Mitigation measures for soil erosion and muddy flooding in Flanders : effectiveness and practicability

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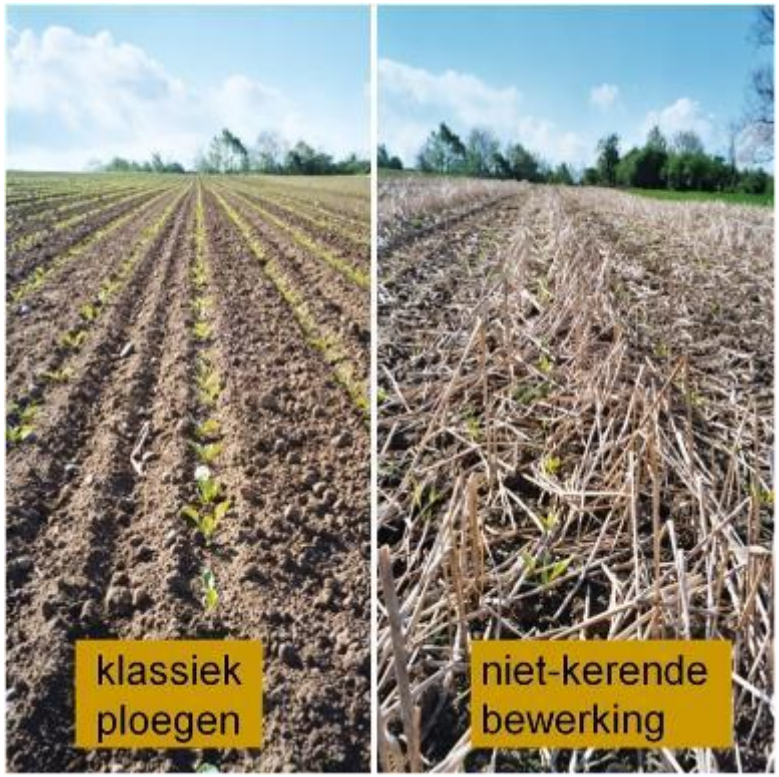
*Evaluation **effectiveness** of individual mitigation measures.*

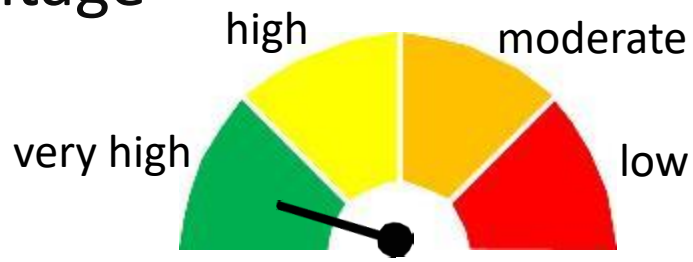
- Based on literature review of journals, research reports, etc.
- Only results of experiments, field measurements
- In the case of missing data, estimated based on the expert judgement of an expert group

*Evaluation **likely uptake (practicability)** of individual mitigation measures*

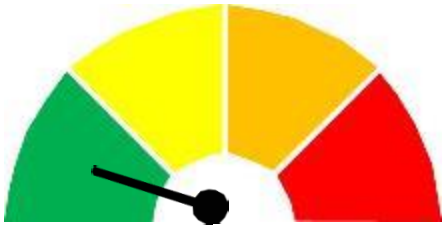
Based on the *judgement of an expert group.* As a result of this expert judgement each control measure is rated according to practicability (i.e. applicable, important constraints and not applicable).

Reduction of soil erosion : no-till farming with **high** cover percentage





Reduction of soil erosion



Reduction of sediment export from field

Soil erosion control measure	Practicability of soil erosion control measures	
	Bottlenecks	Code
No-till farming with high cover percentage on sugar beets, maize and winter wheat	Not for all crops (important yield losses for some crops) Specific machinery is needed Expertise is needed Depends on weather conditions	
No-till farming with low cover percentage on sugar beets, maize and winter wheat	Not for all crops (important yield losses for some crops) Specific machinery is needed Expertise is needed Depends on weather conditions	

Mutiple color codes are used when practicability depends on crop types
(green : applicable without problems / orange : important constraints for practicability / red : not applicable)

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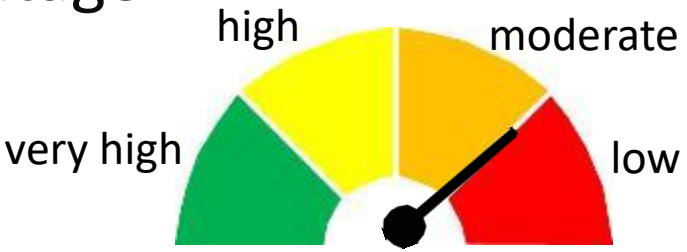
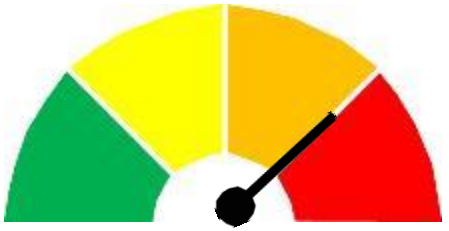
Reduction of soil erosion : no-till farming with **low** cover percentage



Reduction of soil erosion



Reduction of sediment export from field

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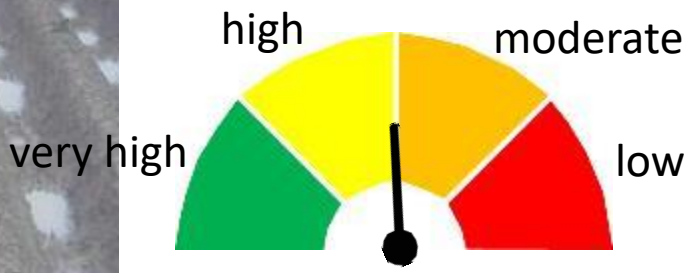
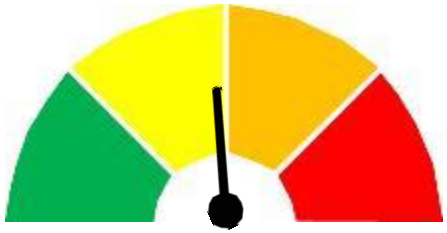
Micro ridges in furrows (potatoes)



Reduction of soil erosion



Reduction of sediment export from field

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	Bottlenecks	Code
Micro ridges in furrows (potatoes)	Specific machinery is needed	

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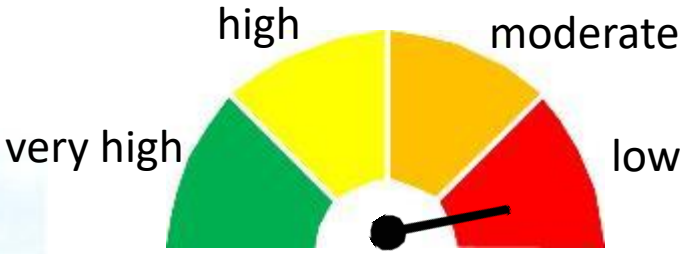
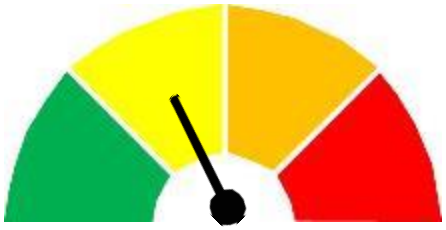
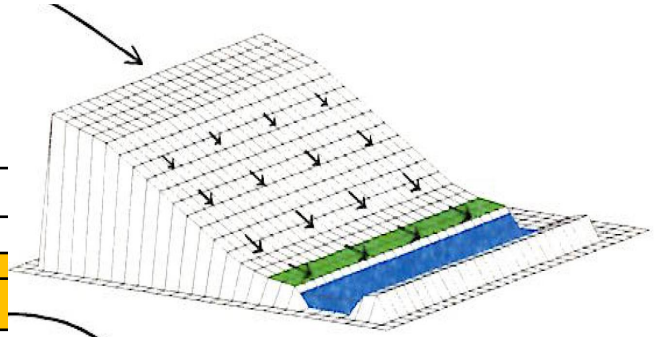
Grass buffer strips (straight slopes)



Reduction of soil erosion (straight slope)



Reduction of sediment export from field (straight slope)



Soil erosion control measure	Practicability of soil erosion control measures		
	Bottlenecks	Code	
Vegetated filter strip (straight slope)	Loss of acreage		
Vegetated buffer strip (slope with overland flow convergence)	Loss of acreage		

Mutiple color codes are used when practicability depends on crop types
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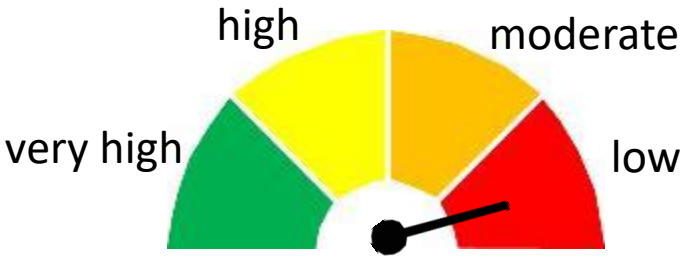
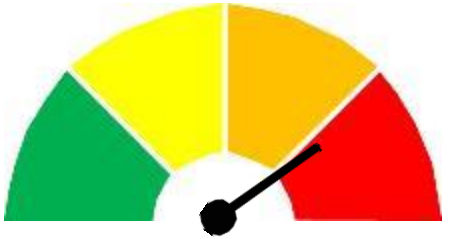
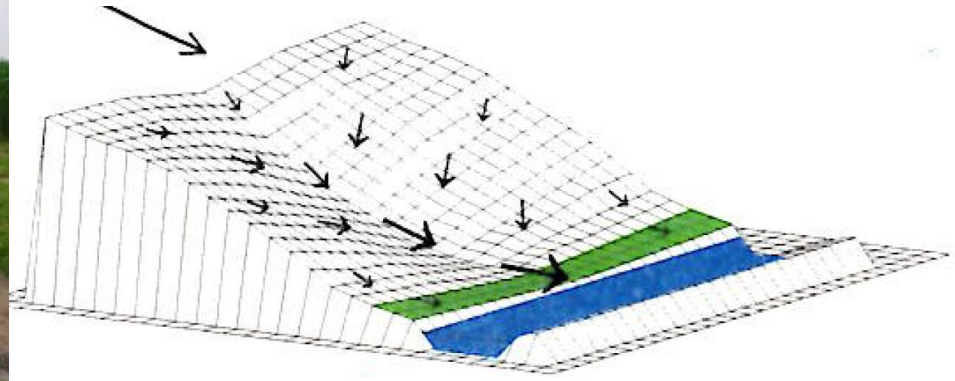
Grass buffer strips (slope with concentration line)



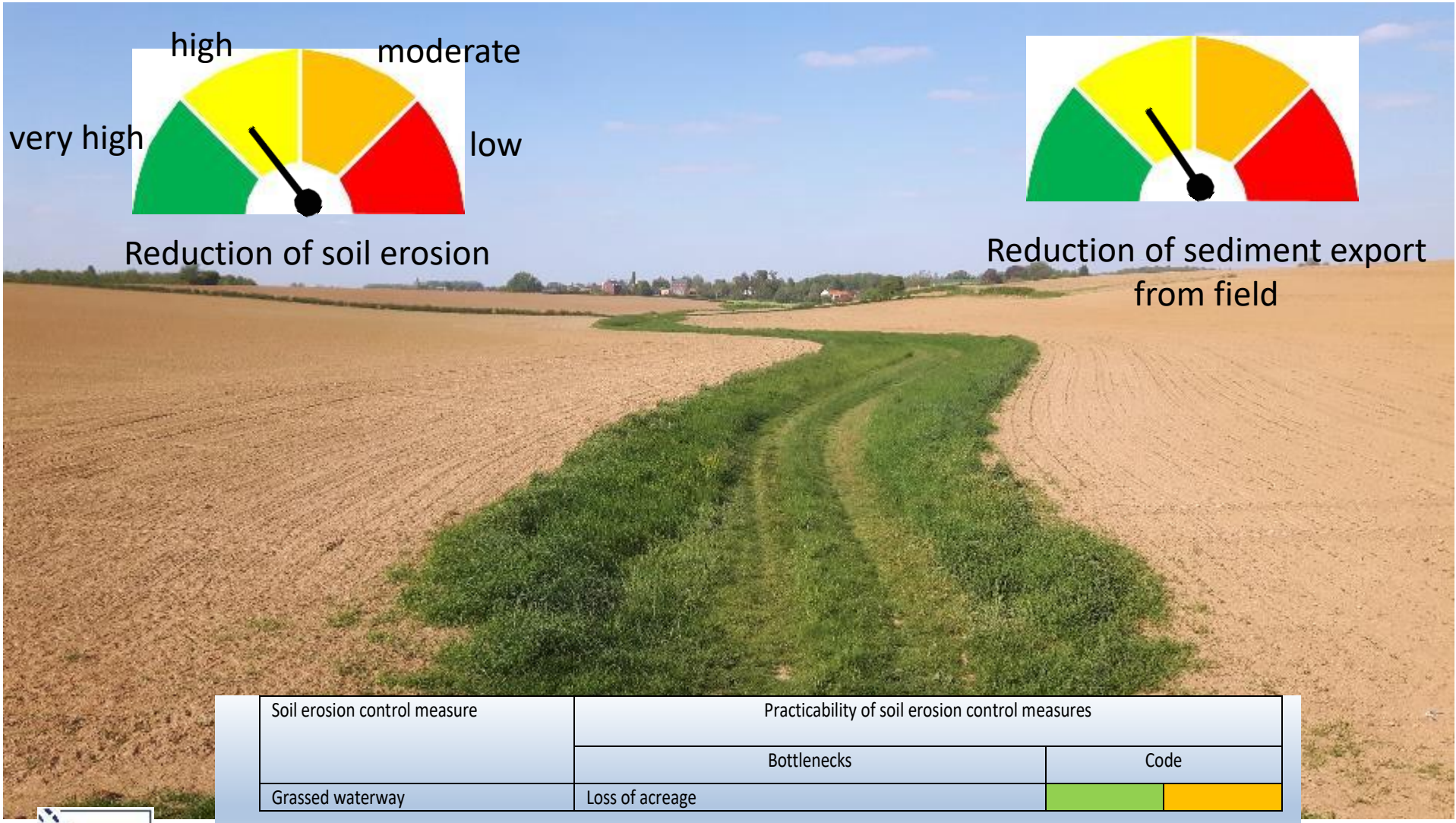
Reduction of soil erosion (concentration)



Reduction of sediment export from field (concentration)



Grassed waterway



Soil erosion control measure	Practicability of soil erosion control measures	
	Bottlenecks	Code
Grassed waterway	Loss of acreage	

Mutiple color codes are used when practicability depends on crop types
(green : applicable without problems / orange : important constraints for practicability / red : not applicable)

Effectiveness grassed waterway = f(erosional system)

Table 7 The relative importance of ephemeral gully erosion (after Vandaele & Poesen 1995).

Location	Ratio ephemeral/ sheet-rill erosion	Remarks
Athens, Georgia (USA)	0.38	Thomas & Welch (1988). Sandy loam soils, conventional tilled soybeans and untilled farrow during winter, 3 ha, slopes 5–6%.
Athens, Georgia (USA)	0.43	Thomas et al. (1986). Sandy-loam soils, double-cropped soybeans and winter wheat, 2–8 ha, slopes 6%.
Pottawattamie county, Iowa (USA)	0.25	SCS unpublished survey data. Loess soil, 8 ha, slopes 3–11%.
Boone county, Iowa (USA)	0.24	SCS unpublished survey data. Loess soil, 8 ha, slopes 3–11%.
Wiregrass, Alabama (USA)	1.47	SCS data. Soil from hydrologic group A.
Wiregrass, Alabama (USA)	1.00	SCS data, Soil from hydrologic group B.
For these data the sheet-rill erosion rate is estimated using the USLE. Ephemeral gully erosion is estimated by field measurements and aerial photographs (after Laflen et al. 1985).		
Treynor, Iowa (USA)	0.53	Spomer & Hjelmfelt (1985). Conservation tillage, continuous corn on contour. Loess soil, steep slopes, 43 ha (1972–1983).
A)	0.29	Spomer & Hjelmfelt (1985) Convention tillage, continuous corn on contour. Loess soil, steep slopes, 24 ha (1964–1983).
sheet-rill erosion rate is estimated using the average sediment yield and a 53. Ephemeral gully erosion is estimated by field measurements and aerial Laflen et al. 1985).		
	1.5	Grissinger & Murphey (1989). Loess soil, conventional tilled, soybeans, 1.9 ha (1985–1987).
heet–rill erosion rate is estimated using the sediment yield at the outlet of the eral gully development was studied by field surveys and aerial photographs.		
	0.85	Auzet, personal communication 1988–1989. Several catchments, loess soil, slopes 3–11%. Conventional tillage; winter and summer crops, 34 ha (mean).
Northern France[1]	0.80	Auzet, personal communication 1989–1990. Several catchments, loess soil, slopes 3–11%. Conventional tillage; winter and summer crops, 34 ha (mean).
Central Belgium	0.9–1.7	Vandaele & Poesen (1995). Conventional tillage, 25 ha. Loess soil.
For these data rill and ephemeral gully erosion is calculated by using volumetric measurements of erosion features.		

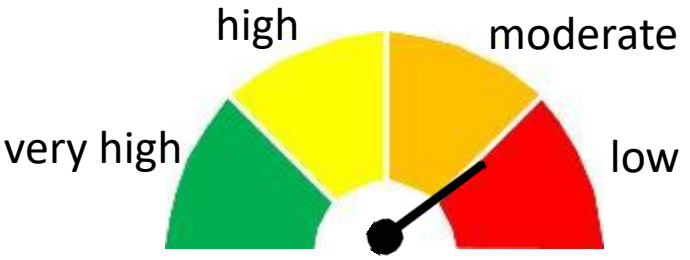
[1] erosion during winter.

Table 3
Sediment budget for the Hammeveld-1 catchment for the period Oct. 1989–Oct. 1992

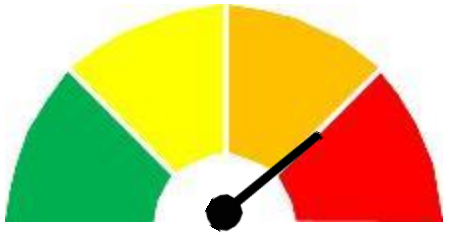
	Sediment source	%	$m^3/ha \cdot yr$
Input	Rill erosion on hillslopes	33	2.42
	Gully erosion on hillslopes	5	0.37
	Rill and ephemeral gully erosion in topographically defined flow paths	41	3.01
	Rill and ephemeral gully erosion in linear elements	11	0.81
	Interrill erosion [a]	10	0.73
Output	Colluviation in catchment	5–25	0.37–1.83
	Suspended load at outlet	75–95	5.50–6.97

[a] Estimate based on literature.

Cover crops (winter period)



Reduction of soil erosion



Reduction of sediment export from field

Soil erosion control measure	Practicability of soil erosion control measures	
	Bottlenecks	Code
Cover crops or mulching during winter months	Depends on weather conditions	

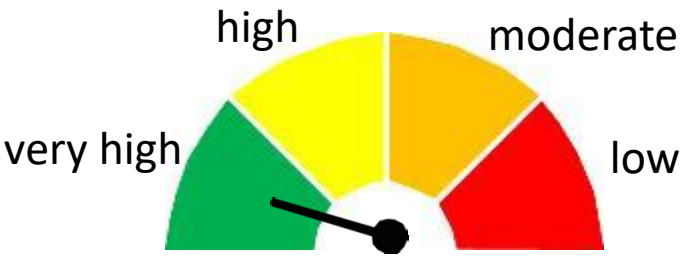
Mutiple color codes are used when practicability depends on crop types
(green : applicable without problems / orange : important constraints for practicability / red : not applicable)

Effectiveness cover crops = f(seasonal erosion rates)

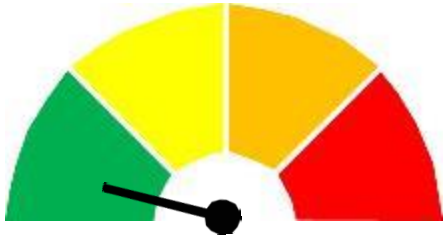
Table 2
Mean annual and seasonal erosion rates for the Hammeveld-1 and Hammeveld-2 catchments (m^3/ha)

	Hammeveld-1			Hammeveld-2		
	autumn/winter	spring/summer	annual	autumn/winter	spring/summer	annual
Oct. 1989–Oct. 1990	0.21	1.42	1.63	0.07	1.75	1.83
Oct. 1990–Oct. 1991	0.77	2.32	3.09	0.46	5.12	5.58
Oct. 1991–Oct. 1992	3.19	8.70	11.89	8.10	8.90	17.00

Direct till / Strip-till / Crop ban



Reduction of soil erosion



Reduction of sediment export from field

Soil erosion control measure	Practicability of soil erosion control measures	
	Bottlenecks	Code
Direct till farming with sufficient ground cover	no expertise in Flanders until now only very few farmers apply this technique specific machinery is needed	
Strip-till farming on maize and sugar beets	No expertise in Flanders until now No farmers apply this technique until now Specific machinery is needed	
Crop ban	Not acceptable for most farmers Economic losses Problems with crop rotations	

Mutiple color codes are used when practicability depends on crop types
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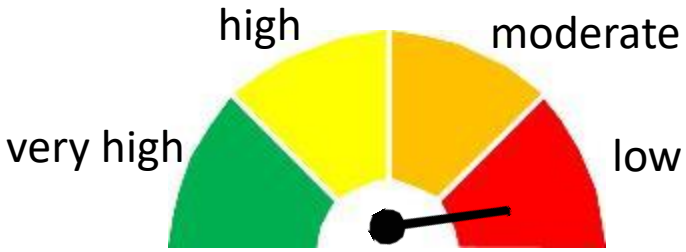
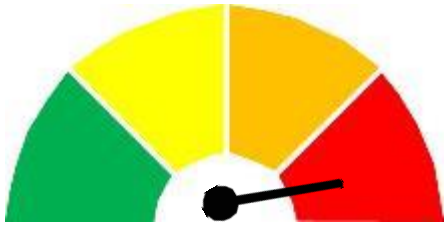
Contour cultivation



Reduction of soil erosion



Reduction of sediment export from field

Soil erosion control measure	Practicability of soil erosion control measures	
	Bottlenecks	Code
Contour farming	Only on uniform fields (without concentration line)	

Mutiple color codes are used when practicability depends on crop types
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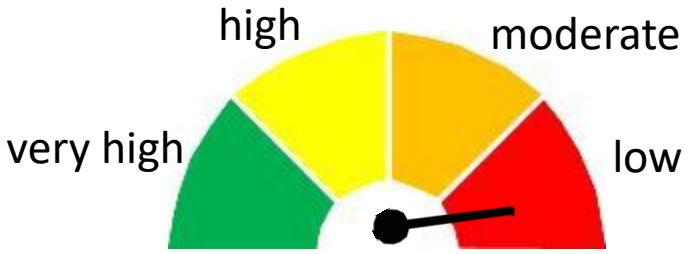
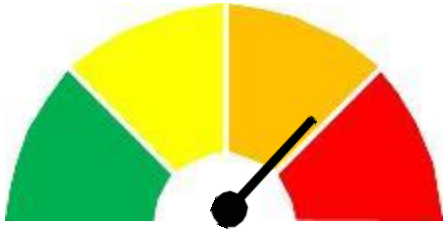
Woodchip barriers, straw dams,…..



Reduction of soil erosion



Reduction of sediment export from field

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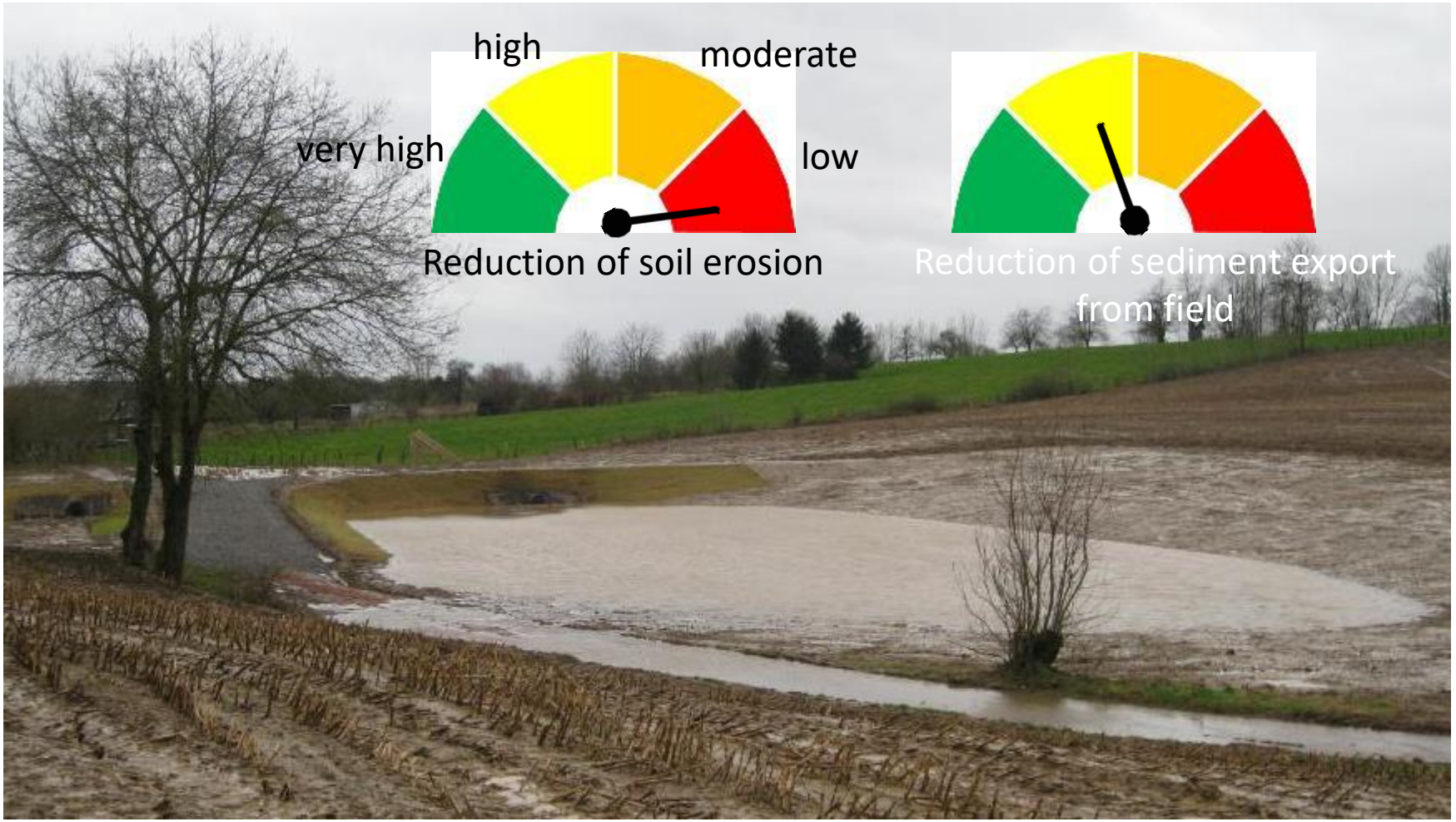
Retention structures



Soil erosion control measure	Practicability of soil erosion control measures	
	Bottlenecks	Code
Retention and sedimentation ponds	Loss of acreage	

Mutiple color codes are used when practicability depends on crop types
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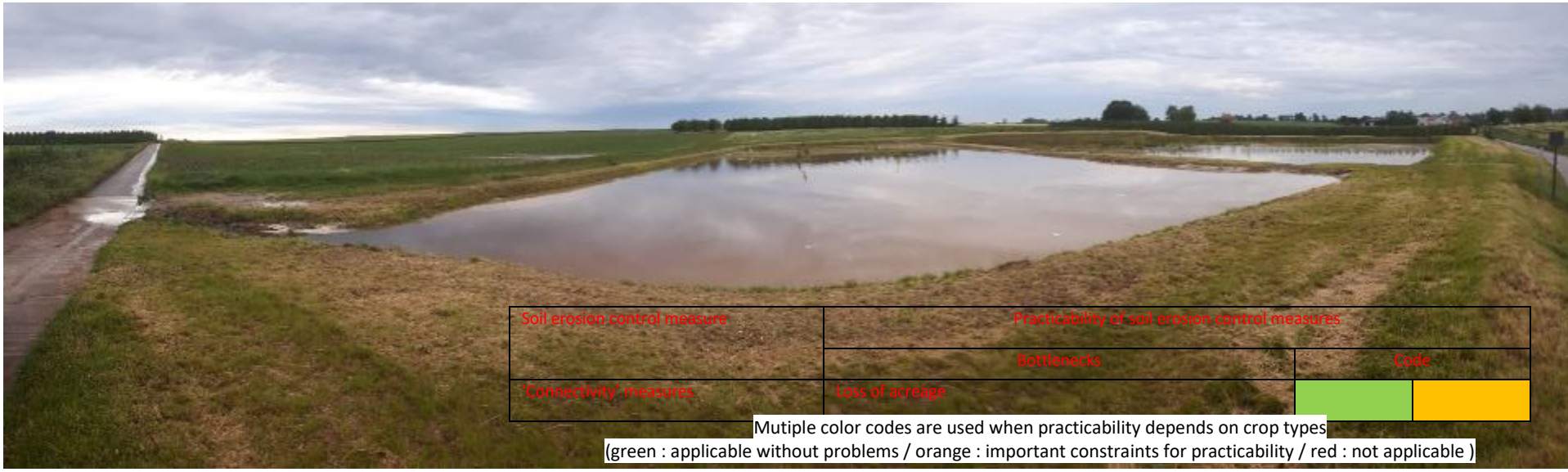
‘Connectivity’ measures



Soil erosion control measure	Practicability of soil erosion control measures	
	Bottlenecks	Code
‘Connectivity’ measures	Loss of acreage	

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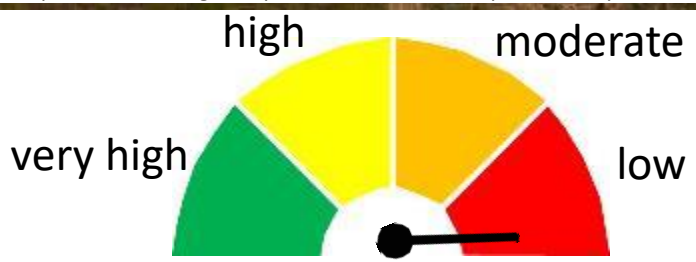
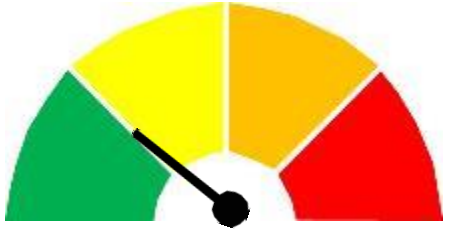
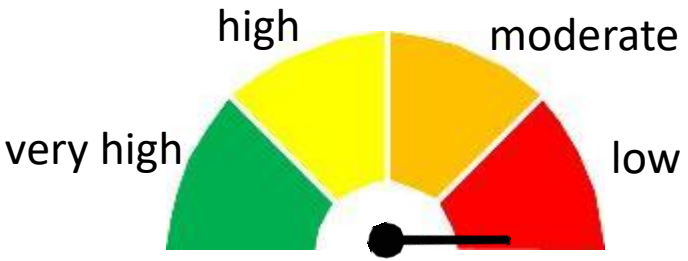


Reduction of soil erosion

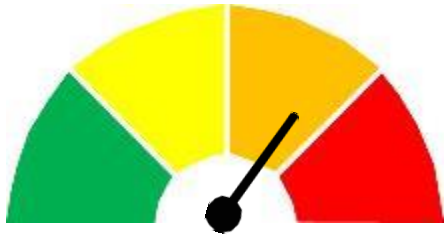


Reduction of sediment transport to ….

‘Mud bump’ in sunken lanes



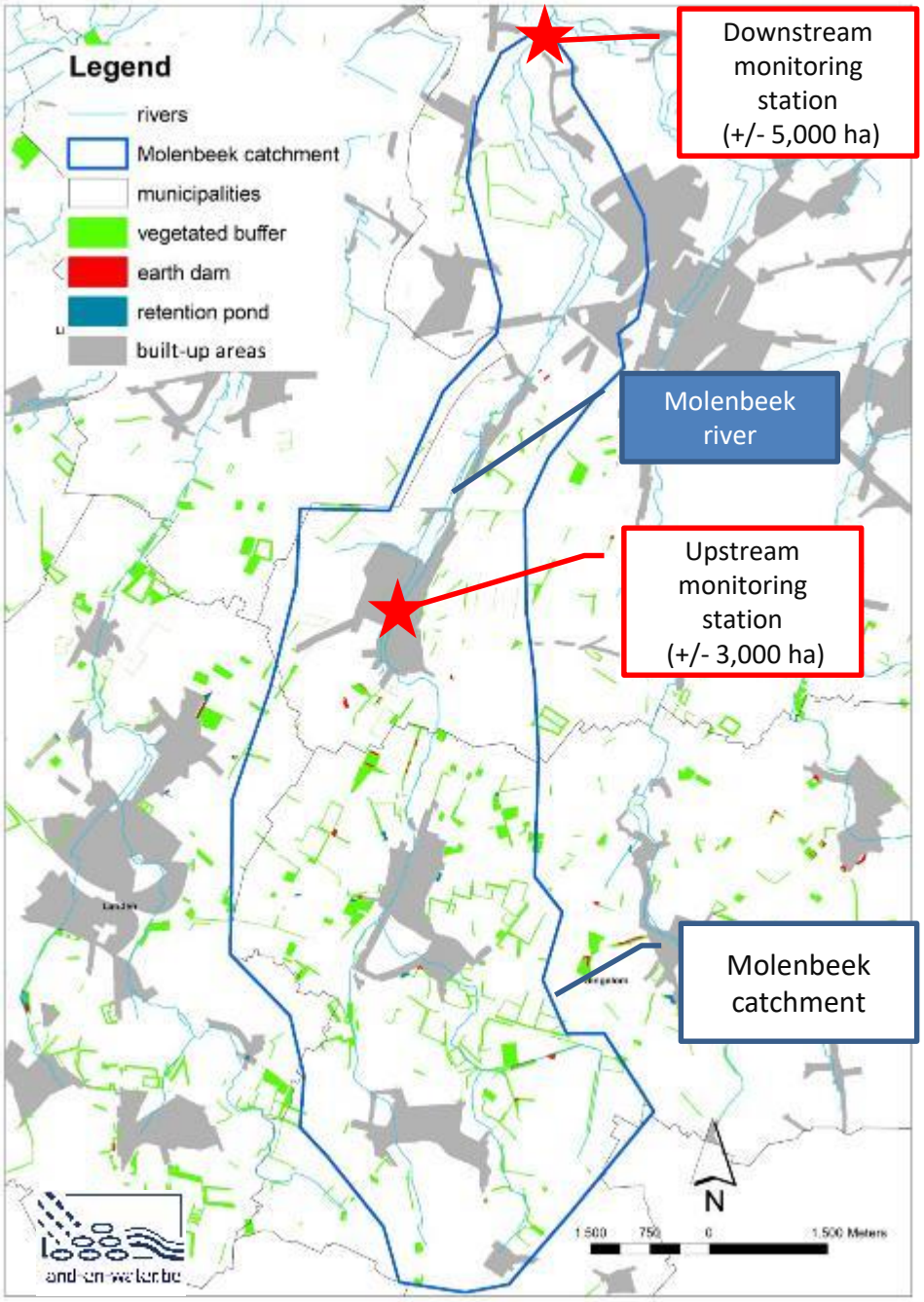
Reduction of soil erosion



Reduction of sediment transport to ….

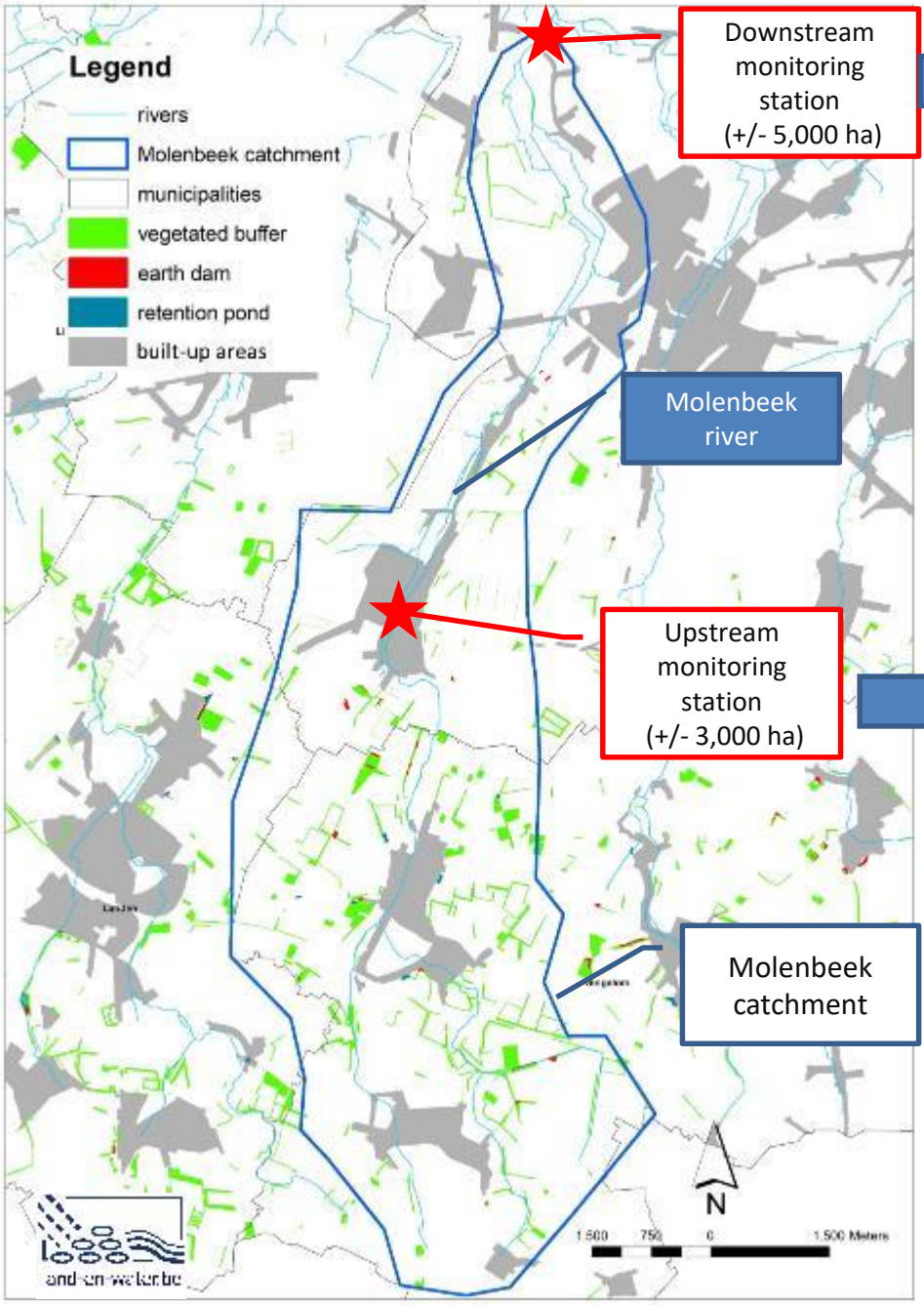
Effectiveness *of mix of mitigation measures at a catchment scale ?*

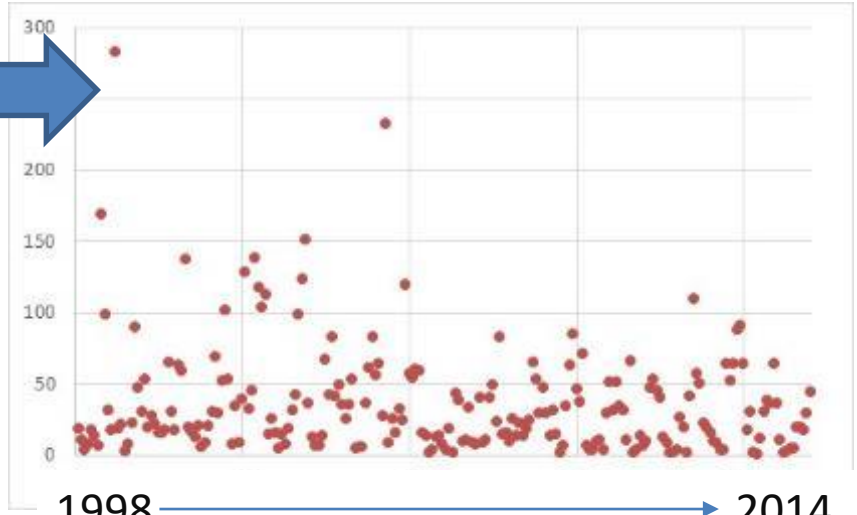
- Modeling exercise : shortcomings on catchment scale
  - connectivity issue,
  - calibration issue,
  - ……
- ***Monitoring sediment transport in the river !***



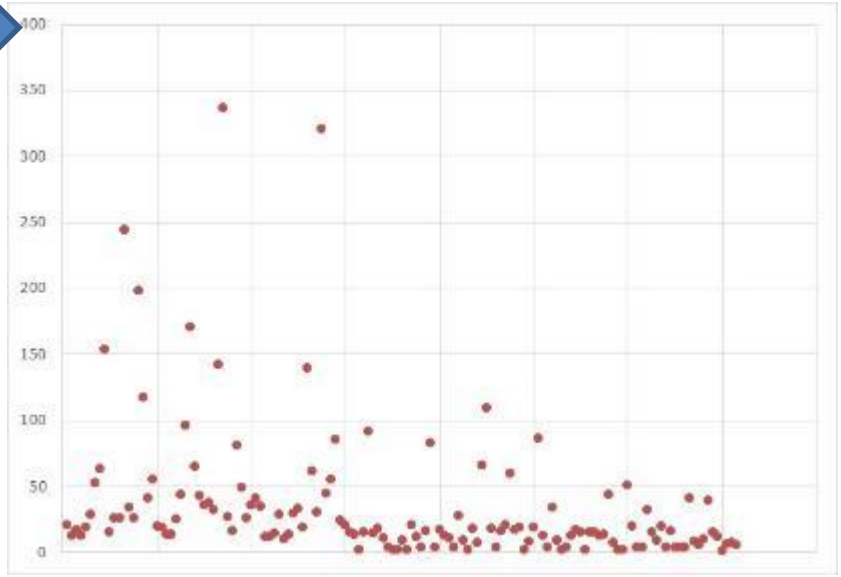
The upper part of Molenbeek-catchment has the highest density of soil erosion control measures in Flanders. About 5 % of the total farmland is used for soil erosion control measures. We started in 2002 !!!!

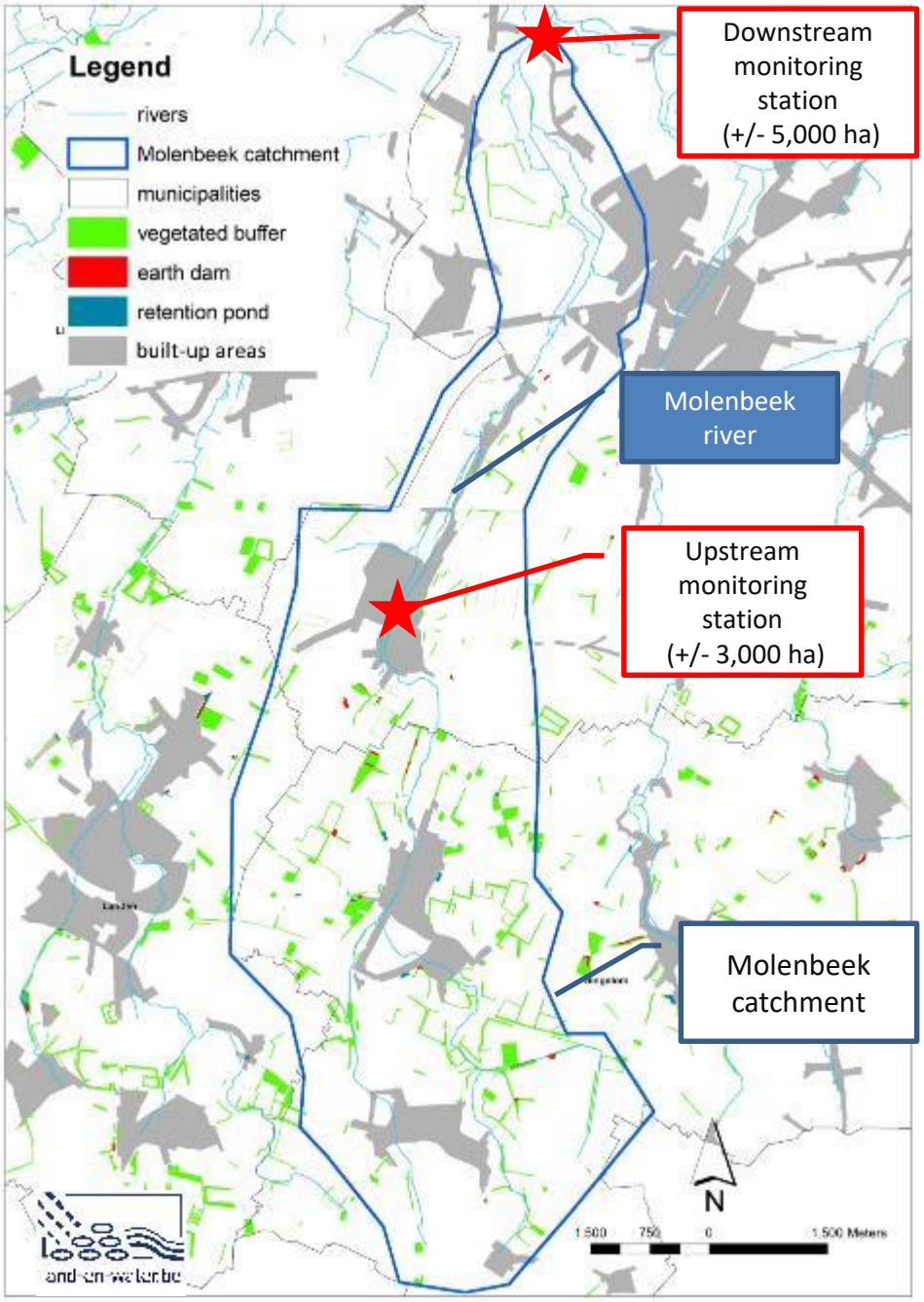
The **Flemish Environment Agency** sampled at two locations in the Molenbeek catchment from **1998 to 2014**. Sampling was monthly at an upstream and downstream location. For the period 1998-2005 there were no or few erosion control measures (a mix of engineered and alternative approaches), and for 2006-2014 many control measures had been introduced.





Evolution sediment concentration (mg/liter) in the Molenbeek river



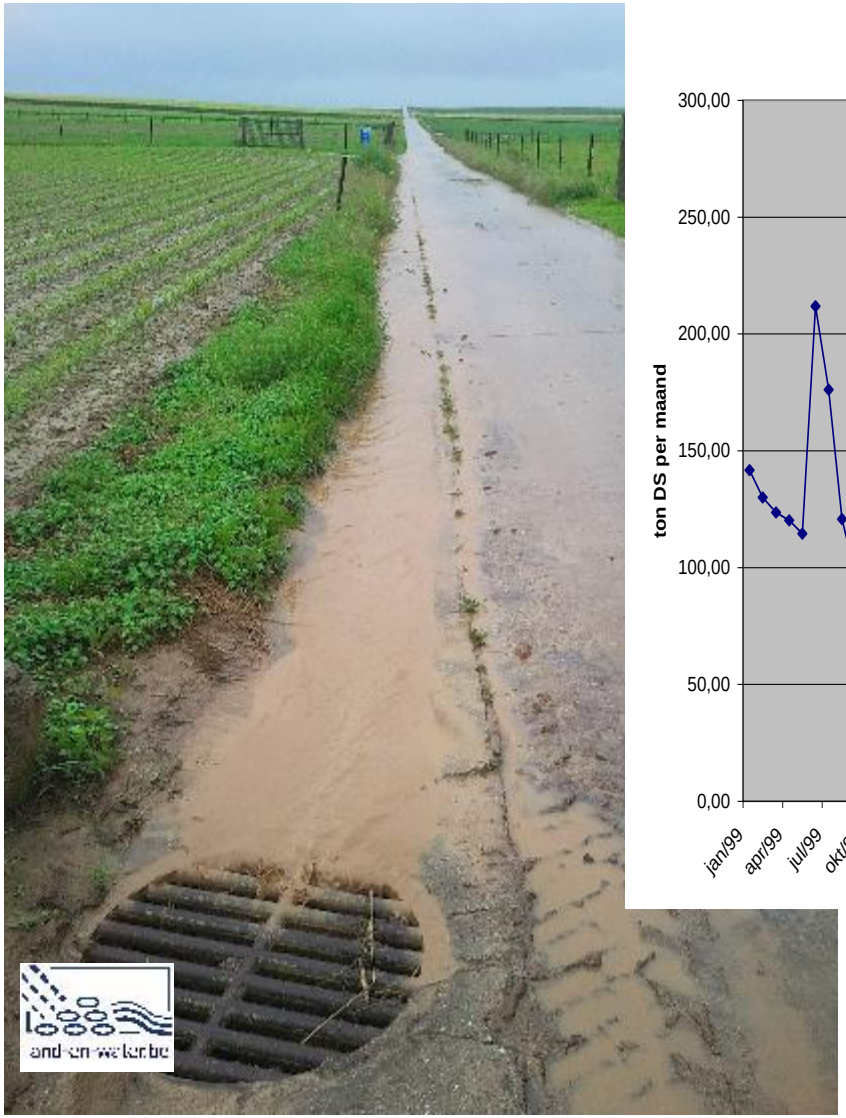


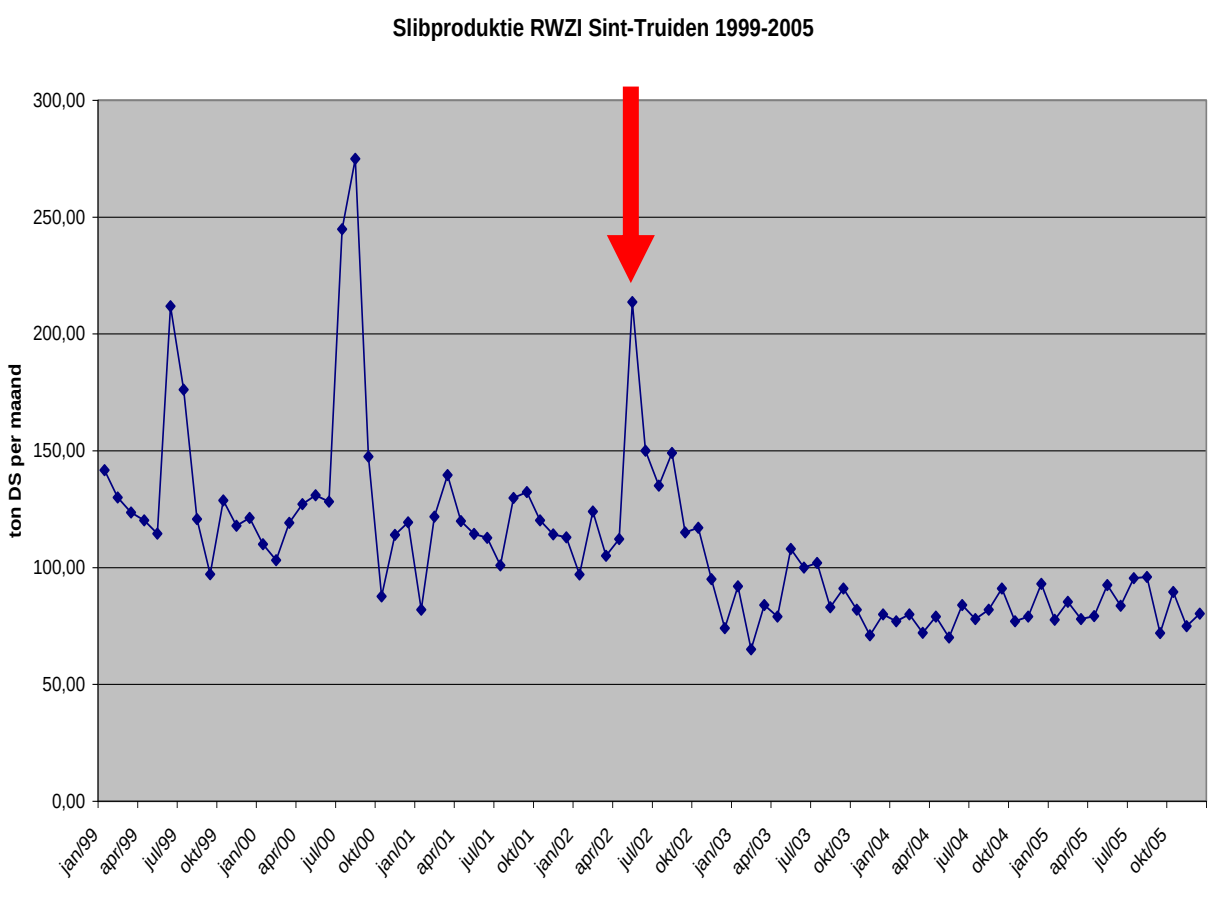
	1996-2005		2006-2014
Downstream site	43.1	→	28.4

Mean sediment concentration (mg/liter) in the Molenbeek catchment

	1998-2005		2006-2013
Upstream site	58.8	→	17.5

Evolution sediment export to sewage treatment plant in Molenbeek catchment





Conclusions

1. We can not rely on one approach to solve soil erosion and muddy flooding (no miracle solution);

2. A mix of mitigation measures can make the difference;

3. Installation of this mix is not a ‘quick fix’;

4. Objective evaluation of effectiveness measures = measurement of sediment yields in river before and after installation mitigation measures= monitoring !

Implementing mitigation measures

Maybe not a bad idea….

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