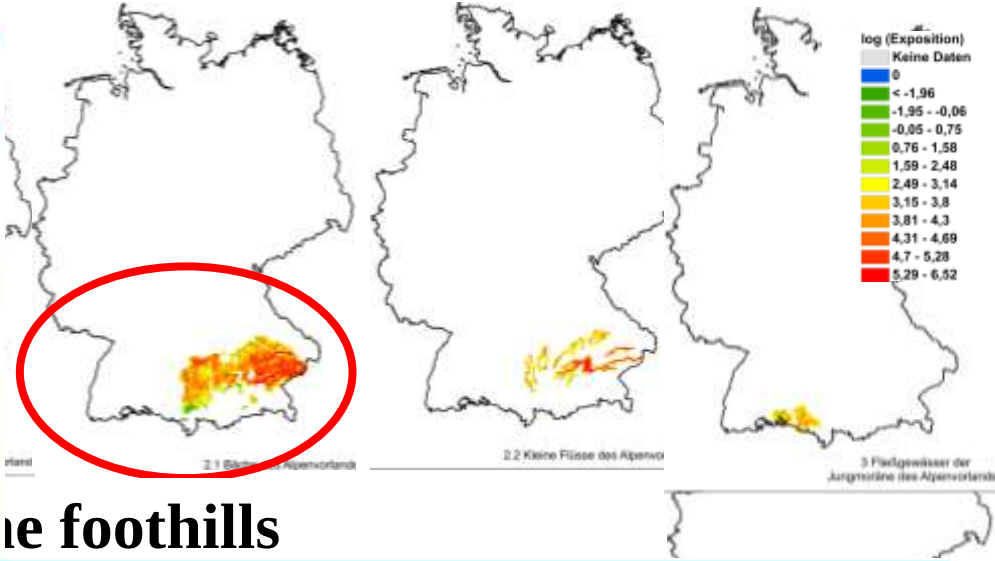
Picture:

Kleine Laber (Bavaria). Photograph: Bavarian Water Management Agency (LfW)

Short description of morphology:

Stream type 2 „Streams in the alpine foothills" comprises both small rivers (sub type 2.1) and mid-sized rivers (sub type 2.2). Characteristic for these stream types is the winding and meandering channel form. Dominant substrates are cobble and depending on catchment geology gravel with varying shares of sand and loam. Cobble and gravel bars with some argyllal and valley peat intrusions are common. Slowly flowing pool sections are disrupted by fast flowing riffles.





ıe foothills

Type 4: Large rivers in the alpine foothills

Distribution in river landscapes and regions according to Briem (2003):

Large coarse material floodplain (over 300 m wide)

Picture:

Inn (Bavaria). Photograph: Bavarian Water Management Agency (LfW)

Short description of morphology:

Large streams with springs in the Alps. Dominant substrates are boulders, cobble, gravel and sand. Average grain size decreases continually down-

Selection matrix: top priority stream types

Stream type			Exposure				Sensitivity		Exposure sensitive streams		Reference water bodies		Priority	
			Intensity		Abundance								Index	Class
Stream type			EI	Class 1,2,3,4,5	EA	Class 0,1,2,3,4	S in %	Class 0,1,2	ES	Class 0,1,2	R in %	Class 0,1,2	Sum classes	1-5, U
		Types in the Alps and Alpine foothills												
F	1	Alpine streams												
F	1.1	Small and mid-sized rivers of the Calcareous Alps	32	1	0,2	0	77	2	1	1	0,00	0	4	2
F	1.2	Large rivers of the Calcareous Alps	56	2	1,1	1	52	2	2	1	0,00	0	6	3
F	2	Streams in the alpine foothills	80	3	3,6	1	0	0		0	0,00	0	4	2
F	2.1	Small rivers in the alpine foothills	172	5	19,1	3	12	2	16	1	0,00	0	11	5
F	2.2	Mid-sized rivers in the alpine foothills	135	5	6,1	2	0	0		0	0,00	0	7	3
F	3	Streams in the Pleistocene sediments of the alpine foothills	63	3	2,2	1	0	0		0	0,00	0	4	2
F	3.1	Small rivers in the Pleistocene sediments of the alpine foothills	68	3	3,1	1	59	2	3	1	0,00	0	7	3
F	3.2	Mid-sized rivers in the Pleistocene sediments of the alpine foothills	46	2	0,2	0	66	2	2	1	0,00	0	5	2
F	4	Large rivers in the alpine foothills	124	5	3,8	1	8,9	1	32	1	0,00	0	8	4

Selection matrix: top priority stream types

		Stream type	Exposure				Sensitivity		Exposure sensitive streams		Reference water bodies		Priority	
			Intensity		Abundance								Index	Class
		Types in the central highlands												
F	5	Small coarse substrate dominated siliceous highland rivers	51	2	43,7	4	16	2	3	1	0,07	1	10	5
F	5.1	Small fine substrate dominated siliceous highland rivers	27	1	10,4	3	10	2	3	1	0,00	0	7	3
F	6	Small fine substrate dominated calcareous highland rivers	58	2	21,9	4	2,5	1	3	1	0,07	1	9	4
F	6_K	Small fine substrate dominated calcareous highland rivers in the Keuper	64	3	9,8	2	2,5	1	7	1	0,00	0	7	3
F	7	Small coarse substrate dominated calcareous highland rivers	46	2	17,2	3	7,4	1	6	1	0,00	0	7	3
F	9	Mid-sized fine to coarse substrate dominated siliceous highland rivers	35	1	10,6	3	8,4	1	4	1	0,10	1	7	3
F	9.1	Mid-sized fine to coarse substrate dominated calcareous highland rivers	45	2	8,0	2	0,6	1	5	1	0,00	0	6	3
F	9.1_K	Subtype in the Keuper	69	3	3,9	1	19	2	24	1	0,00	0	7	3
F	9.2	Large highland rivers	42	2	8,3	2	3,5	1	18	1	0,16	1	7	3
F	10	Very large gravel-dominated rivers	50	2	6,3	2	0	0		0	0,24	1	5	2

Silikat

Type 5: Small coarse substrate dominated siliceous high-land rivers

(incl. Sub type 5.2)

Distribution in river landscapes and regions according to Briem (2003):

Schists, gneiss, granites and similar rocks, volcanic regions

Picture:

Kleine Schmalenau (North Rhine-Westphalia).

Short description of morphology:

Streams of this type run in different valley forms depend
source and the local conditions. Depending on the valley
valleys, troughs, u-shaped valleys – the stream channe
sinuous or (slightly) meandering. Beside single channel

Type 6: Small fine substrate dominated calcareous high-land rivers

Distribution in river landscapes and regions according to Briem (2003):

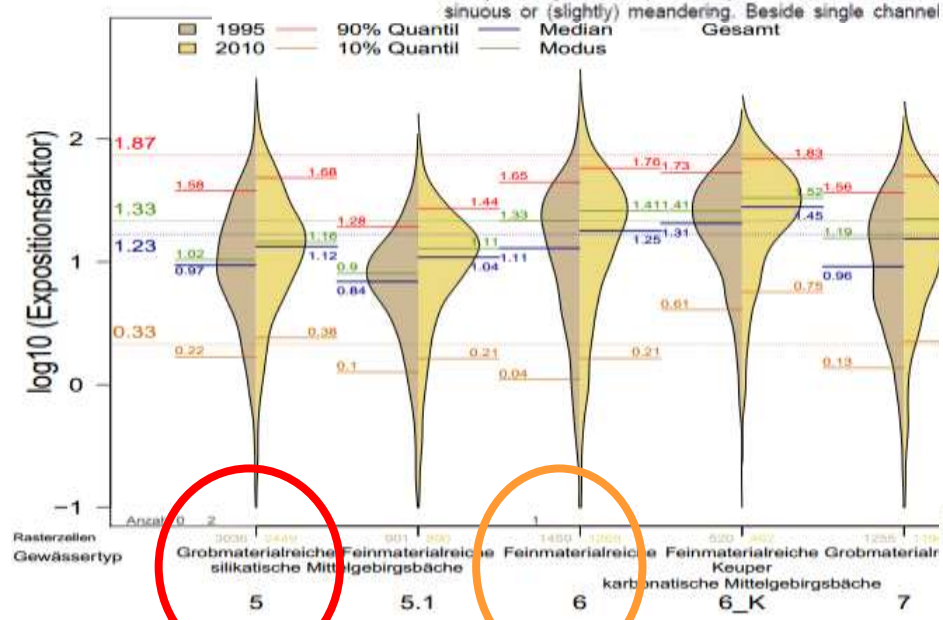
Loess regions, upper Triassic rocks, Permian rocks (sandstone, claystone, conglomerate rocks), middle and lower Jurassic (sandstone, claystone and marl)

Picture:

Fischbach (Baden-Württemberg) LfU (1998). Photograph: R. Bosselmann

Short description of morphology:

Sinuate to meandering streams, dominated by fine substrate. As a result of erosion in soft sediments, the streams are cut-in and run in entrenched channels often exhibiting undercut banks or eroding cliffs. Channel substrate



fein– bis grobmaterialreiche Mittelgebirgsflüsse

9 9.1 9.1_K 9.2 10

Selection matrix: top priority stream types

		Stream type	Exposure				Sensitivity		Exposure sensitive streams		Reference water bodies		Priority	
			Intensity		Abundance								Index	Class
		Types in the central plains												
F	14	Small sand-dominated lowland rivers	135	5	43,9	4	0,8	1	8	1	0,39	1	12	5
F	15	Mid-sized and large sand and loam-dominated lowland rivers	128	5	19,3	3	0,9	1	12	1	1,27	1	11	5
F	15_g	Very large sand and loam-dominated lowland rivers	120	4	1,5	1	0	0		0	0,00	0	5	2
F	16	Small gravel-dominated lowland rivers	74	3	29,8	4	1,6	1	5	1	0,24	1	10	5
F	17	Mid-sized and large gravel-dominated lowland rivers	47	2	5,6	2	4,6	1	8	1	0,00	0	6	3
F	18	Small loess and loam-dominated lowland rivers	78	3	7,1	2	0,7	1	9	1	0,00	0	7	3
F	20	Very large sand-dominated rivers	60	3	6,3	2	0	0		0	1,75	1	6	3
F	22	Marshland streams of the coastal plains	17	1	0,1	0	0	0		0	0,00	0	1	1
F	22.1	Subtype small to mid-sized streams	62	3	7,7	2	0	0		0	1,42	1	6	3
F	22.2	Subtype large rivers	132	5	2,5	1	0	0		0	0,00	0	6	3
F	22.3	Subtype very large rivers	29	1	0,3	0	0	0		0	0,00	0	1	1
F	23	Backwater and brackish water influenced Baltic Sea tributaries	29	1	1,4	1	0	0		0	0,00	0	2	1

Type 14: Small sand-dominated lowland rivers

Distribution in river landscapes and regions according to Briem (2003):

Outwash plains, sandy deposits, ground moraines; also in sandy regions of lower and older river terraces

Picture:

Type 15: Mid-sized and large sand and loam-dominated lowland rivers

Distribution in river landscapes and regions according to Briem (2003):

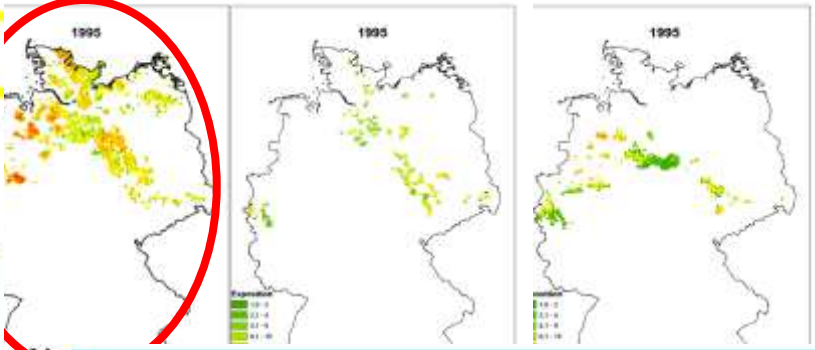
Large floodplains (over 300 m wide), outwash plains, sandy deposits, loess regions, ground moraines, also in sandy regions of river terraces.

Picture:

Lippe (North Rhine-Westphalia). Photograph: T. Ehlert

Short description of morphology:

Sinuate to meandering streams in shallow troughs or wide u-shaped valleys. Besides the dominant sand and loam fractions, gravel is an important substrate, which can form gravel banks; clay and marl are common and can



Type 16: Small gravel-dominated lowland rivers

Distribution in river landscapes and regions according to Briem (2003):

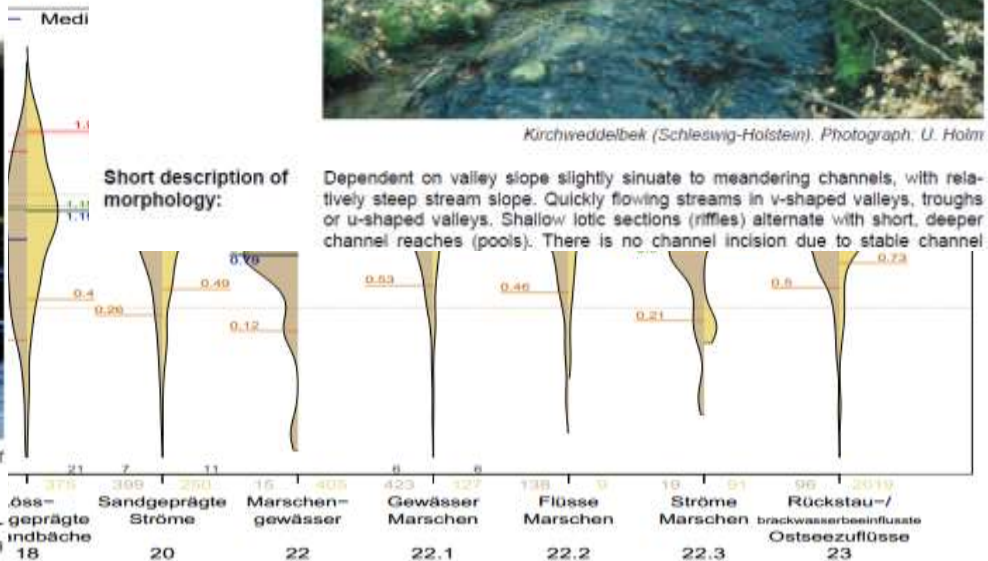
Ground and terminal moraines of young and older moraine landscapes and older river terraces.

Picture:

Kirchweddelbek (Schleswig-Holstein). Photograph: U. Holm

Short description of morphology:

Dependent on valley slope slightly sinuate to meandering channels, with relatively steep stream slope. Quickly flowing streams in v-shaped valleys, troughs or u-shaped valleys. Shallow lotic sections (riffles) alternate with short, deeper channel reaches (pools). There is no channel incision due to stable channel



Selection matrix: top priority stream types

		Stream type	Exposure				Sensitivity		Exposure sensitive streams		Reference water bodies		Priority	
			Intensity		Abundance								Index	Class
		Ecoregion independent stream types												
F	11	Small organic substrate-dominated rivers	76	3	18,6	3	2,1	1	2	1	0,36	1	9	4
F	12	Mid-sized and large organic substrate-dominated rivers	66	3	5,6	2	2,0	1	15	1	0,32	1	8	4
F	19	Small streams in riverine floodplains	146	5	29,5	4	1,7	1	10	1	0,19	1	12	5
F	21	Lake outflows												
F	21_N	Subtype in the Northern Plains (North)	29	1	4,3	1	2,4	1	5	1	0,91	1	5	2
F	21_S	Subtype in the Alpine foothills (South)	39	1	0,1	0	83	2	3	1	0,00	0	4	2

Type 11: Small, organic substrate-dominated rivers

Distribution in river landscapes and regions according to Briem (2003):

Ecoregion independent stream type. Old and young moraine landscapes (ground and terminal moraines); outwash plains and sandy deposits; river terraces (including lower river terraces); mires; occasionally in upper reaches of streams in basement and overlying mountains; large floodplains of the alpine foot hills (over 300m wide).

Picture:

Type 12: Mid-sized and large organic substrate-dominated rivers

Distribution in river landscapes and regions according to Briem (2003):

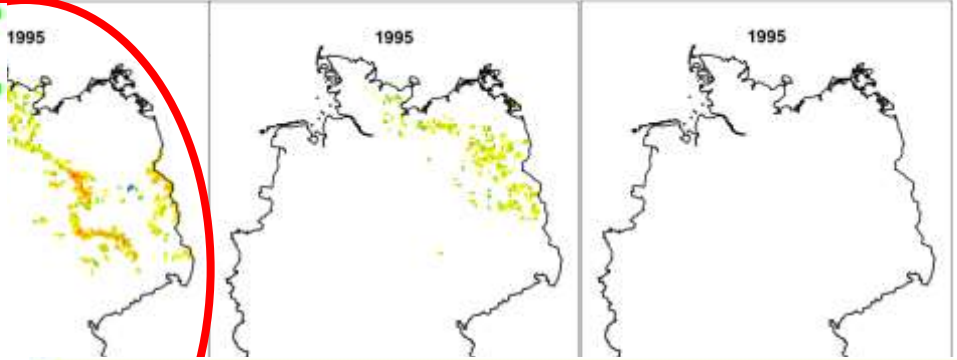
Ecoregion independent stream type. Large floodplains (over 300 m wide) with valley peat, bogs, mainly organic material; outwash plains and sandy deposits, lower river terraces, old river terraces

Picture:

Stepenitz (Brandenburg). Photograph: C. Feld

Short description of morphology:

Organic rivers typically meander or flow in anastomising channels in u-shapes valleys with many side channels. The transition to the floodplain is often gradual. The floodplain and river bed are dominated by organic substrates (peat, fallen leaves, macrophytes, etc.). Some mineral substrates can



Type 19: Small streams in riverine floodplains

Distribution in river landscapes and regions according to Briem (2003):

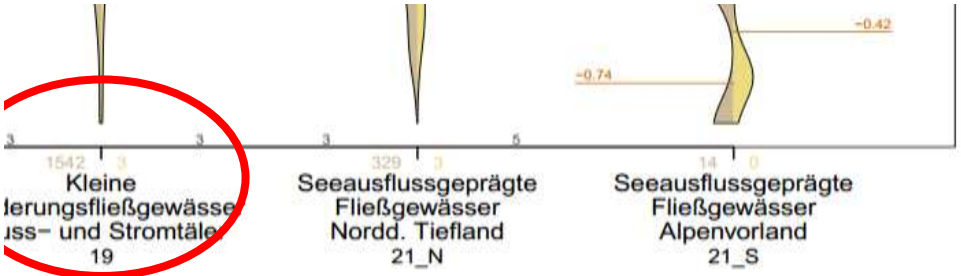
Ecoregion independent stream type. Large floodplains (over 300 m wide), Lower river terraces

Picture:

Hellbach (Schleswig-Holstein). Photograph: J. Stuhr

Short description of morphology:

Streams with very low slope, running in winding to meandering, in parts multiple channels, through floodplains of main stem rivers, which hydrologically influences these tributaries.



Conclusions & Further Tasks

- The developped selection method could be successfully applied for stream types providing a base for Part II selection of indicator species

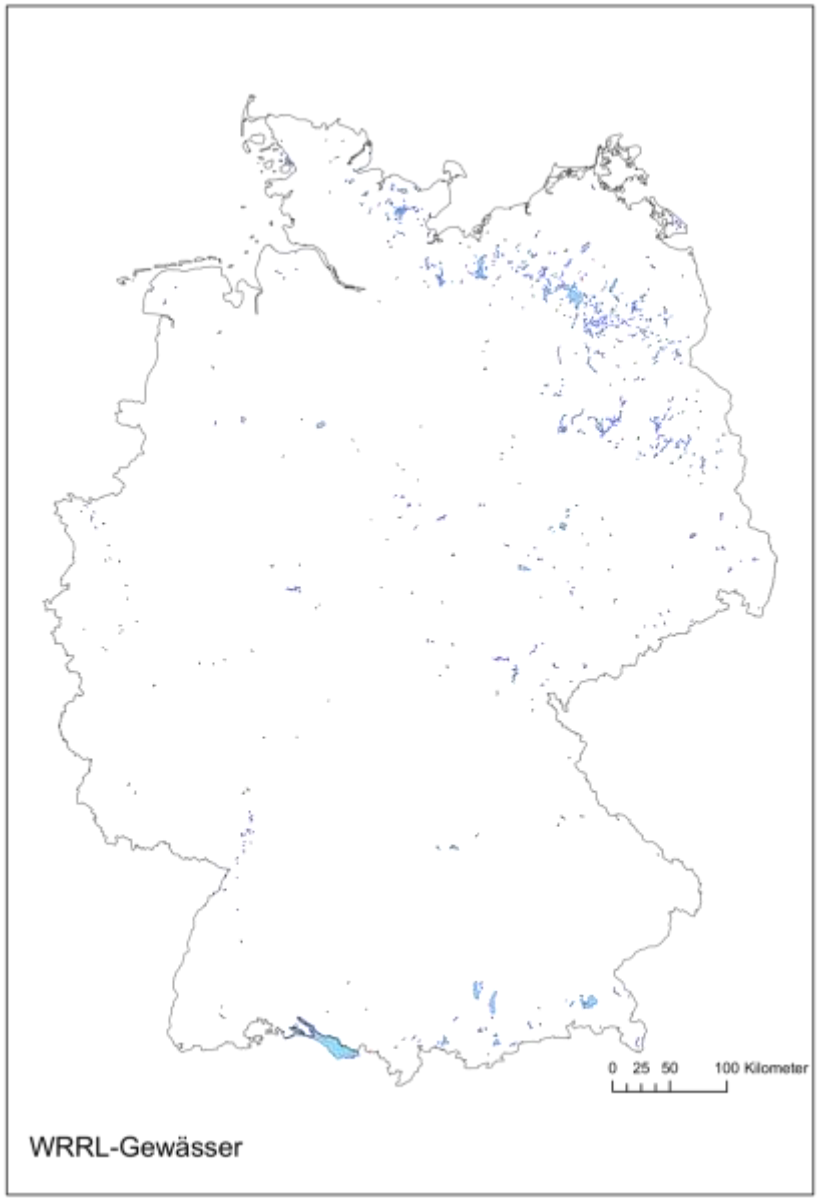
Further tasks:

- Lakes: The method can be transfered for a selection of lakes with little adaptions – but the WFD data base for lakes has not been established enough to date.

- Smaller water bodies: The same applies to smaller water bodies not being included in the actual state of the WFD.


Thank you for listening!

Exposure assessment of lakes



Similar method potentially applicable as soon as data base of WFD will be accomplished

- **Exposure factor lakes E_L:**

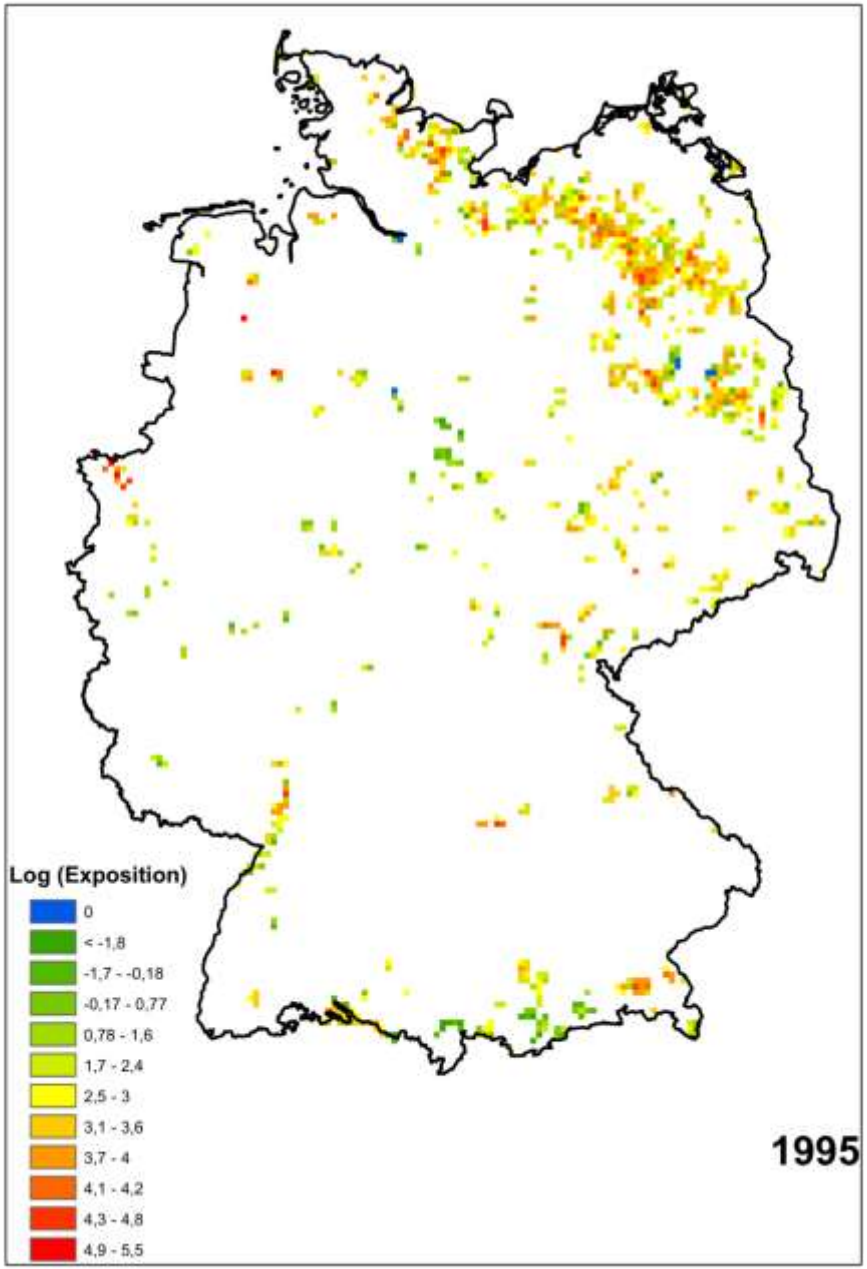
E_L = Length of shore line [km] x density of maize cultivation [%]

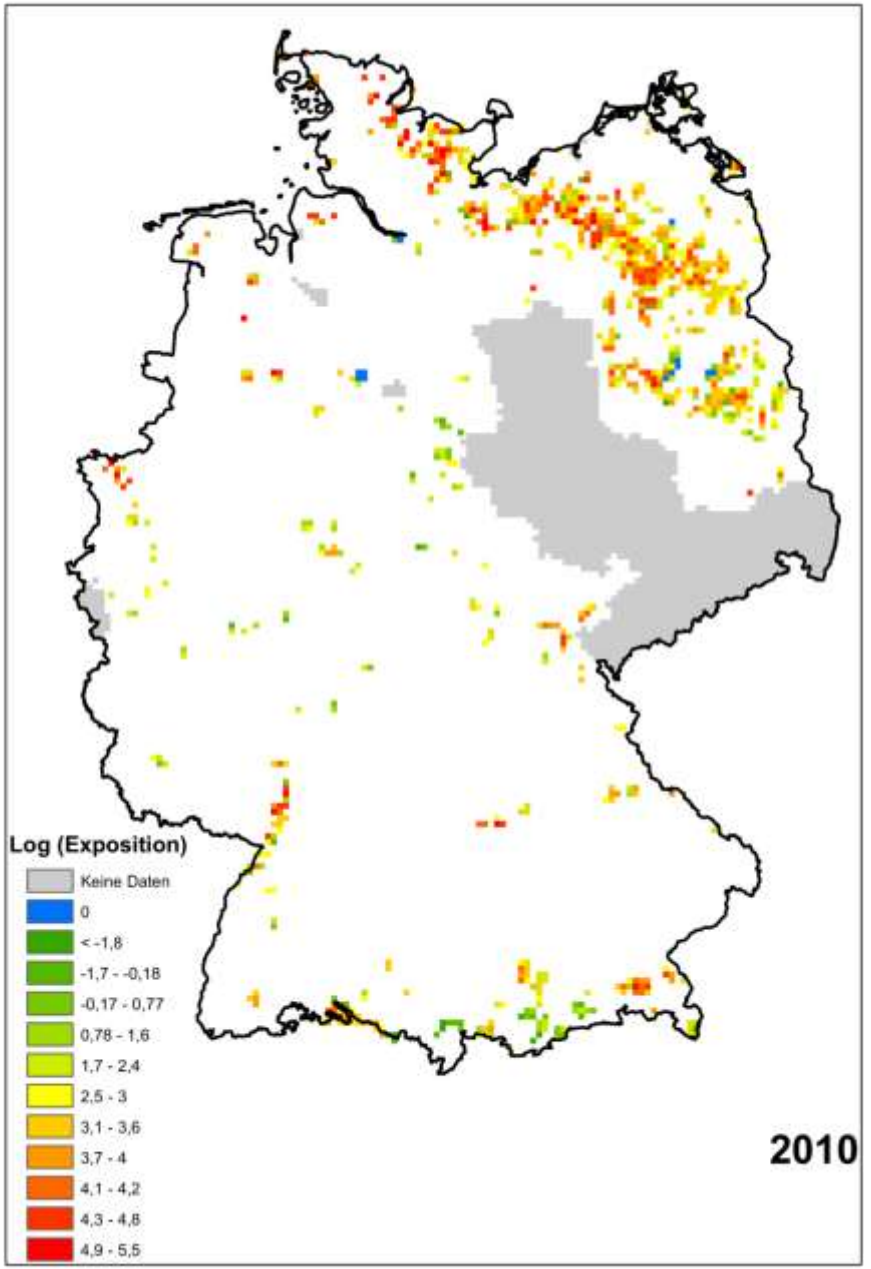
- **Problem:**

WFD focussen on lakes >50 ha actually,
the smaller lakes and ponds are not included yet
--> inhomogenous distribution over Germany

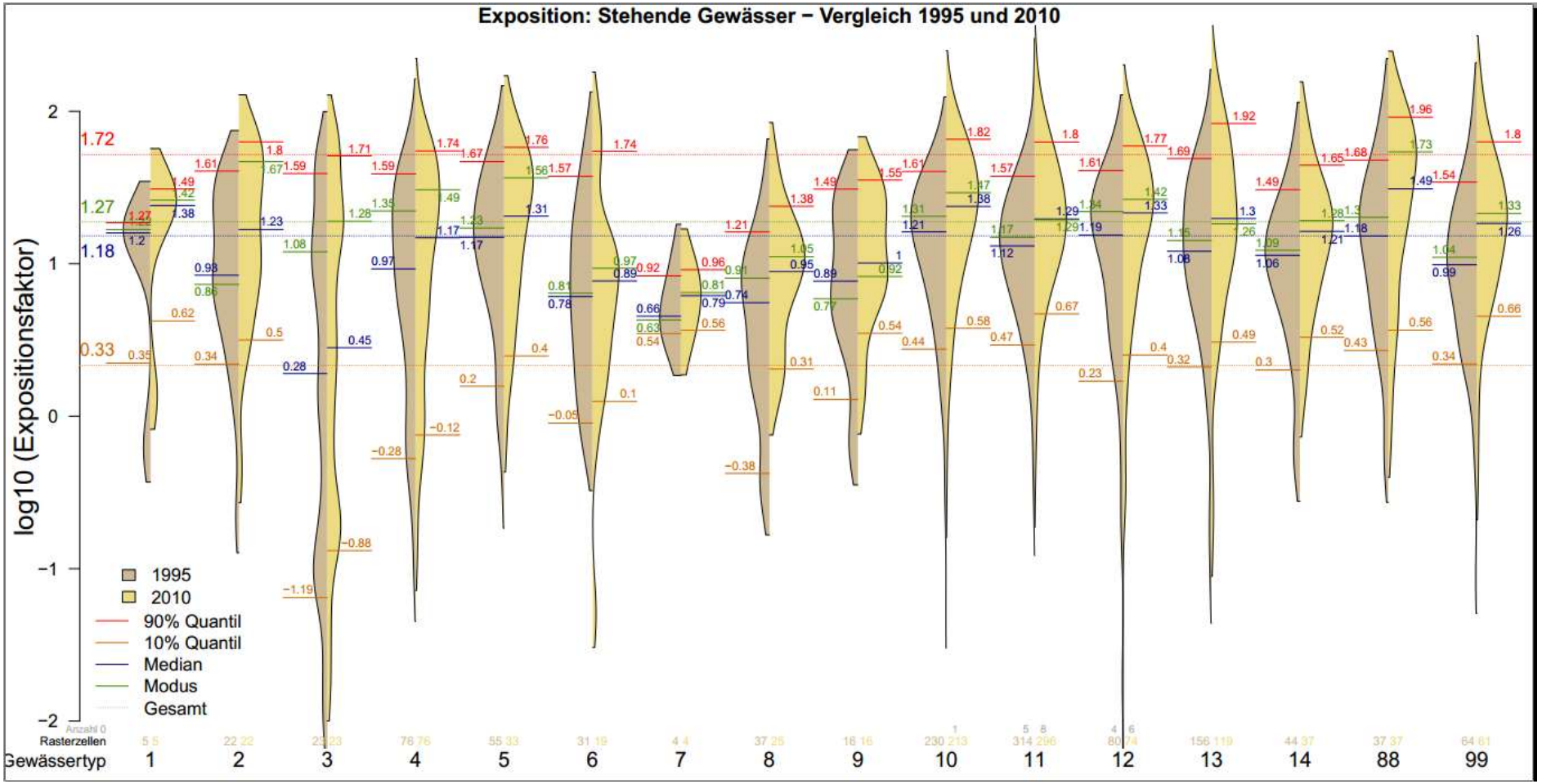
The classification and documentation is still in progress and not in the necessary detail available yet

Exposure risk maps for lakes (preliminary)





Exposure density distribution for lakes (preliminary)



Ökoregion Alpen und Alpenvorland | **Ökoregion Mittelgebirge** | **Ökoregion Norddeutsches Flachland**

1 Kalkreicher, ungeschichteter Voralpensee mit relativ großem Einzugsgebiet
2 Kalkreicher, geschichteter Voralpensee mit relativ großem Einzugsgebiet
3 Kalkreicher, geschichteter Voralpensee mit relativ kleinem Einzugsgebiet
4 Kalkreicher, geschichteter Alpensee mit relativ kleinem oder großem Einzugsgebiet
5 Kalkreicher, geschichteter Mittelgebirgssee mit relativ großem Einzugsgebiet
6 Kalkreicher, ungeschichteter Mittelgebirgssee mit relativ großem Einzugsgebiet
7 Kalkreicher, geschichteter Mittelgebirgssee mit relativ kleinem Einzugsgebiet
8 Kalkarmer, geschichteter Mittelgebirgssee mit relativ großem Einzugsgebiet
9 Kalkarmer, geschichteter Mittelgebirgssee mit relativ kleinem Einzugsgebiet
10 Kalkreicher, geschichteter Flachlandsee mit relativ großem Einzugsgebiet
11 Kalkreicher, ungeschichteter Flachlandsee mit relativ großem Einzugsgebiet und einer Verweilzeit >30d
12 Kalkreicher, ungeschichteter Flachlandsee mit relativ großem Einzugsgebiet und einer Verweilzeit > 3d und < 30d
13 Kalkreicher, geschichteter Flachlandsee mit relativ kleinem Einzugsgebiet
14 Kalkreicher, ungeschichteter Flachlandsee mit relativ kleinem Einzugsgebiet
88 Sondertyp natürlicher Seen (Moorsee, Strandsee u.s.w.)
99 Sondertyp künstlicher Seen (z.B. Abgrabungsseen)

Suggestion for lakes and ponds

- **Preliminary selection of lakes for each ecoregion according WFD**
- **Exemplary selection of smaller lakes and ponds below WFD classification in respect to abundance in maize cultivation areas and relevance for nature conservation, for example „Sölle“**
- **For lakes a selection of eco zones / habitats is recommended, e.g.**
  - **accumulation zones at shore line esp. around estuars of streams, reed zones**
  - **sedimentation** zones
  - habitats of freshwa**ter mussels (monitoring indicator)**
    (Douville et al. 2007)

Kleingewässer mit Einzugsgebiet <10 km² bei Fließgewässern und Seen <50 ha sind von der WRRL derzeit noch ausgeklammert.

Möglicher Ansatz für Einbeziehung von Kleingewässern (Fließ- und Stillgewässer) für weiterführende Vorhaben:

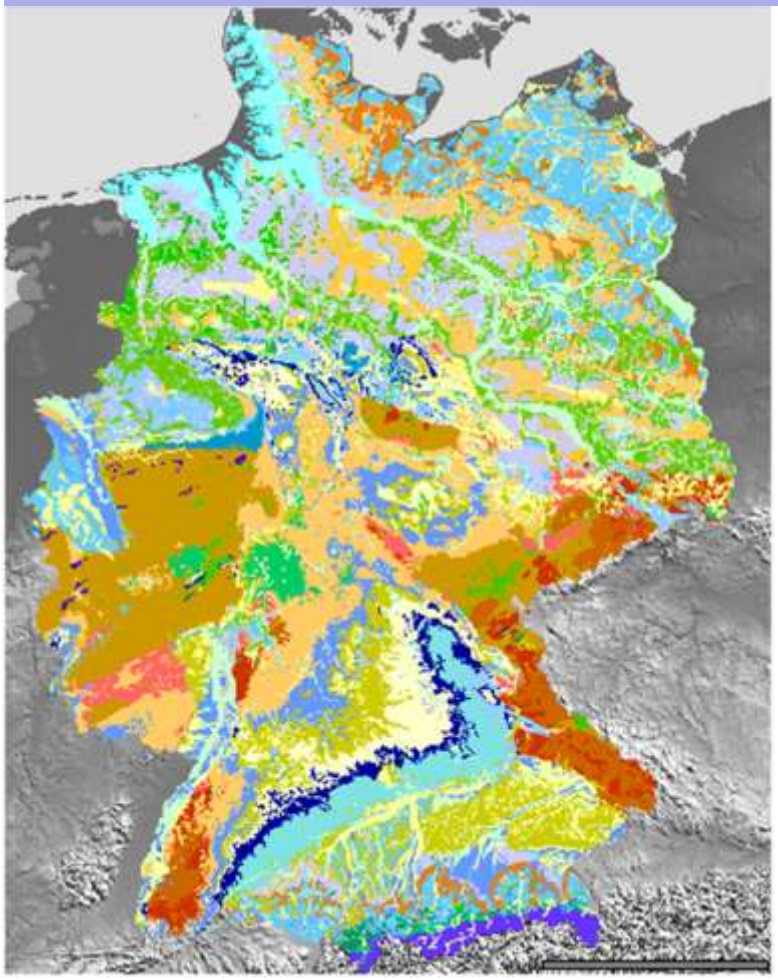
Die Typisierung basiert auf den Gewässerlandschaften, die sich nach dem geomorphologischen Untergrund und weiteren Aspekten richten. Sie gilt auch für kleinere Fließgewässer und ist flächendeckend verfügbar.

Berechnung eines Expositionsfaktor für Kleingewässer erfolgt über Verschneidung von Maisanbaudichte mit WRRL-Gewässerlandschaften, die flächendeckend sind:

E_K =
Deckungsgrad Gewässerlandschaftstyp [%]
x
Maisanbaudichte [%]

Berechnung wäre im GIS technisch beim derzeitigen Kenntnisstand prinzipiell machbar.

WRRL Gewässerlandschaften



Flächendeckende Grundlage für Gewässertypisierung

- Geo-Morphologie
- Höhe
- Klima
- Biologie
- …