Abwasserverband Braunschweig

Water Reuse –
The Braunschweig experience

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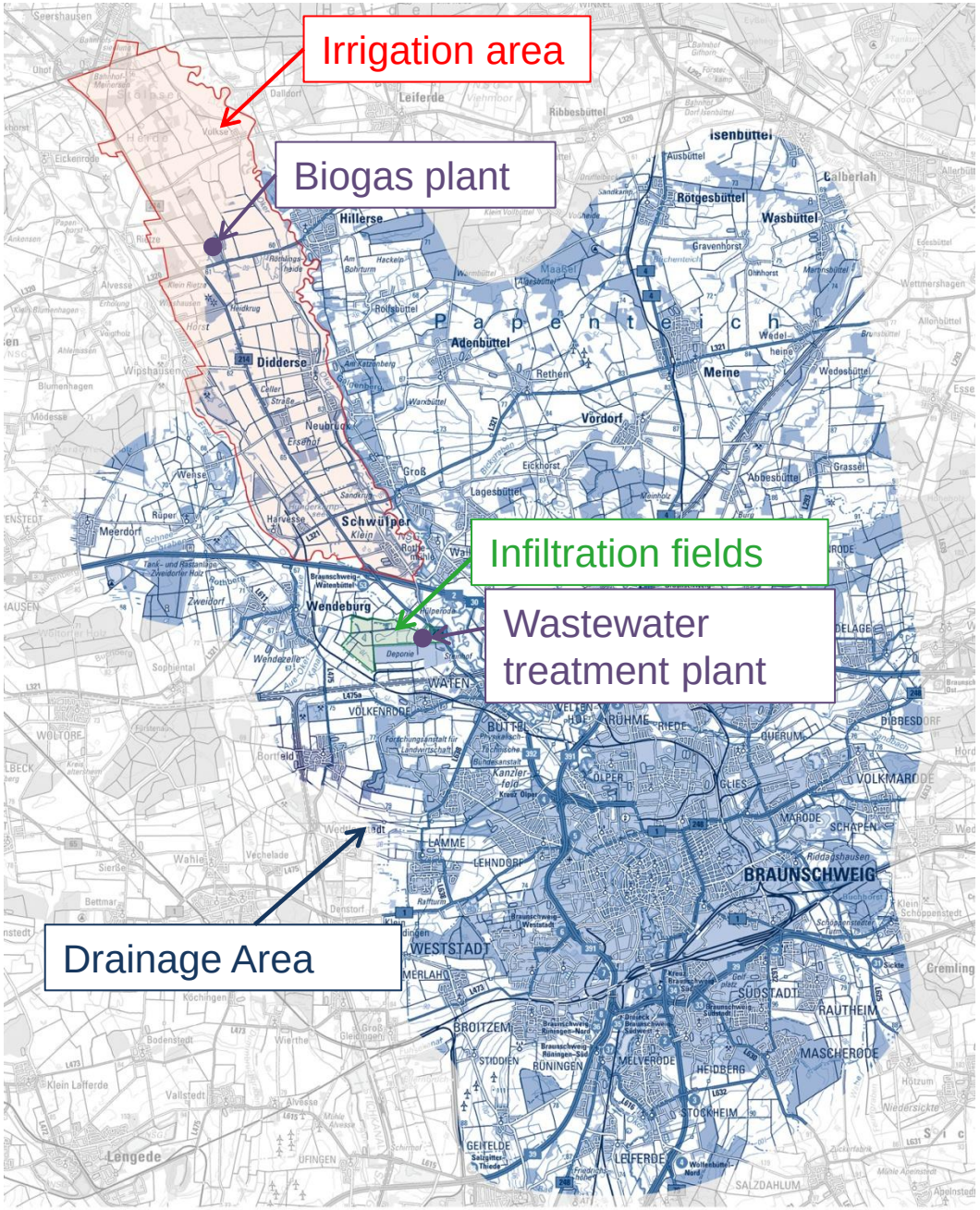
1. Development of the sewage board

History of wastewater reuse in Braunschweig

- 1894 Initiation of the first irrigation fields
- 1954 Formation of the sewage board
- 1955 – 1966 Extension of the 4 drainage areas approx. 3,000 ha
- 1955 – 1979 Sprinkler irrigation of mechanically pre-treated wastewater
- 1979 – 1991 Construction of the treatment plant in 4 stages
- 1985 – 1990 Modification of the irrigation fields
- 2000 Construction of the sludge digester



Area of the Sewage Board

LGLN Landesamt für Geoinformation und Landentwicklung Niedersachsen

Verregnungsgebiet/Verbandsgebiet | Rieselfelder | Einzugsgebiet

2. Wastewater reuse concept Braunschweig

Wastewater treatment plant Steinhof

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Wastewater treatment plant Steinhof

- Population equivalents: 385,000

- Treatment process
  - mechanical
  - biological
  - nutrient removal

- Flow: 55,000 m³/d

Irrigation

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Irrigation

Sprinkling irrigation 1956 - 1974

Sprinkling irrigation by sprinkling machines since 1974

Concept for wastewater reuse

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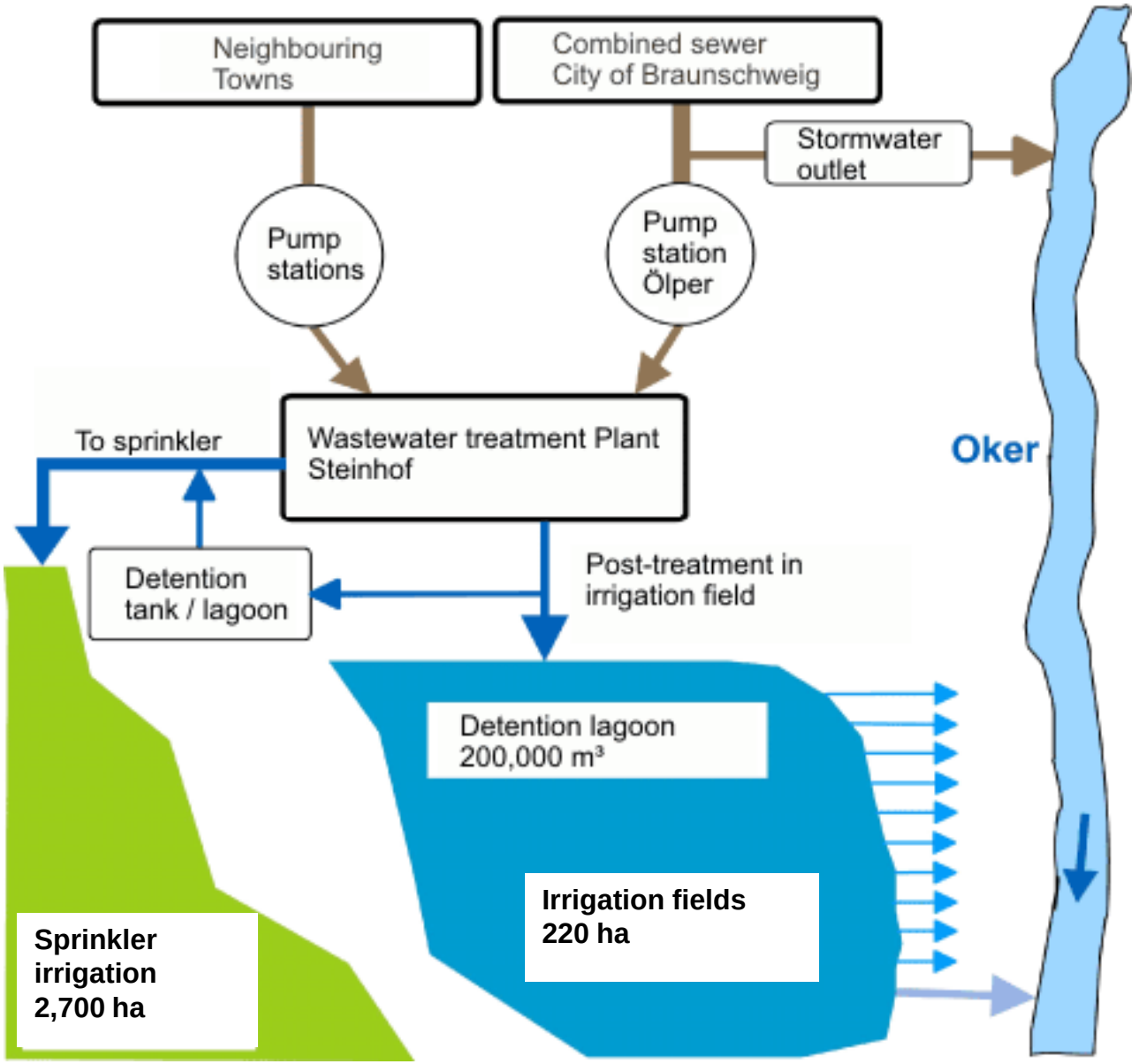
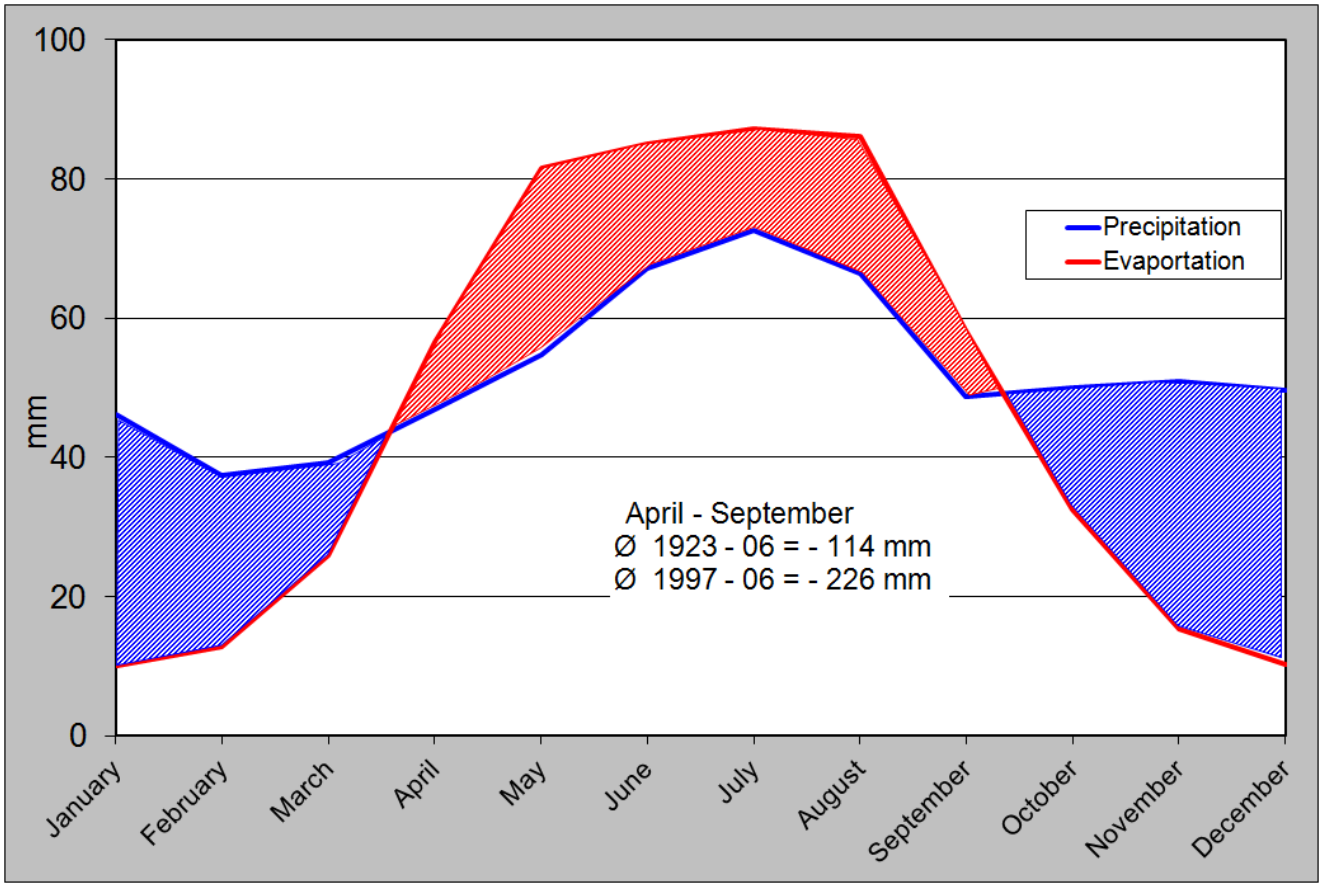


3. Necessity of irrigation and advantages of wastewater reuse in agriculture

Average water balance 1923 - 2011



Source: DWD, Station Braunschweig

Cultivation in the irrigation area

	1950	1970	1990	2010
	%	%	%	%
Crop	42	39	60	40
Potatoes	26	20	6	4
Sugar-beets	6	16	25	17
Maize	0	2	2	32
Other	26	23	7	7

4. Relevance of wastewater reuse and its ingredients for resource protection

Wastewater flow

- Annual amount of treated water 21,0 Mio.m³/a
  - reused by sprinkler irrigation 14 Mio.m³/a
  - artificial groundwater recharge 7 Mio.m³/a
- Additional water demand for irrigation approx. 100 mm on 2,700 ha 3,6 Mio.m³/a
- Total amount of water for artificial groundwater recharge 10,4 Mio.m³/a

Amount of sewage sludge

- Primary sludge and activated sludge 6,800 t TS/a
- Reduction by 30% by digestion 2,050 t TS/a
- Anaerobic digested sludge 4,750 t TS/a
  - 60% sprinkler irrigation 2,750 t TS/a
  - 40% elsewhere reused in agriculture 2,000 t TS/a

Ø Nutrient load and nutrient demand (kg/ha)

	Load	Demand
Ammonium, nitrate	50	140
Phosphate (P_2O_5)	69	70
Potassium (K)	78	130
Sulphur (S)	105	25
Magnesium (MgO)	38	45
Calium (CaO)	318	380
Organic substance	640	-

Nutrient loads per year in the irrigation area

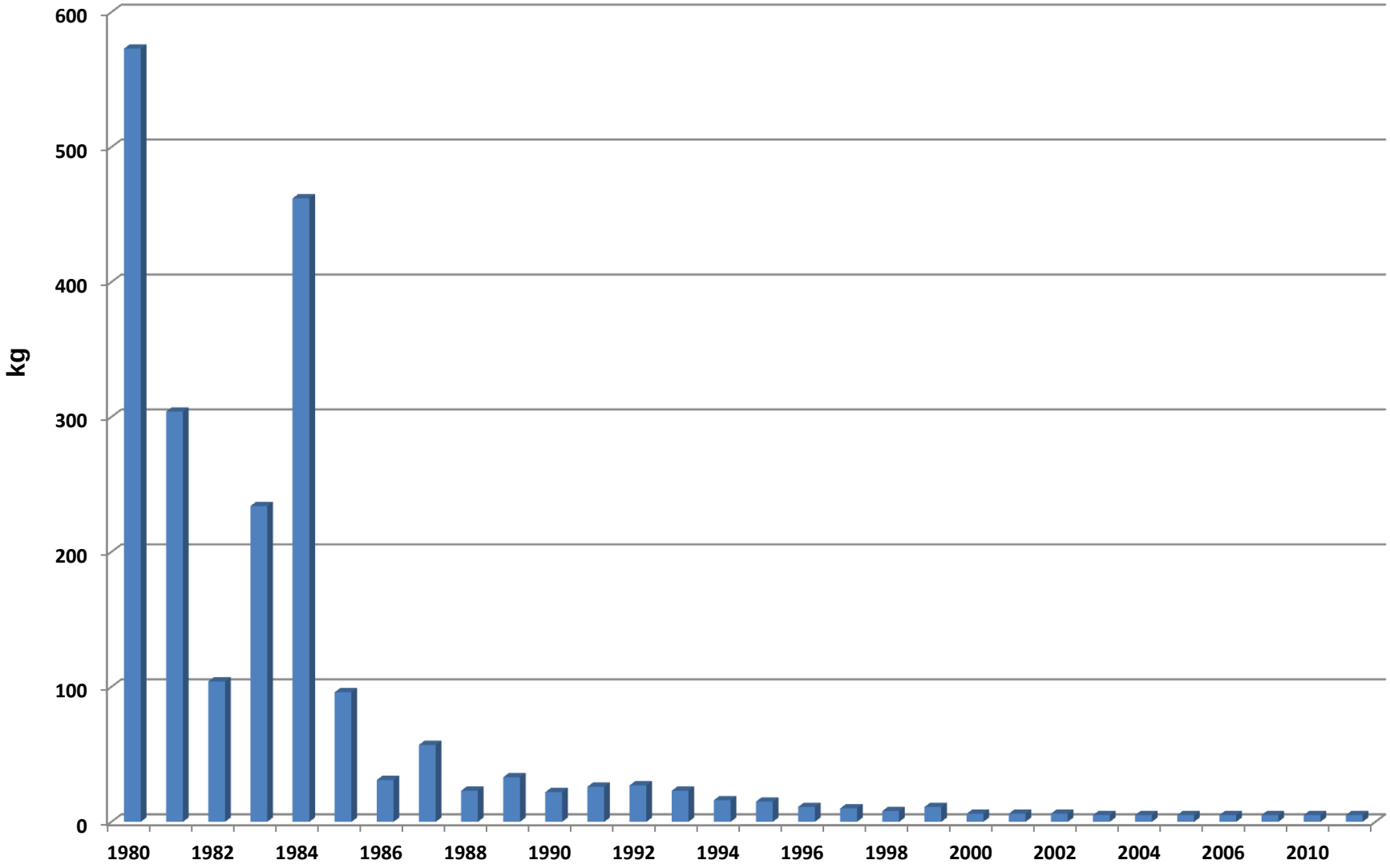
	Load
Ammonium (NH_4, NO_3)	135 t/a
Phosphate (P_2O_5)	185 t/a
Potassium (K)	210 t/a
Magnesium (MgO)	100 t/a

5. Arrangements for the protection of soil and groundwater

Indirect discharger monitoring in Braunschweig for 30 years

Dry-cleaner	2
Glass processing	6
Breweries	1
Chemical Companies	1
Print shops	16
Food industry	6
Institutes and Laboratories	26
Metal industry	10
Garages, petrol stations,etc.	262
Hospitals	7
Waste disposal sites	3
Water treatment plants	20
Varnish production	6
Other	35
Sum	**401**

Cadmium-load in sludge and irrigation water (kg)



Consultancy for farmers

- Support of intertillage to hold nutrients in the soil during groundwater recharge
- Fertilisation tests of sugar-beets, winter wheat, winter rapeseed and maize
- N_{min}-analysis to determine the subsequent supply of nitrogen of the soil
- Extensive information on the fertilisation-effect of the sprinkler-water in the „irrigation area“ due to weekly analysis
- Balance of total amount of sprinkler-water and allocation of the nutrient load (approx.12,000 checks per year)

Water-monitoring for 50 years

- Testing of
  - 6 discharge points from 500 ha drained area
  - groundwater testing of 3 of 33 observation wells by the water authority (analysis of 4 samples per year)

- Parameters
  - pH, electrical conductivity, dissolved oxygen, total-P, nitrite-N, nitrate-N, ammonium-N, organic bound nitrogen, TOC, COD, BOD5

QLA Certification

- The agricultural sludge utilisation is certified since 2006 and will be confirmed every 2 years

Poseidon project 2001-2004

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Monitoring results: 56 compounds were analyzed

PPCPs not found in wells (50)

Estrogens,
Betablockers,
Macrolide antibiotics
Musk fragrances
Antiphlogistics
Sympathomimetics
Lipid regulators

PPCPs found in wells (6)

Antiepileptics:
Carbamazepine
Sulfonamide antibiotics:
Sulfamethoxazole
Contrast media
Diatrizoate, Iothalamic acid,
Iohexol, Iopamidol

Degradation products (mineralisation) are unknown,
Sorption should be relevant for musk fragrances and estrogens

6. Results of the research project Routes

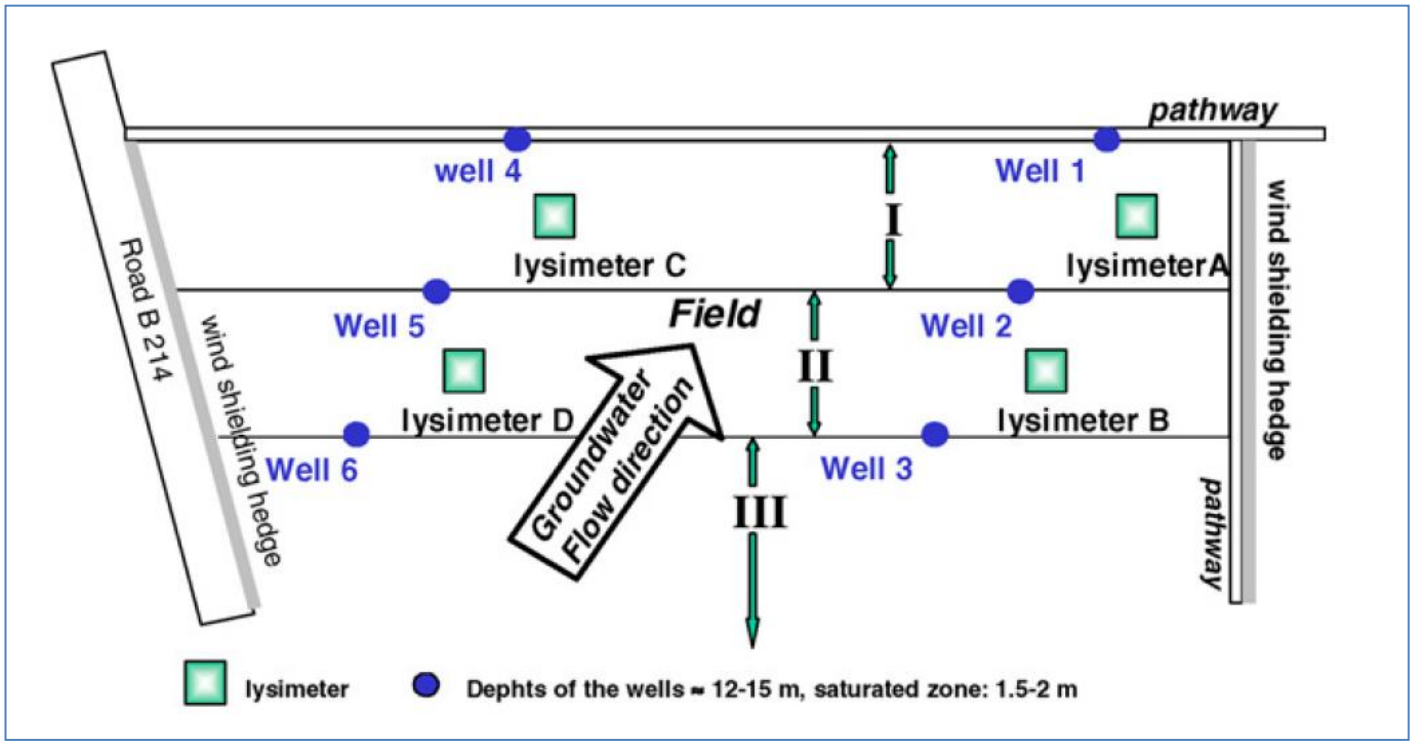
Measurements done by:

Federal Institute of Hydrology (BfG)

Department of Water Chemistry

Head: Prof. Dr. Thomas Ternes

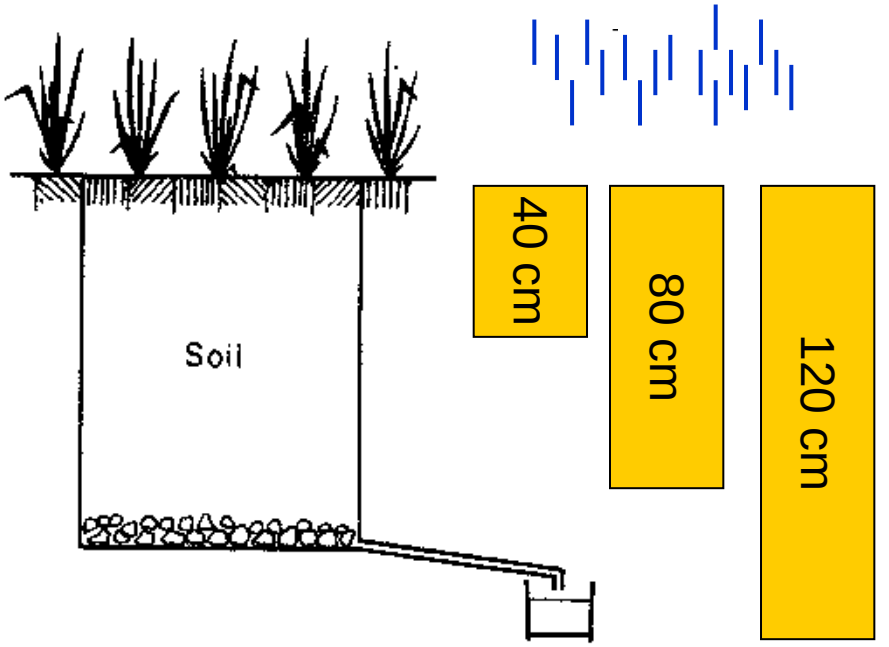
Experimental field in irrigation area



(Ternes et al. 2007 *Chemosphere*)

Lysimeters

- Undisturbed soil columns
- Steel cylinders of Ø 80 cm

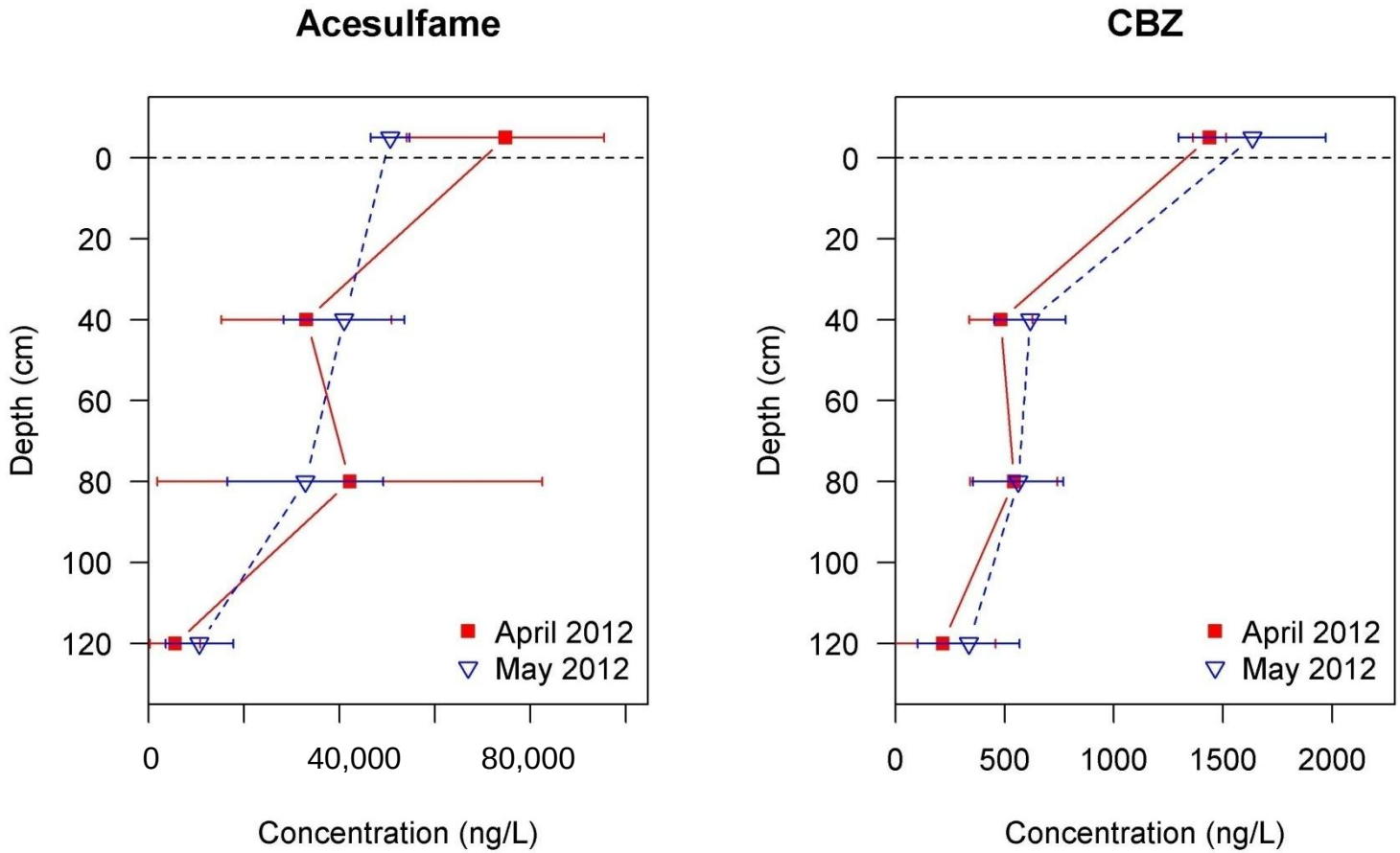


- Collecting of leachates
- Determination of micropollutants

Evaluation No. 1

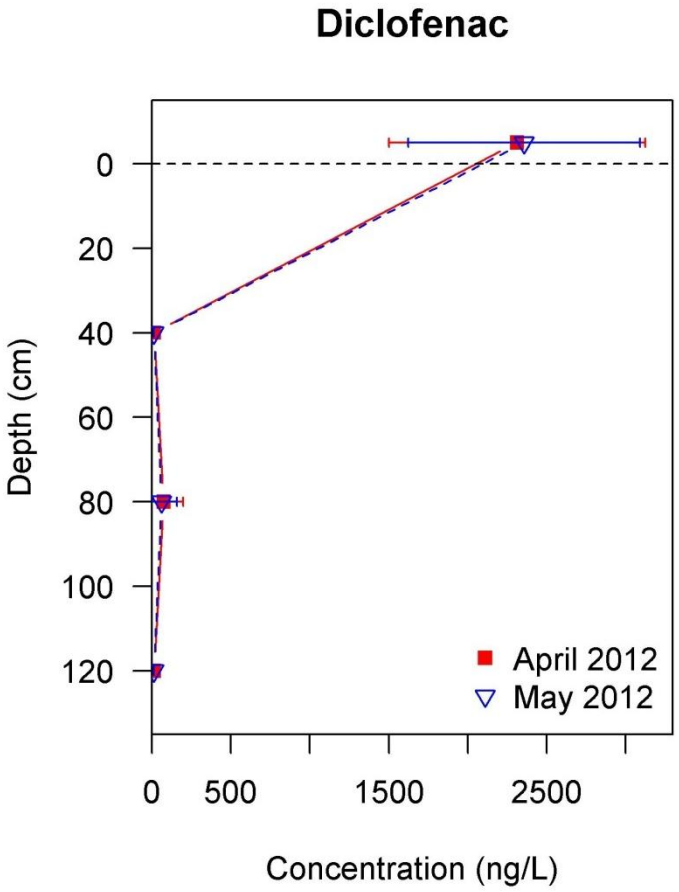
- Results of April and May 2012
- Average of four lysimeters
- Samples from 16./17.04.12 and 22./23.04.12
- Samples have been enriched by solid phase extraction
- Measured by HPLC-MS/MS

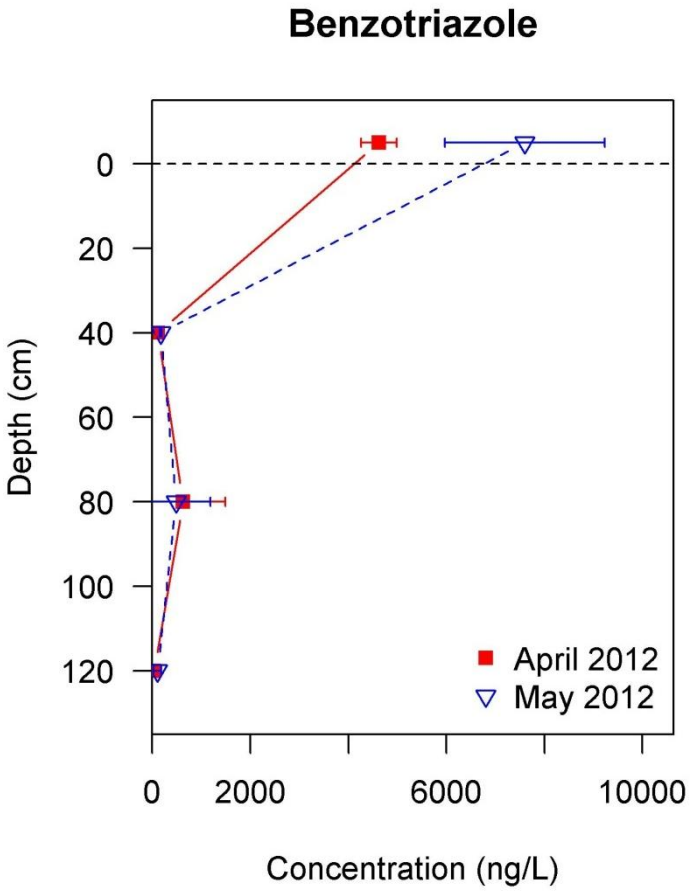
Persistent and not sorbing, concentration decrease by dilution



(Source: Kunkel et al., *in prep*)

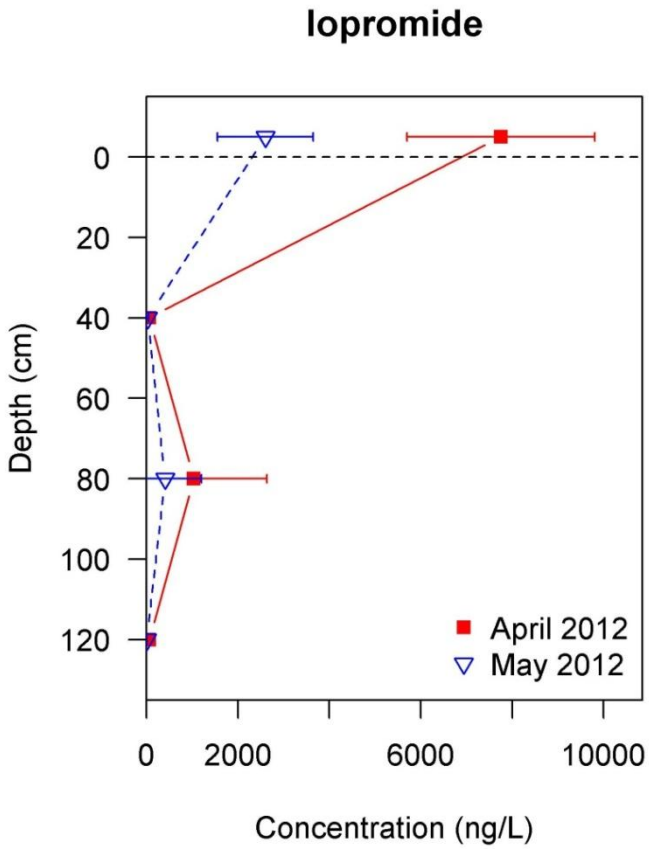
Barley sorbing, decrease primarily by biodegradation

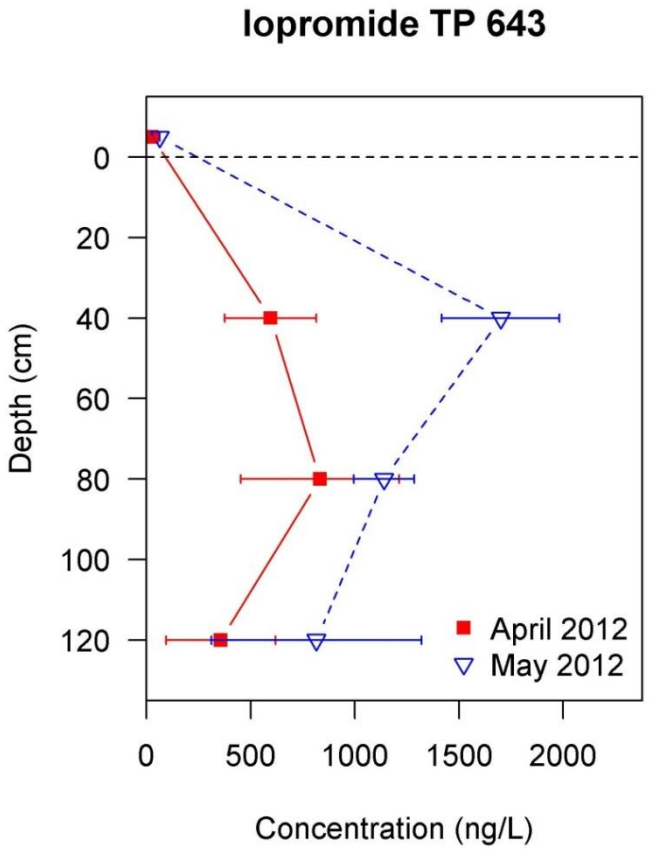




(Source: Kunkel et al., *in prep*)

Barley sorbing, decrease primarily by biodegradation, building of transformation products



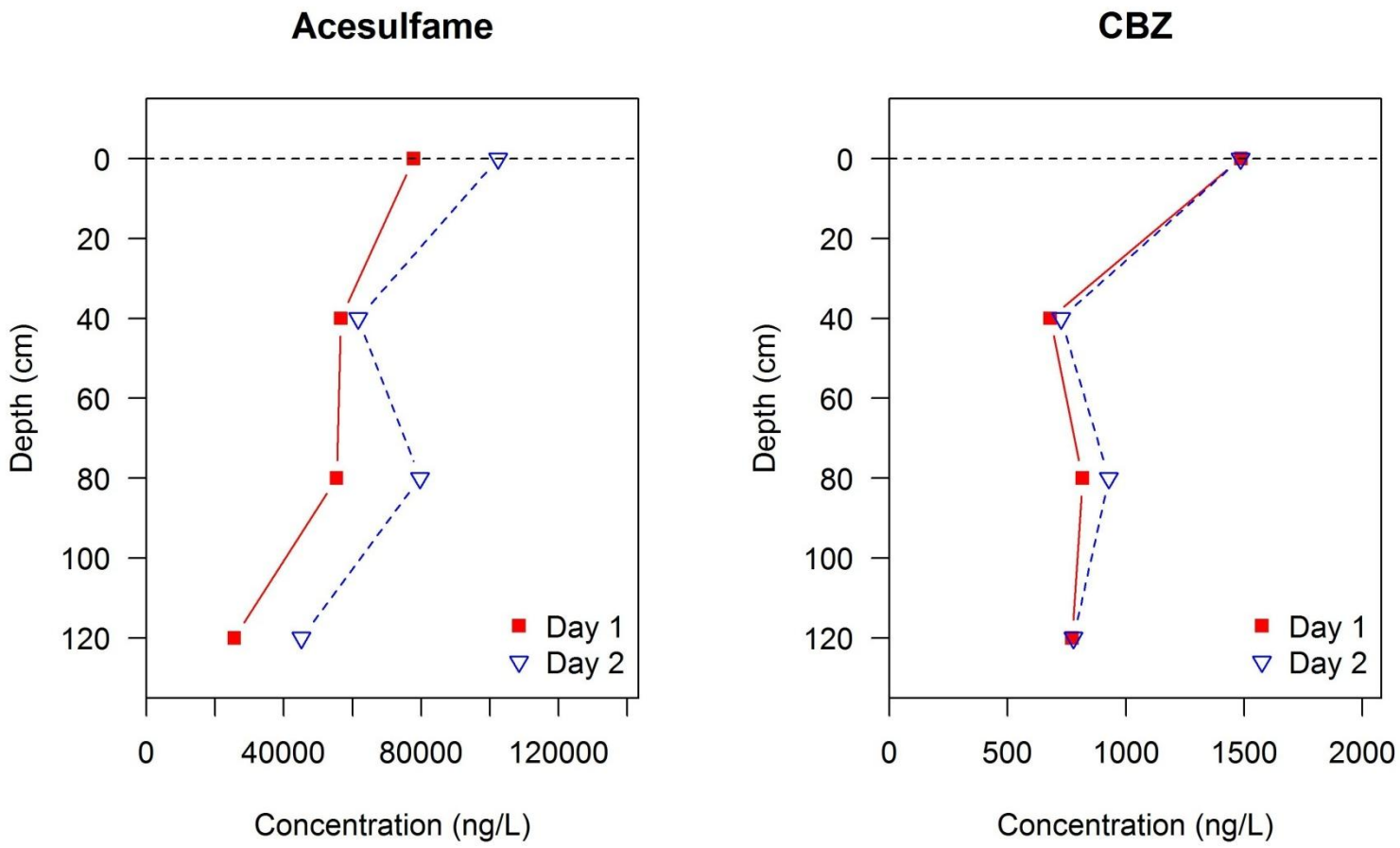


(Source: Kunkel et al., *in prep*)

Evaluation No. 2

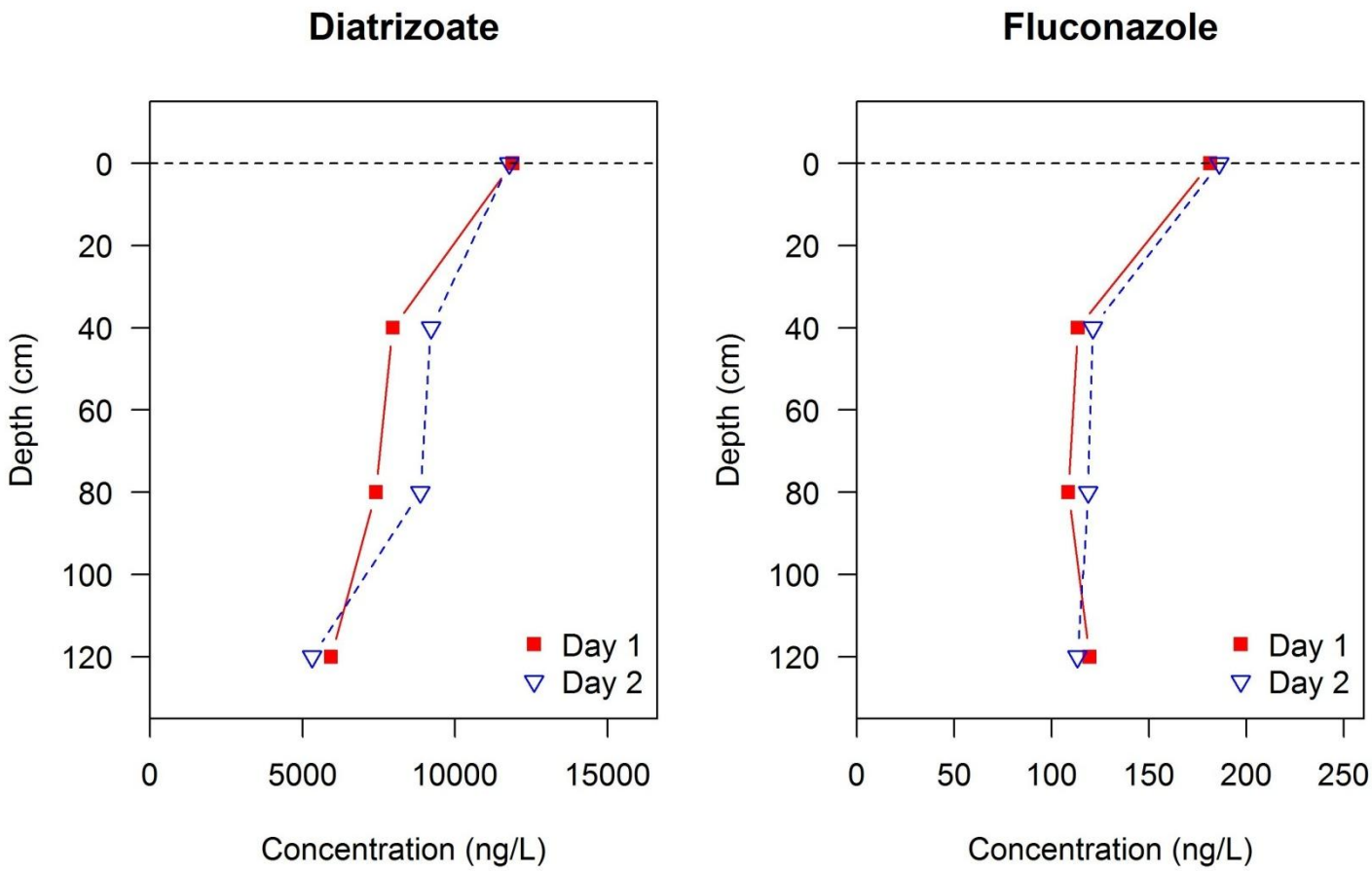
- Results of September 2012
- Individual values of lysimeter C
- Samples from 26.09.12 and 28.09.12
- Samples have been measured by direct injection without SPE with HPLC-MS/MS

Persistent and not sorbing, decrease by dilution with rainwater



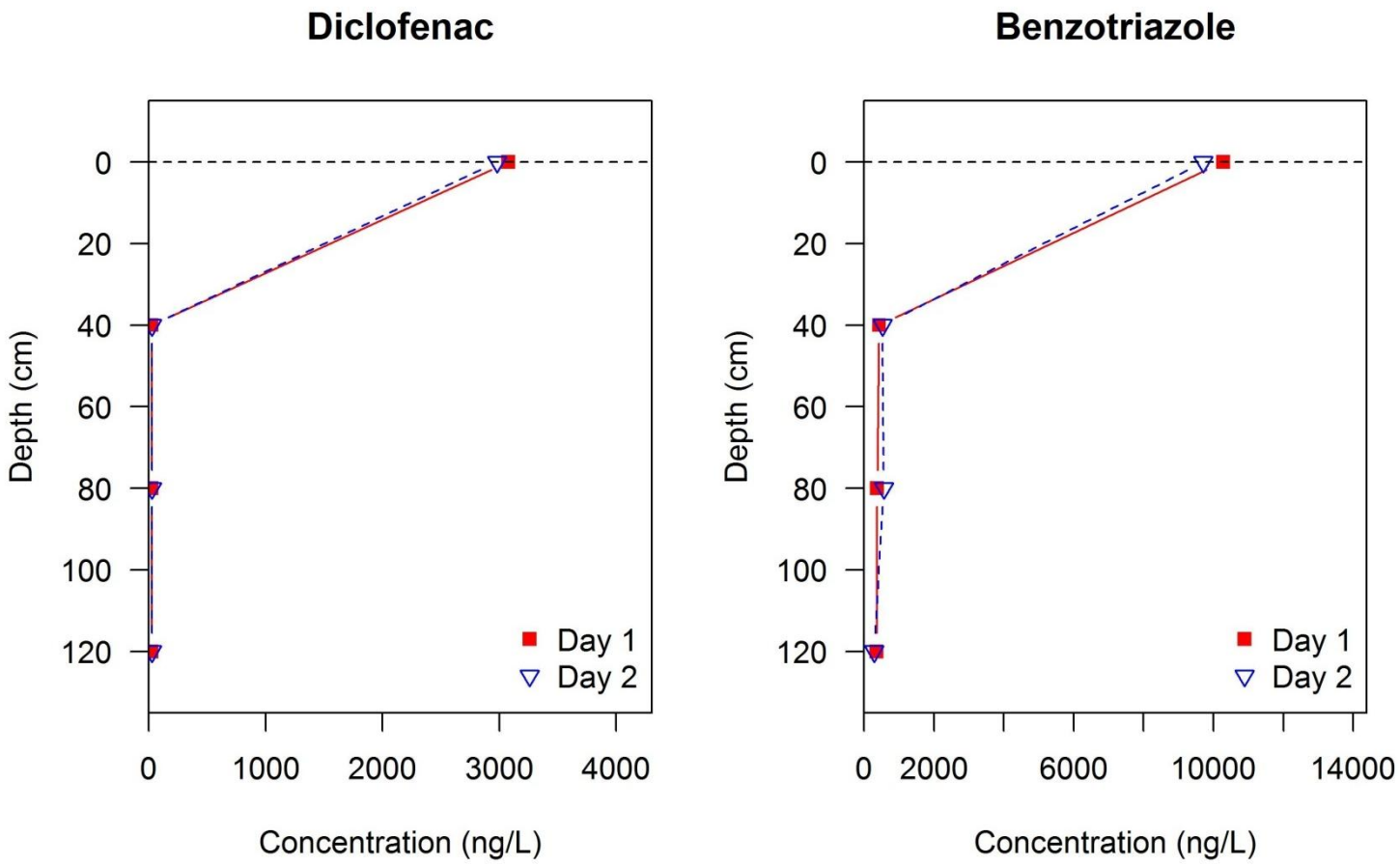
(Source: Kunkel et al., *in prep*)

Persistent and not sorbing, decrease by dilution with rainwater



(Source: Kunkel et al., *in prep*)

Barley sorbing, decrease primarily by biodegradation



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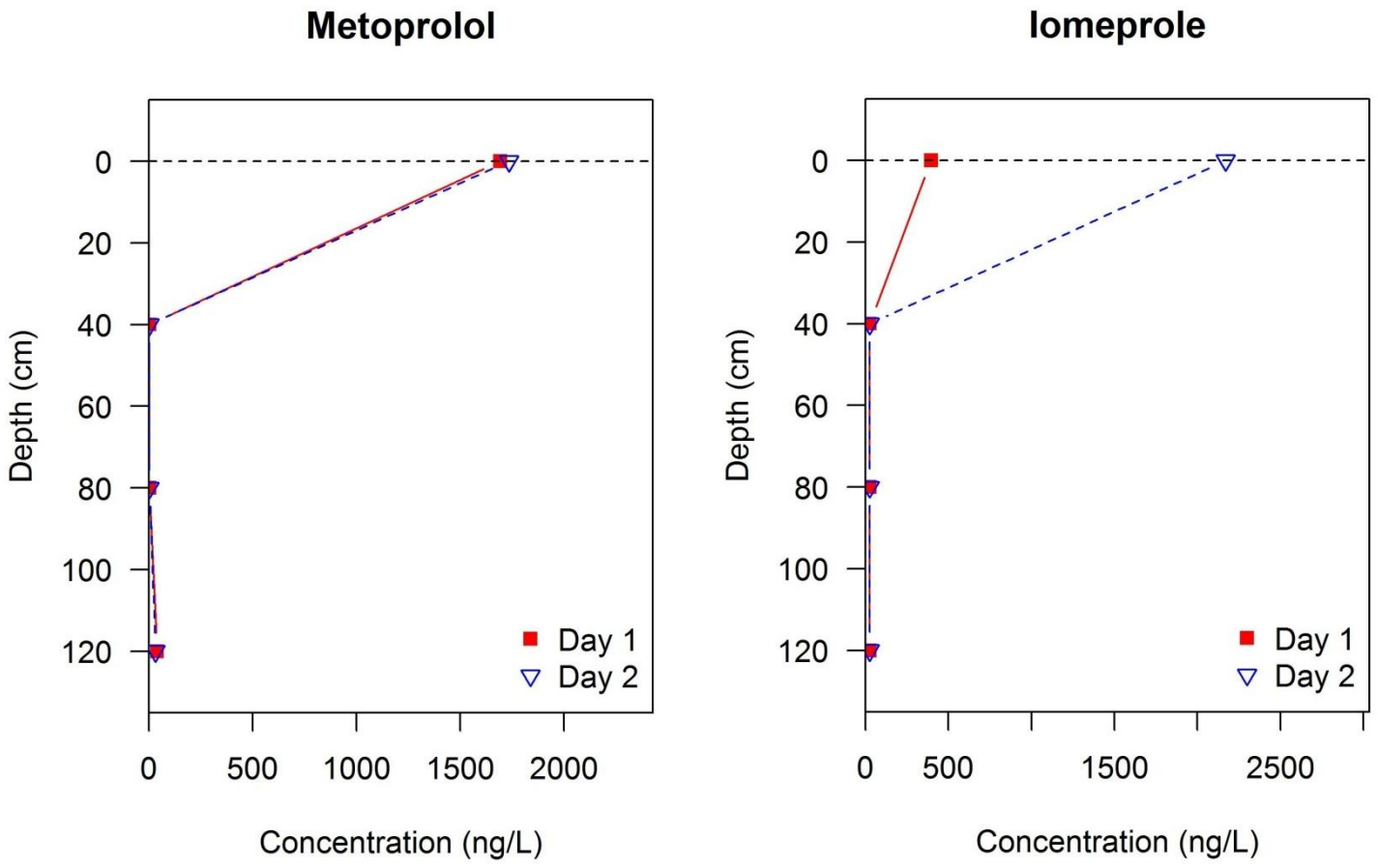
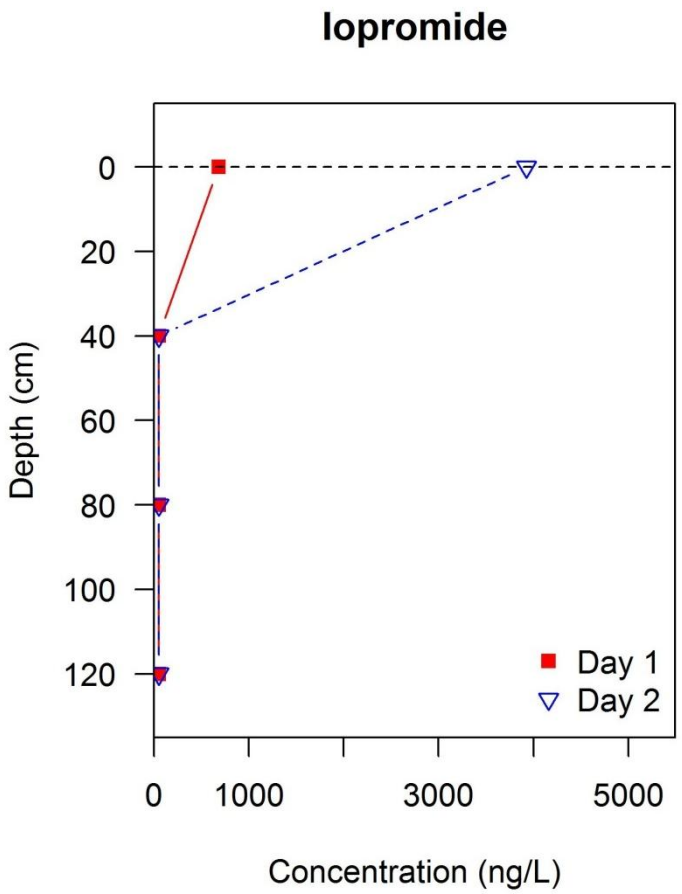
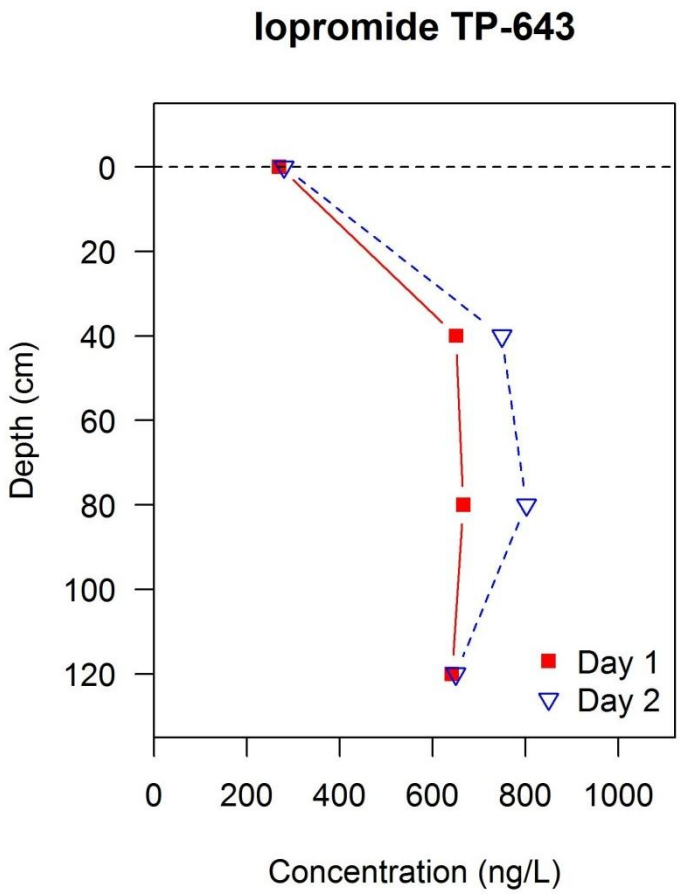
Barley sorbing, decrease primarily by biodegradation



(Source: Kunkel et al., *in prep*)

Barley sorbing, decrease primarily by biodegradation, building TP's





(Source: Kunkel et al., *in prep*)

7. Biogas plant and renewable resources

Biogas plant Hillerse

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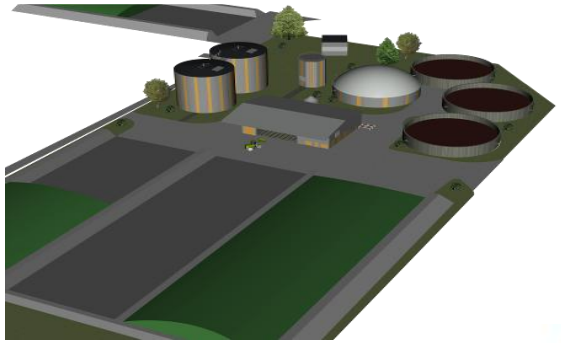
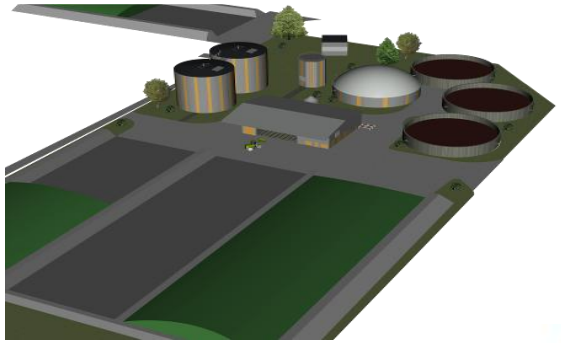
Biogas plant Hillerse
Technical data

- Total capacity 2.5 Mw_{el}
- 2 x 1 MW_{el} at Ölper (BS Energy)
- 0.5 MW_{el} at Hillerse
- 20 km gas pipeline from Hillerse to powerplant Ölper



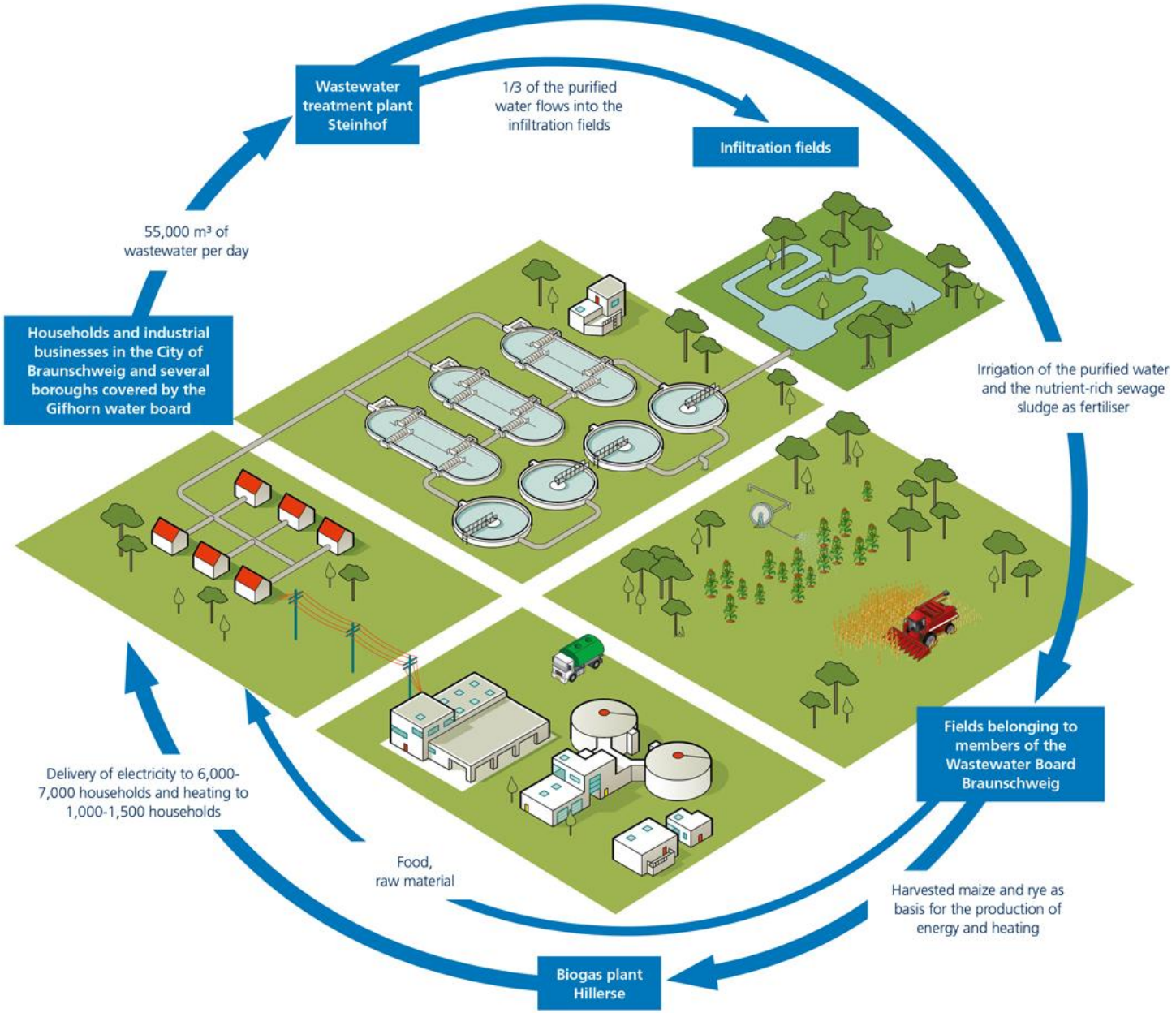
Biogas plant Hillerse
Demand of raw materials

• Substrate per year	43,000 t (maize, rye)
• Agricultural crop land	1,000 ha
• Daily „feeding“	101 t maize silage 16 t rye silage



8. Résumé

Water-nutrient-energy cycle



Advantages of water reuse...

...For inhabitants

- high treatment efficiency
- no filtration necessary
- solution for sludge disposal

...For water reusers (farmers)

- supply and application of sprinkler water
- use of nutrients
- use of organic ingredients

Advantages of water reuse...

...For the environment

- Ecology / water resources
  - Resources conservation
  - Prevention of contamination of rivers
  - No groundwater extraction
  - Promotion of groundwater recharge

- Closed loop recycling management
  - Dual use of water
  - Reclamation of ingredients

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Thank you for your attention!