# How to control muddy floods from cultivated catchments ?

Lessons from the Melsterbeek catchment in Flanders (Belgium)

Karel Vandaele, Jo Lammens, Peter Priemen & Olivier Evrard\* Samenwerking Land & Water









**UCL** Unité de géographie



- 1. Introduction
- 2. Muddy floods: what are they?
- 3. How to control?
- 4. Mitigation measures in the Melsterbeek catchment
- 5. Evaluating the effectiveness
- 6. Conclusions

# Soil Erosion in Europe

#### Large areas in Europe are confronted with intense soil erosion

EDITORS JOHN BOARDMAN AND JEAN POESEN

WILEY



#### Impacts of soil erosion

	On-site impacts	Off-site impacts
Short term	Variable plant growth Yield losses Nutrient losses 	Declining water quality due to sediment and sediment-fixed contaminants Muddy flooding (damage to property and infrastructure) 
Long term	Loss of productivity of the land Degradation and disturbances of archeological sites	Sedimentation in river channels & sewage systems Retention pond sedimentation Destruction of habitats 

#### Muddy floods: what are they?





Floods caused directly by runoff from agricultural land, carrying large quantities of soil as suspended sediment or bedload. These floods cause damage to property and (public) infrastructure.

(Boardman et al., 2006)

Muddy floods ? ►How to control ? >Melsterbeek 🌶 Conclusions Introduction >Monitoring

## Muddy floods in central Belgium 10-year period The Netherlands





0

Introduction

Conclusions

### Muddy floods in central Belgium

Seasonal variation

Melsterbeek catchment (c. 200 km²)



Evrard et al., accepted

Introduction

Conclusions

### Muddy floods in central Belgium



Melsterbeek catchment (c. 200 km²)



Evrard et al., accepted

Introduction

Conclusions

#### Muddy floods in central Belgium

#### Damage extent

For the entire Belgian loess belt

Off-site damage to private properties 1.6 – 16.5 × 10<sup>6</sup> € yr<sup>-1</sup>

to public infrastructure 12.5 – 122 × 10<sup>6</sup> € yr<sup>-1</sup>



![](_page_8_Picture_10.jpeg)

Total 14 – 138 × 10<sup>6</sup> € yr<sup>-1</sup>

Evrard et al., accepted

- Government response
  - In Flanders: erosion decree since 2001
- Agri-environment measures (AEMs)
  - In Flanders and Wallonia: grass strips; cover crops (until 2007 in Flanders)
  - In Flanders : grassed waterways, conservation farming practices
  - In Wallonia : agri-environmental scheme at the farm scale; strips for erosion mitigation

Financial support schemes for local authorities, farmers and land-owners to take mitigation measures

The implementation of these measures is voluntary

Mitigation measures : what are they ?

![](_page_10_Picture_2.jpeg)

Main aims of these measures:

- 1. Soil erosion & runoff reduction
- 2. Interrupt flow
- 3. Increase retention
- 4. Sediment export reduction

![](_page_10_Picture_8.jpeg)

The Melsterbeek catchment is a pilot structure in Flanders. Five municipalities as well as the local water agency collaborate in the framework of a common structure to address specifically the problems of flooding

Melsterbeek catchment, central Belgium

![](_page_11_Figure_3.jpeg)

# The "Melsterbeek catchment agency" (samenwerking land & water)

An soil-erosion expert was recruited on a full-time basis.

Mandate of this expert :

- 1. Formulate proposals for mitigation measures
- 2. Consultation with farmers and land-owners (stake-holders)
- 3. Consultation with relevant authorities (regional, provincial, municipal, ..)
- 4. Implementation of mitigation measures
- 5. Monitoring
- 6. Coordination of erosion control policy in Melsterbeek catchment

Objective : eliminating the risk of muddy flooding

![](_page_13_Picture_0.jpeg)

![](_page_14_Picture_0.jpeg)

![](_page_14_Picture_1.jpeg)

#### Mitigation measures : grassed waterways in dry valley systems

![](_page_15_Picture_0.jpeg)

![](_page_16_Picture_0.jpeg)

![](_page_17_Picture_0.jpeg)

#### Mitigation measures : earth dams + retention zone

![](_page_17_Picture_2.jpeg)

![](_page_18_Picture_0.jpeg)

Distanting to a

Mitigation measures : earth dams + retention zone

#### Mitigation measures : earth dams + retention zone

![](_page_19_Picture_2.jpeg)

![](_page_20_Picture_0.jpeg)

#### Mitigation measures : conservation tillage

![](_page_20_Picture_2.jpeg)

Gillijns, K., Govers, G., Leys, A, K.U.Leuven

![](_page_20_Picture_4.jpeg)

![](_page_21_Picture_0.jpeg)

Mitigation measures in Melsterbeek catchment

10 km

14 km

![](_page_21_Picture_2.jpeg)

100 ha grass buffer strips

15 ha grassed waterways

![](_page_21_Figure_5.jpeg)

75 ha conservation tillage

How are measures financed ?

- Construction costs (e.g. for building dams,...) :
  - 75 % of the costs are paid by Flemish Government
  - 15 % of the costs are paid by the Province
  - 10 % of the costs are paid by the municipality

![](_page_22_Picture_6.jpeg)

- 2. Subsidies for farmers & land-owners :
  - 75 % of the costs are paid by Flemish Government
  - 25 % of the costs are paid by the municipality

![](_page_22_Picture_10.jpeg)

#### How is this local catchment agency financed?

Costs for this agency (e.g. salary of the erosion control manager "Dr. Mud", office, car,...) are paid by the 5 municipalities of the Melsterbeek catchment and the local water agency

Each municipality contributes € 7 euro ha<sup>-1</sup> per year

![](_page_23_Picture_4.jpeg)

No financial input from Province or Flemish Government

# Evaluating the effectiveness of the measures :

- 1. Field observations
- 2. Monitoring of a well-equiped 300 ha catchment
- 3. Study of fire brigade interventions after muddy floods in the entire Melsterbeek catchment

![](_page_25_Picture_0.jpeg)

![](_page_25_Picture_2.jpeg)

![](_page_25_Picture_3.jpeg)

![](_page_25_Picture_4.jpeg)

![](_page_26_Picture_2.jpeg)

![](_page_27_Picture_2.jpeg)

![](_page_29_Picture_0.jpeg)

![](_page_29_Picture_2.jpeg)

![](_page_30_Picture_0.jpeg)

![](_page_30_Picture_2.jpeg)

![](_page_31_Picture_2.jpeg)

![](_page_32_Picture_2.jpeg)

#### **Field observations**

#### Evolution water heigth retention zone behind earth dam construction (2002-2008)

![](_page_33_Figure_3.jpeg)

Datum

![](_page_34_Picture_0.jpeg)

![](_page_34_Picture_2.jpeg)

## Detailed monitoring

'Heulen Gracht' equipped catchment (300 ha)

![](_page_35_Figure_3.jpeg)

![](_page_36_Picture_0.jpeg)

Impact on soil erosion and sediment export : N = 11

- Decrease of sediment discharge (- 93 %)
- No more concentrated erosion
- Erosion = interrill phenomenon

Verstraeten and Poesen (2001)

**3.5** T.ha<sup>-1</sup>.yr<sup>-1</sup>

SSY

![](_page_36_Picture_7.jpeg)

8.2 T.ha<sup>-1</sup>.yr<sup>-1</sup>

Since 2006

![](_page_36_Picture_10.jpeg)

0.5 T.ha<sup>-1</sup>.yr<sup>-1</sup>

![](_page_37_Picture_0.jpeg)

```
Impact on runoff : N = 39
```

- Reduction of peak discharge per ha (- 69%)
- Reinfiltration for low- and moderateintensity events (RC - 50%)
- Increase of runoff duration (+ 5 to 12 h)
- Increase of lag time (+ 75%)

#### Significant differences using a *t*-test !

### Occurrence of an extreme event June 11, 2007

![](_page_38_Figure_2.jpeg)

### Fire brigade interventions after muddy floods

Fire brigade interventions after muddy floods

![](_page_40_Figure_2.jpeg)

#### Is it financial feasible to install control measures?

Melsterbeek catchment (2002–2008) : Total cost of the measures =  $\notin$  2.335.000 =  $\notin$  126 ha<sup>-1</sup> Total cost of the agency =  $\notin$  720.000 <u>=  $\notin$  35</u> ha<sup>-1</sup>  $\notin$  161 ha<sup>-1</sup>

Damage cost of muddy floods  $= \in 53,50 \text{ ha}^{-1}$  per year

The investments in the Melsterbeek catchment are cost-effective in 3 years

![](_page_42_Figure_0.jpeg)

- 1. A combination of grassed waterways, grass buffers, earth dams and conservation tillage has been effective in eliminating the risk of muddy flooding in the Melsterbeek catchment.
- 2. The investments for muddy flood control measures in the Melsterbeek catchment are cost-effective in less than 3 years
- National or regional control schemes should be systematically coordinated, promoted and carried out by a 'local catchment agency' (100 – 500 km<sup>2</sup>)
- 4. Structural and integrated approach at catchment scale is needed

### Thank you for your attention!

![](_page_43_Picture_1.jpeg)