LIFE07 ENV/B/000038

Pilot project « Walphy » : Walloon experimentation of river restoration

WALPHY

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Université de Liège

LHGF

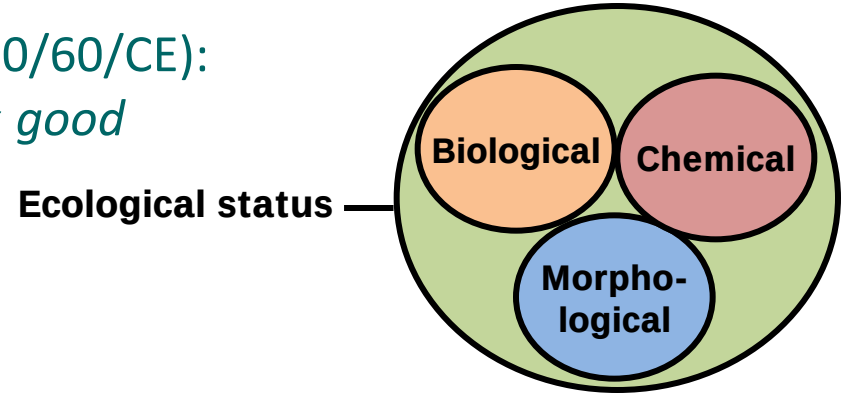
UNIVERSITY OF NAMUR

SPW

Service public de Wallonie

I. Context & objectives of the project

Context : Water Framework Directive (2000/60/CE):
Water bodies are required to achieve the « good ecological status » by 2015

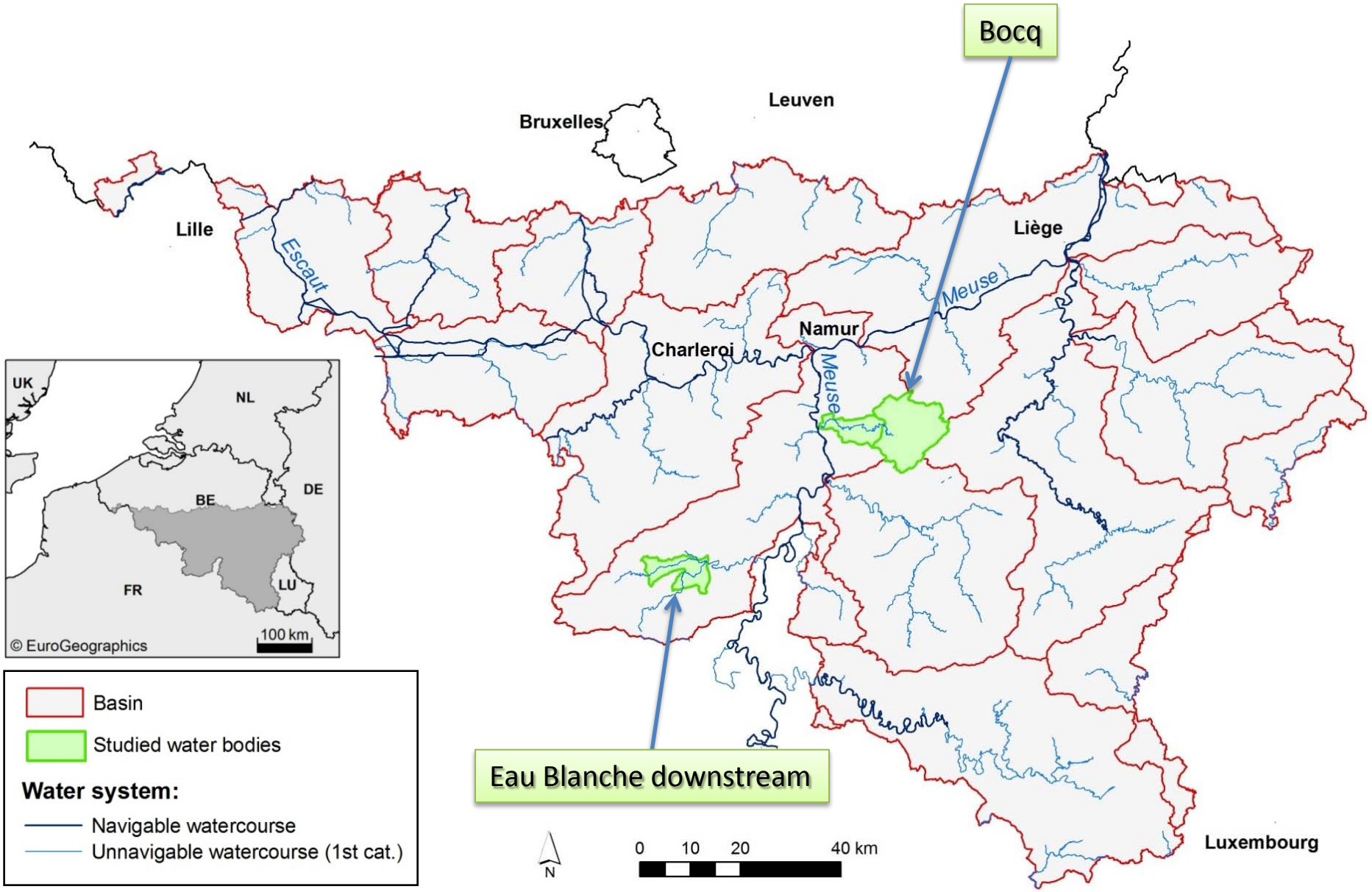


Pilot project « Walphy » - Design of a decision tool for hydromorphological restoration of water bodies in Walloon Region (LIFE07 ENV/B/000038)

Objectives:

- To develop a structured approach aiming at improving morphological quality of the upstream Meuse basin in order to achieve the “good ecological status” (WFD)
- To carry out experimental river restoration works on several risk water bodies
- Ecological and geomorphological monitoring of the restored river systems
- To develop a useful and suitable methodology to determine and schedule river restoration works in Wallonia

Context & objectives of the project



II. River restoration work

Bocq :

Catchment area: 233 km²
Average slope: 4.8 ‰
ω ~ 85 W/m²
Many obstacles

➡ Disruption of the longitudinal continuity

➡ Improvement of the river continuity

Eau Blanche:

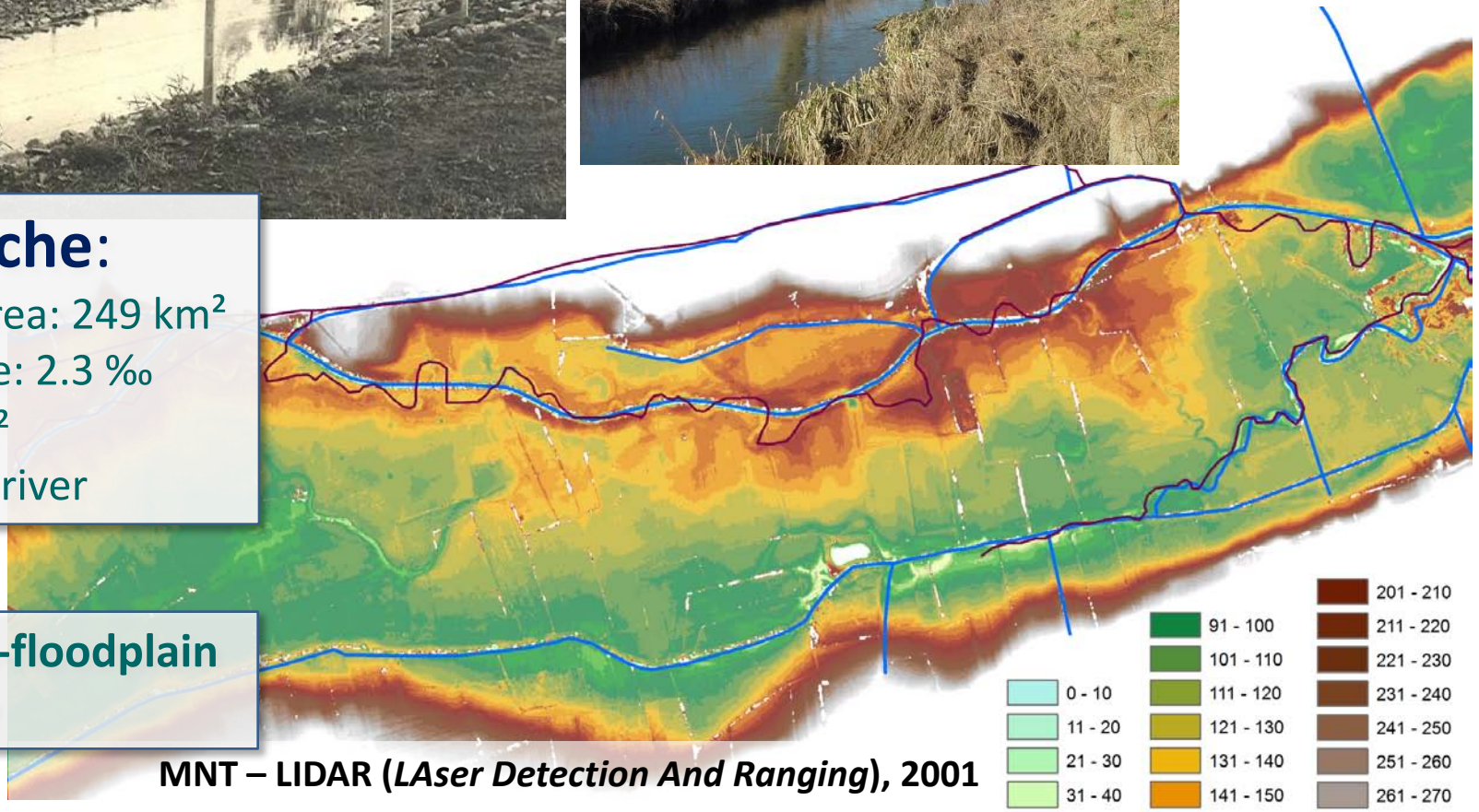
Catchment area: 249 km²

Average slope: 2.3 ‰

ω ~ 20 W/m²

Straightened river

Poor stream-floodplain connectivity

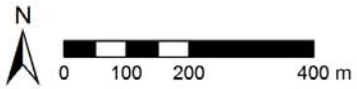


MNT – LIDAR (*LAser Detection And Ranging*), 2001

Elevation above water level (cm)

Violet: Watercourse from 1910 (IGM, 1948)

Blue: Current watercourse (SPW, 2004)



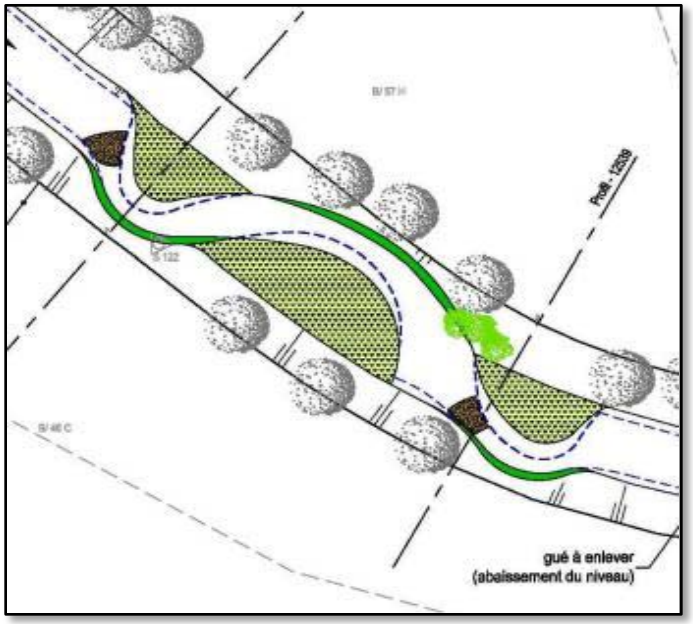
Varied restoration techniques

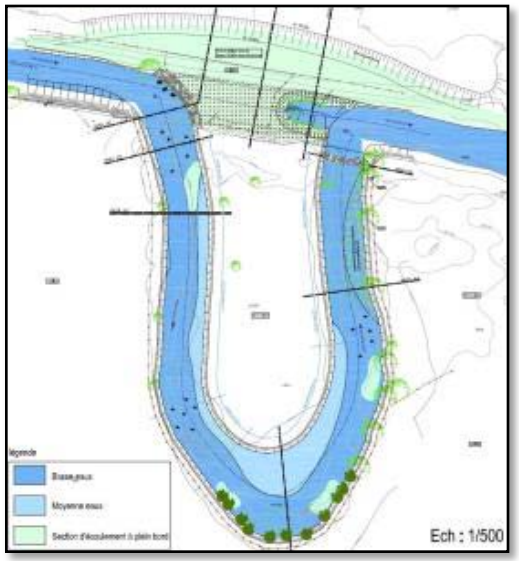
Flow deflectors and gravel re-introduction

Woody debris

Low level berm

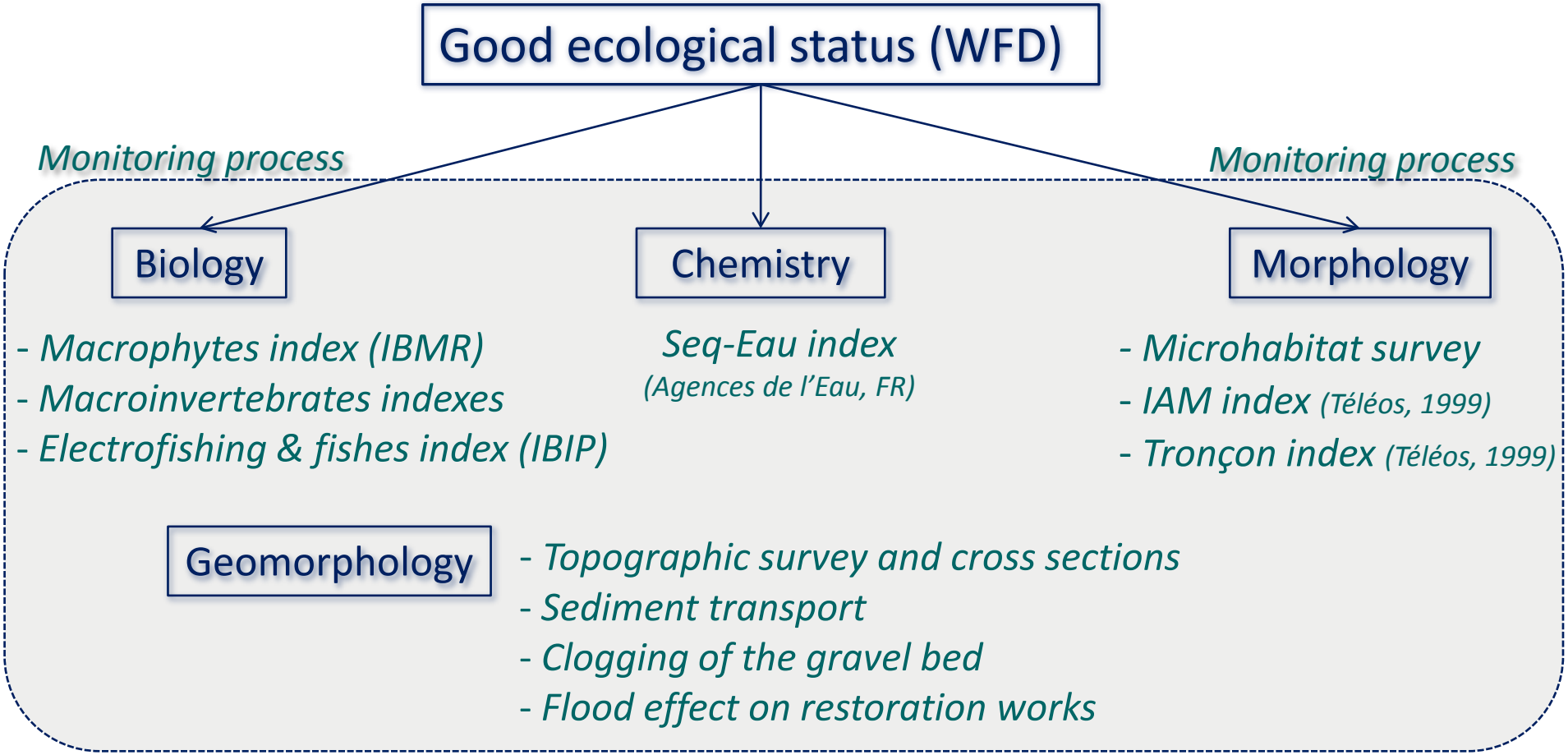

Meandering channel


gué à enlever
(abaissement du niveau)


Ech : 1/500


Reconnecting remnant meander

III. Monitoring: data collection and analysis



Aim : assessing the success of restoration projects

Biology:

Macrophytes: IBMR index (Haury *et al.*, 1998) based on:
- cover,
- ecological amplitude,
- trophic level of taxa.

Feedback:

- For long-term monitoring
- Reflects the quality of water and substrates

Macroinvertebrates: indexes based on:
- abundance,
- diversity,
- species richness,
- specific pollution sensitivity index,
- habitat quality,…

Multiple indexes

↓

Optimized data analysis

Electrofishing and IBIP index (Didier, 1997, Kestemont *et al.*, 2001) **based on:**
- abundance,
- density,
- species richness,…

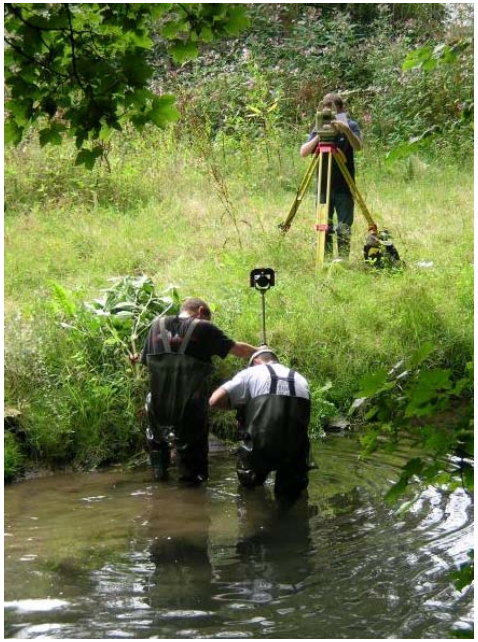
Morphology:

Microhabitat mapping

a) Water depth model

Field survey of the stream channel:

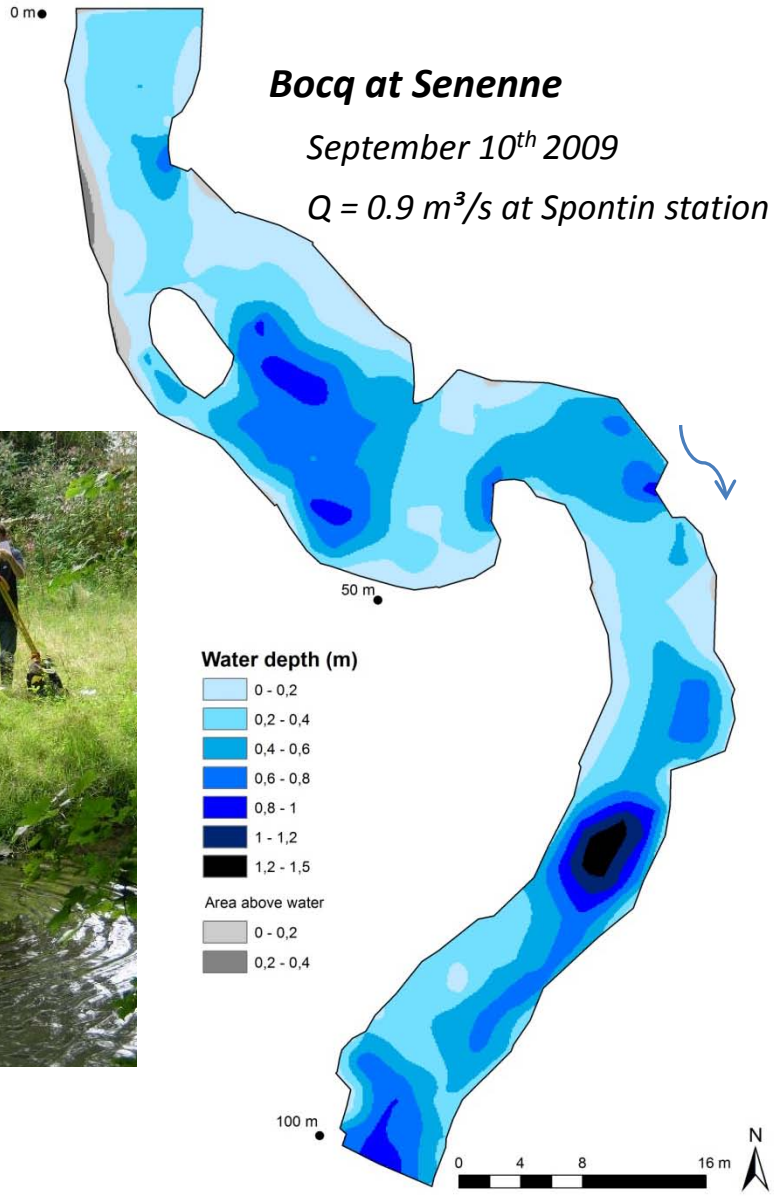
- Stream bed boundary
- Stream bed elevation
- Water surface elevation



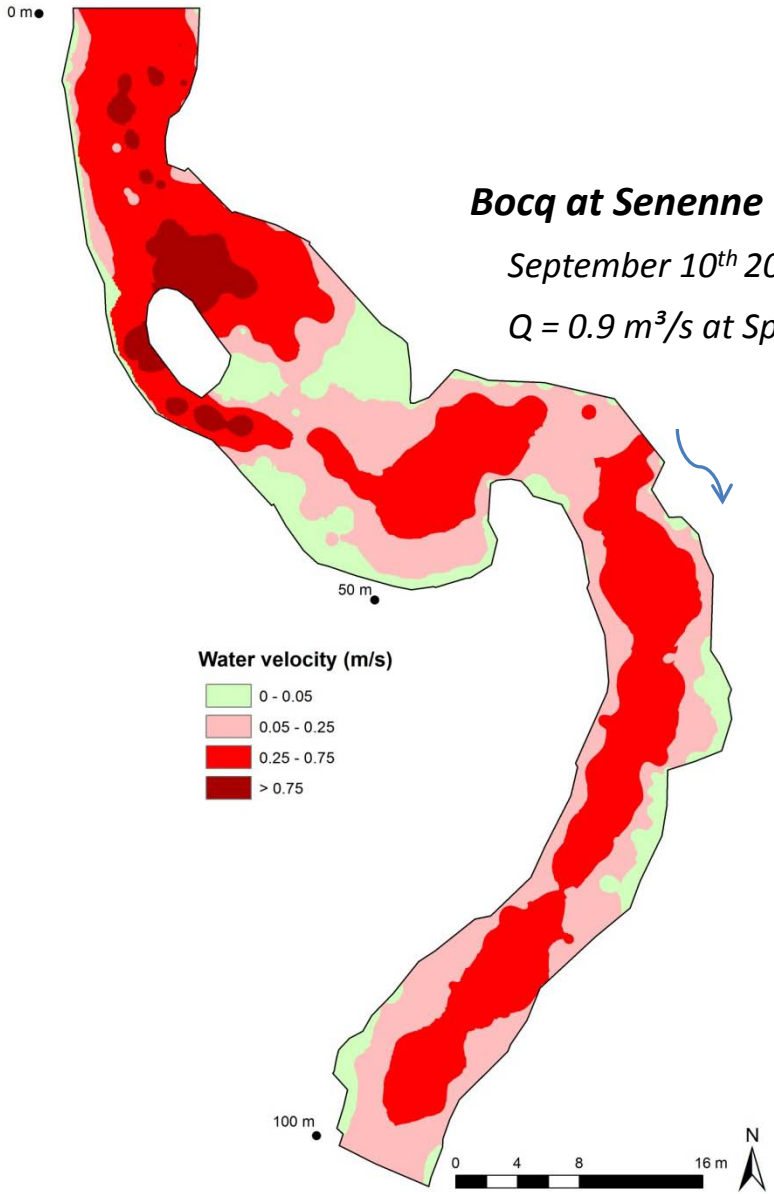
- Stream bed DEM

- Water surface DEM

Water depth model



b) Water velocity model



Bocq at Senenne

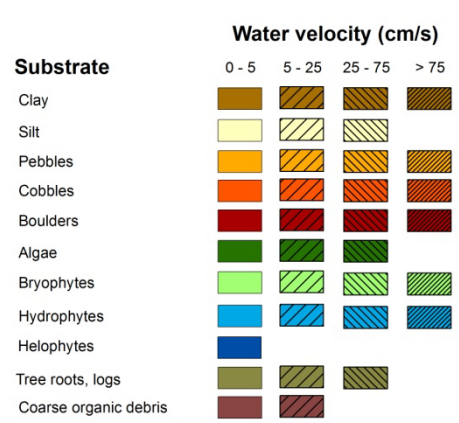
September 10th 2009

Q = 0.9 m³/s at Spontin station

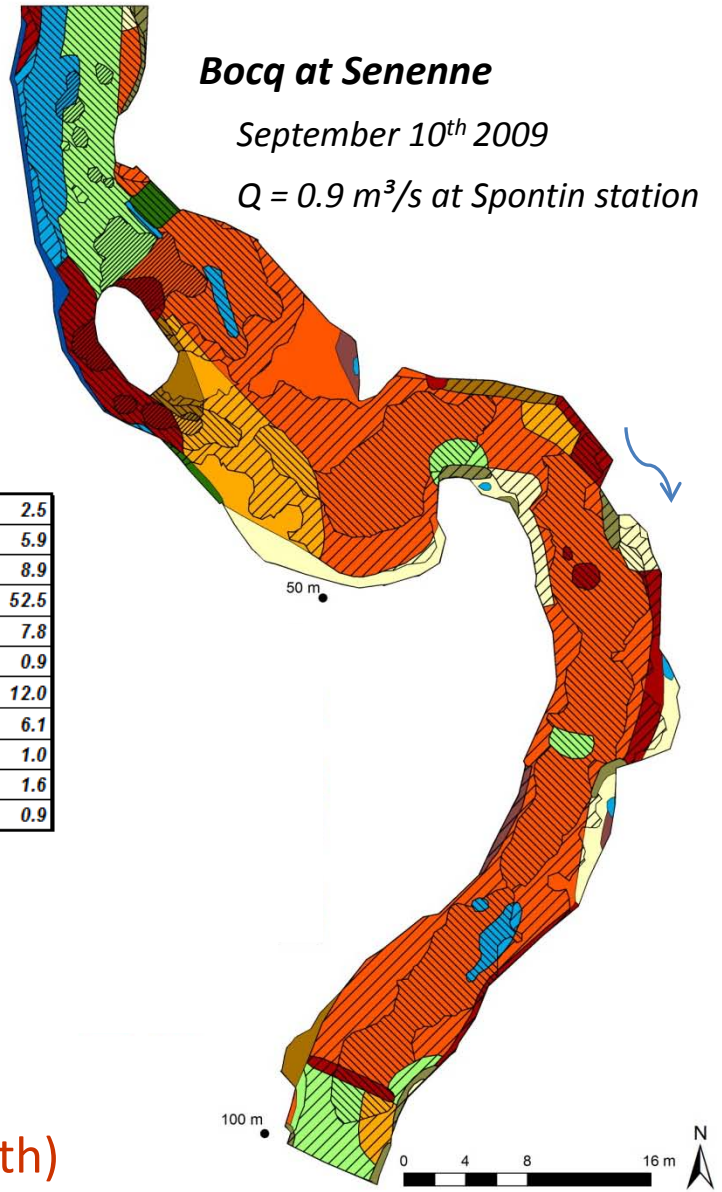
c) Dominant substrate class

Morphology:

Microhabitat mapping



	Area (%)	WATER VELOCITY v < 5 cm/s	5 < v < 25 cm/s	25 < v < 75 cm/s	v > 75 cm/s	
SUBSTRATE	Clay	1.2	0.9	0.3	0.1	***2.5***
	Silt	3.5	2.1	0.3		***5.9***
	Pebbles	1.9	4.9	2.0	0.2	***8.9***
	Cobbles	3.3	19.9	28.2	1.2	***52.5***
	Boulders	0.6	2.2	3.6	1.5	***7.8***
	Algae	0.2	0.1	0.6		***0.9***
	Bryophytes	0.2	2.8	7.3	1.7	***12.0***
	Hydrophytes	0.2	1.0	4.6	0.3	***6.1***
	Helophytes	1.0				***1.0***
	Tree roots, logs	0.4	1.0	0.2		***1.6***
	Coarse organic debris	0.5	0.4			***0.9***
		12.8	***35.3***	***47.1***	***4.9***	



Bocq at Senenne

September 10th 2009

Q = 0.9 m³/s at Spontin station

Feedback:

- Good accuracy of the mapping
- Time consuming (field survey)
- Influence by the season (vegetation growth)
- Influence by the discharge (water velocity and depth)

Taken into account when monitoring (before and after restoration work)

Morphology:

Morphodynamic attractivity index (IAM) (Teleos, 1999)

$$IAM_{calculated} = \left(\sum_{1}^{n} (Si * Attract.(subs.) \right) * Var(subs.) * Var(he) * Var(v)$$

Si *= Area of the i substrate*
Attract. *= attractivity of the i substrate for the fish*
n *= Number of substrate*
Var(subs.) *= Number of substrate*
Var(he) *= Number of depth class*
Var(v) *= Number of water velocity class*

"IAM calculated" compared to "IAM reference"

Substrate	Attractivity
Root wads, woody coarse debris	100
Undercut banks	90
Hydrophytes	80
Boulders (with fish caches)	60
Cobbles	50
Helophytes	40
Root mats	40
Boulders (without fish caches)	30
Mix of pebbles and cobbles	25
Pebbles	20
Organic debris	10
Sands	8
Clay and silt	4
Mud	3
Concrete surface and slab	1
Affluents, spring	+25%

Feedback:

- Easily calculated from the microhabitat mapping
- Same remarks as for the microhabitats
- Provides fish habitat predictions
- Index with a fish orientation
- Useful for monitoring

Morphology: Tronçon index (Teleos, 1999)

Heterogeneity
Sinuosity, diversity of width, depth, flow, substrate, presence of backwaters,…

Attractivity
Spawning ground, hiding places, presence of backwaters,…

Connectivity
Obstacles, banks, riparian areas,…

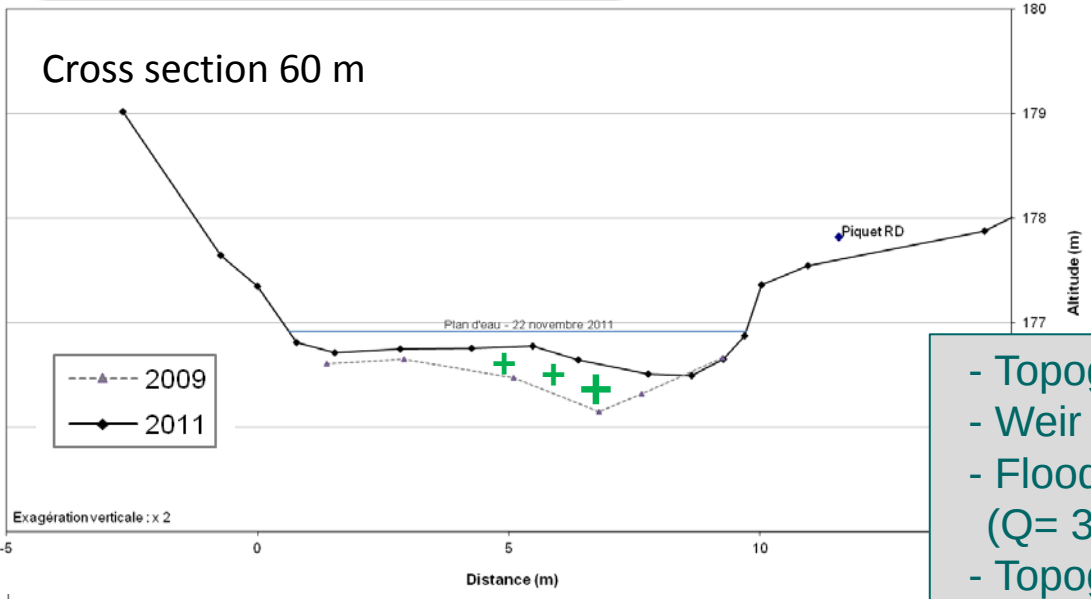
Heterogeneity (H)		Attractivity (A)		Connectivity (C)		Stability (S)		PHYSICAL QUALITY	
score of 111		score of 90		score of 130		score from -60 to +40		= (H + A) x C x K Score of 30 600	
A	≥ 50	A	≥ 45	A	≥ 65	Sedimentation	> +10	A	≥ 6 500
B	40 - 49	B	34 - 44	B	49 - 64	Balance	-10 / +10	B	3 500 - 6 500
C	28 - 39	C	23 - 33	C	33 - 48	Erosion	-25 / -10	C	1 500 - 3 500
D	14 - 27	D	11 - 22	D	16 - 32	Strong erosion	-60 / -25	D	400 - 1 500
E	≤ 13	E	≤ 10	E	≤ 15	*Gives a K coefficient*		E	< 400

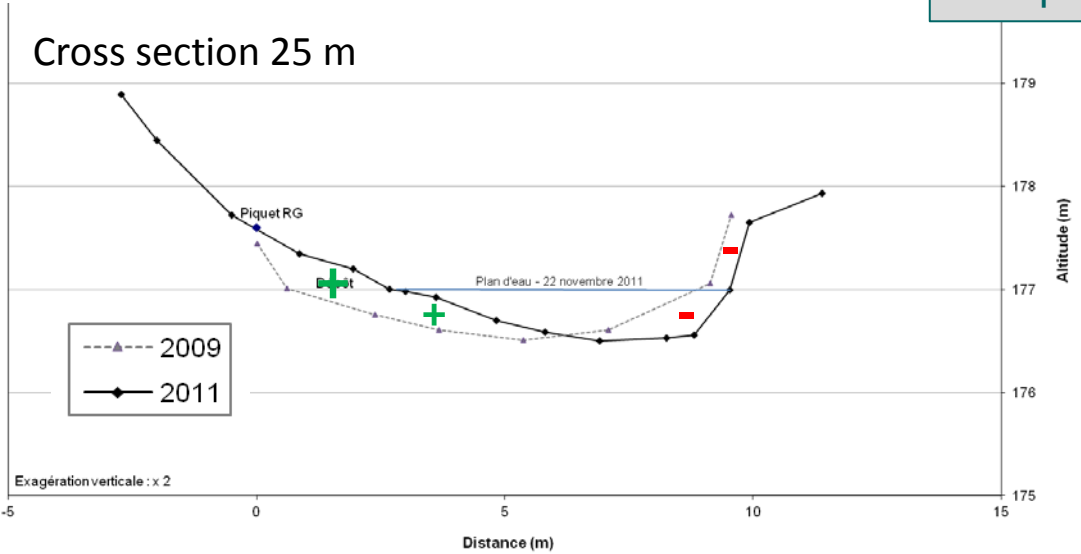
K	*-60 < S < -26*	*-25 < S < -11*	*-10 < S < 9*	*10 < S < 40*
H ≥ 50	K = 0.85	K = 1	K = 1.25	K = 0.75
H < 50	K = 0.85	K = 1	K = 0.85	K = 0.75

Feedback:

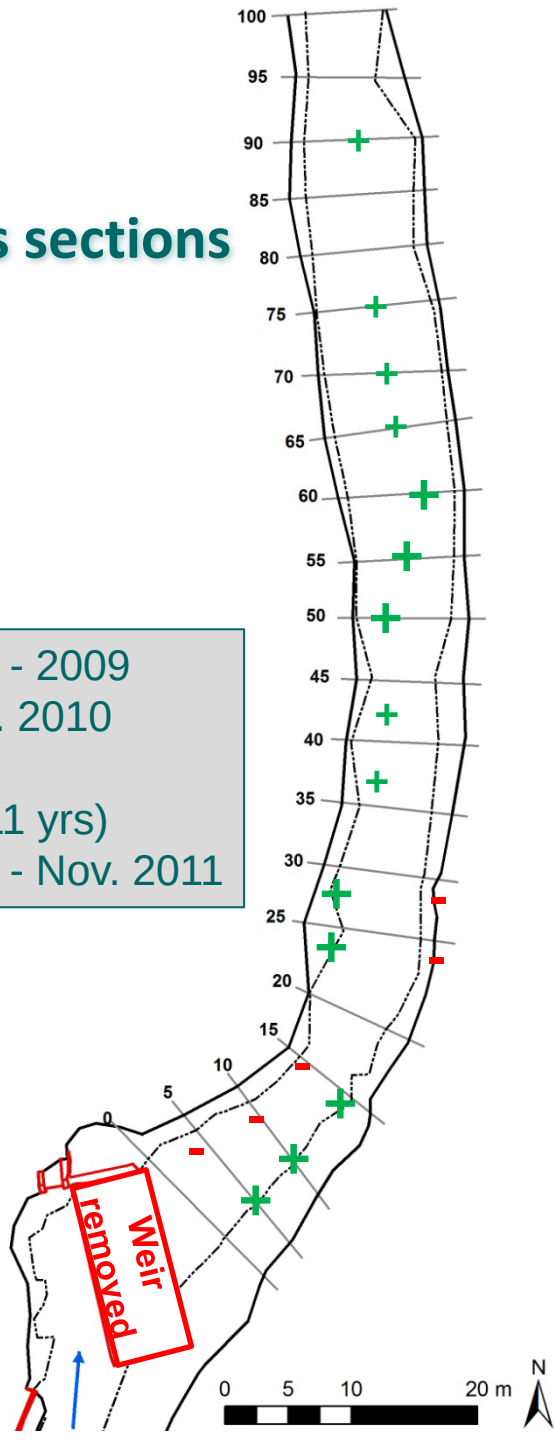
- Uneasy-to-use codage file
- Semiquantitative method
- Index with a fish orientation
- Useful subindexes to define problems (pre project) and for monitoring

Geomorphology: Topographic survey and cross sections





- Topographic survey - 2009
- Weir removal - Dec. 2010
- Flood - 7/01/2011
  (Q= 33,8 m³/s ; T~ 11 yrs)
- Topographic survey - Nov. 2011



Geomorphology: Sediment transport

Evaluating bedload mobility using traced pebbles and PIT-tags

PIT tagged pebbles placed in rivers at:

- reference reaches
- reaches impacted by obstacle (e.g. upstream of weir)
  - ➡ enable to highlight restoration of free movement of sediment
- reaches with spawning gravel reintroduction
  - ➡ enable to characterize the mobility of new spawning gravel

Feedback:

- Allows particles with b-axis of 20 mm to be traced
- Do not contain a battery
- Great recuperation rate (more than 80%)
- Requires expensive equipment
- Provide useful information (bedload movement discharge, distances travelled, granulometric indexes)

Geomorphology: Clogging of the gravel bed

Sediment traps buried into the gravel bed on:
- reference reaches
- reaches impacted by restoration work
- reaches with gravel reintroduction

Feedback:
- Susceptible to loss (flood, scour,…)
- Cannot be used in water deeper than 0.8m
- Time-consuming (laboratory analysis)
- Installation does not provide natural conditions (breaking of the armour layer)

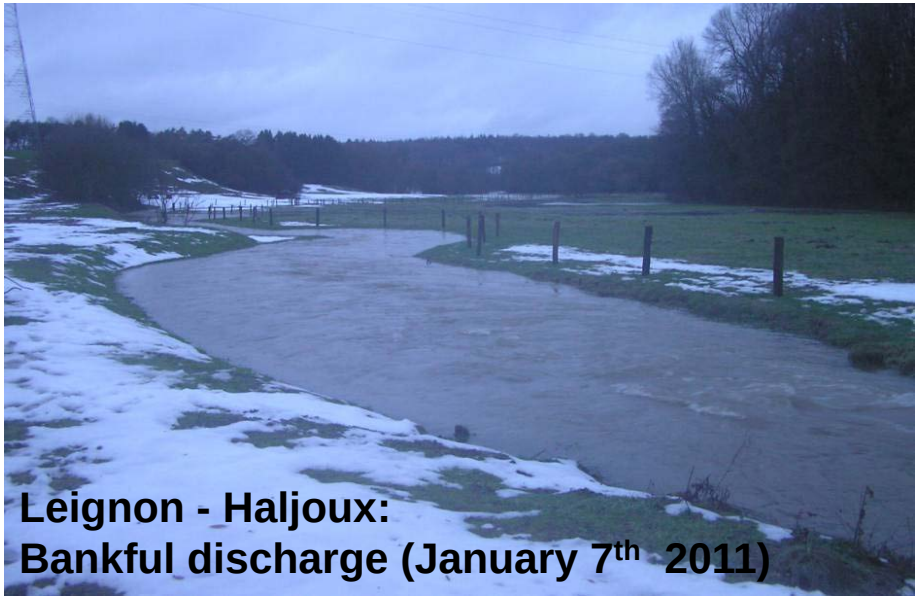
➡ Suitable to evaluate short period of work

Wooden stakes inserted into the gravel bed on:
- reference reaches
- reaches with gravel reintroduction

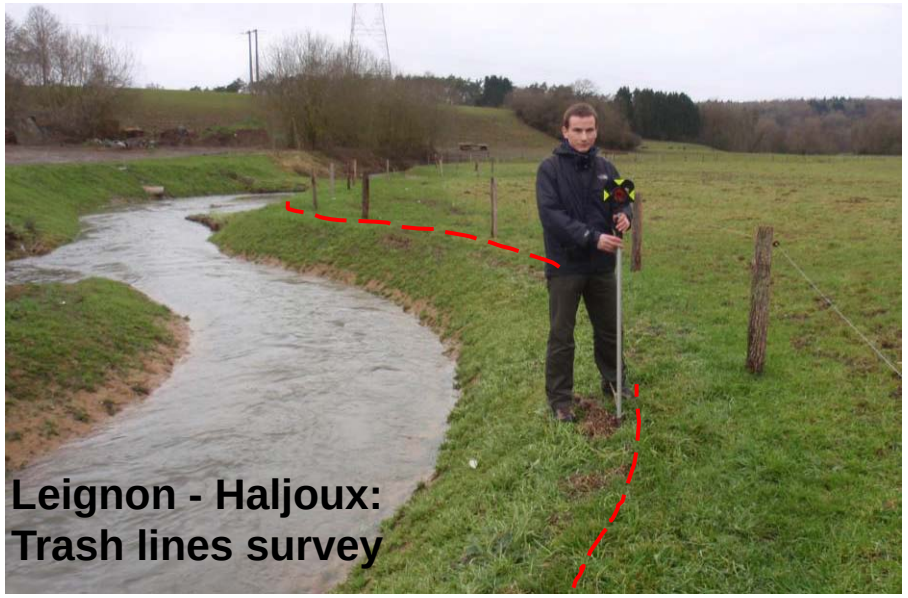
Feedback:
- Qualitative method
- Simple technique to implement

Geomorphology: Flood effect on restoration works

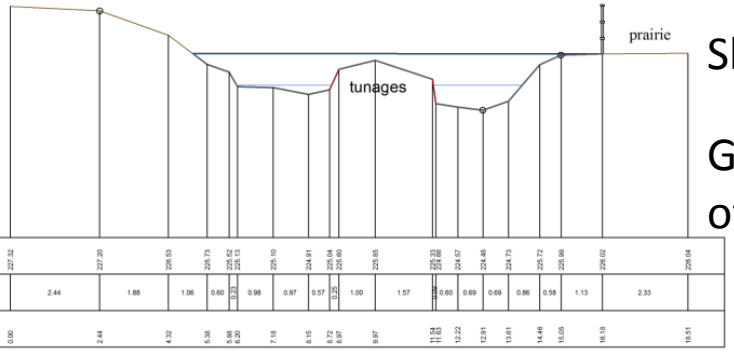
Restoration works and their stability and resistance to erosion:
related to flood characteristics (discharge, recurrence, specific stream power, shear stress)



Leignon - Haljoux:
Bankful discharge (January 7th 2011)



Leignon - Haljoux:
Trash lines survey



Slope of the water surface
+
Geometrical characteristics
of the wetted cross-section
+
Discharge

- Specific stream power
- Shear stress

Thank you for your attention

DCENN : Francis Lambot – Bernard de le Court – Louis-Michel Petiau - Olivier Desteucq – Pierre Joye
ULg / LHGF : Alexandre Peeters – Eric Hallot – François Petit
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