Overland flow and soil erosion modelling on cultivated catchment (100-1000km²) at the cultural year scale

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1 Context

Agriculture intensification in Normandy increases the risk of soil erosion, downhill flooding and river pollution.

Watershed syndicates need tools to address these issues and assess the efficiency of their environmental policies.

Models used in this purpose must take land use changes over space and time into account.

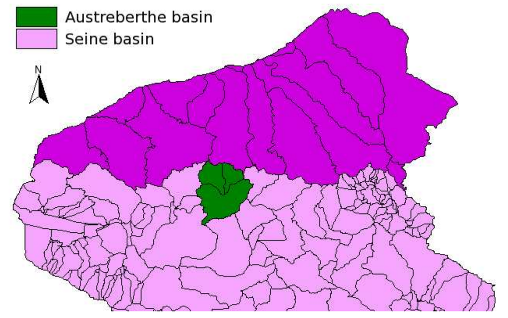
We propose a solution based on overland flow and erosion modelling over a whole agricultural year.

Originality: the use of dynamic and distributed data!

How can we handle model parametrisation and data availibility?

Case studied:
Austreberthe basin (215km²)

Agricultural cycle:
1 Sept. 1996 - 31 Aug. 1997

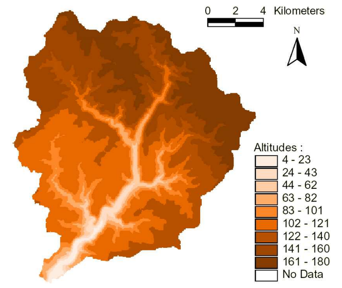


STREAM is an operational model which handles GIS data and text files

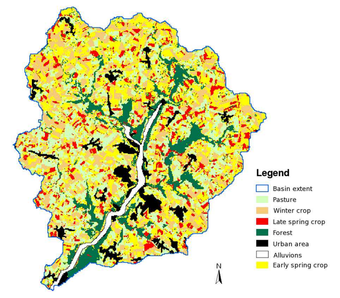
3 Data availability

Static data: easy to get

Topographical data
DEM: IGN raster grid (50m x 50m)

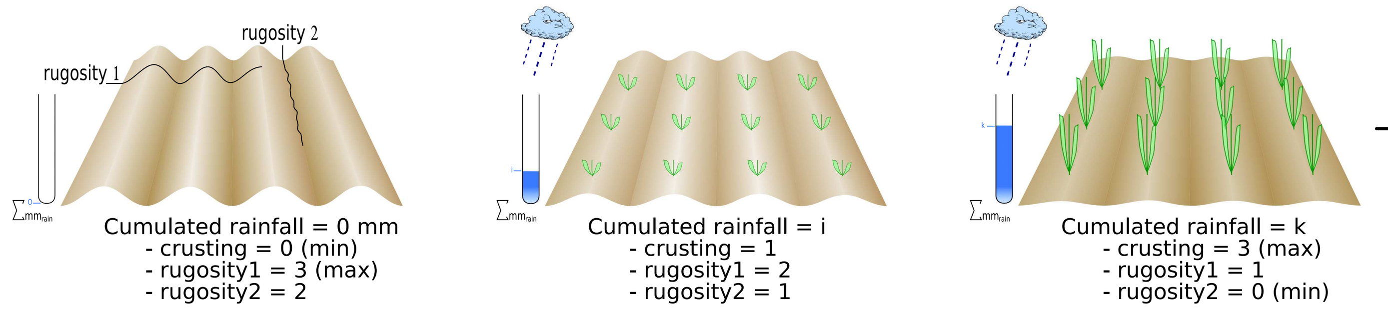


Land use data
Classified SPOT image
Corine Land Cover
CAP data



Rainfall data
Distributed height:
- 2 rain gauges + DEM
Intensity:
- 1 tipping bucket

Soil surface characteristics data
Extraction of empirical laws of evolution based on cumulated rainfall thresholds (560 fields monitored)



Parameter classes and cumulated rainfall thresholds for winter crops (corn)

Crusting	0->1	28 mm
	1->2	115 mm
	2->3	225 mm
Rugosity 1	3->2	38 mm
	2->1	163 mm
	1->0	248 mm
Rugosity 2	2->1	47 mm
	1->0	245 mm

Dynamic data: hard to get

Static data are easy to get and require none or little instrumentation

Dynamic data are hard to get and require field work or expert knowledge

2 The STREAM erosion model

- distributed: allow land use management

Land use, soil characteristics
Topography : runoff routing...
Rainfall event characteristics

- process-based: only dominant processes are modelled

Infiltration / runoff budget
Soil erosion / deposition budget

- parameter values are discretised in classes

Crusting: 0 (min), 1, 2, 3 (max)
Rugosity: 0 (min), 1, 2, 3, 4, 5 (max)
Vegetation cover: 1 (<30%), 2, 3 (>60%)

Besides, STREAM includes a dictionary of parameter values for a large panel of land uses, which allows automatic parametrisation.

STREAM outputs operational results:
- at the DEM spatial resolution
- at the rainfall event timestep

STREAM handles distributed data and requires little parametrisation

4 Results

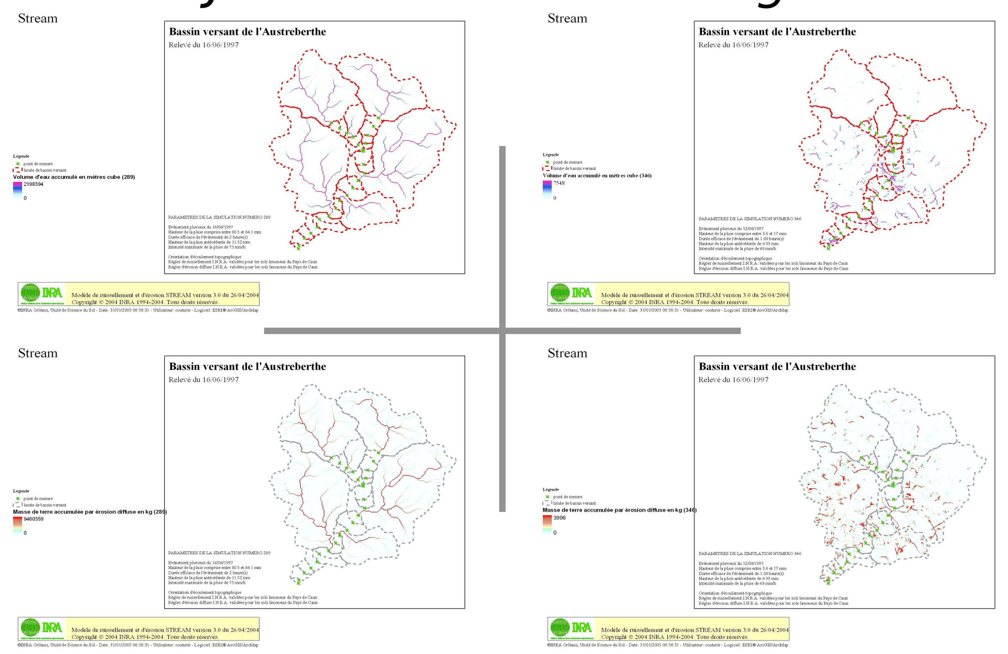
We used the empirical laws of evolution extracted from field monitoring data to model the evolution of land use and soil charactetitics over time, resulting in 14 different maps (only affecting attributes of GIS objects).

Overland flow and erosion responses are not linear and vary according to rainfall and soil characteristics.

16 June 97 *12 August 97*

Overland flow

Erosion



Although the results have not been validated yet, they seem coherent with known local variability of response.

Problems

Rainfall intensity is a sensitive parameter of STREAM but was estimated by a tipping bucket gauge outside the basin.
Simulation precision can be increased with better data quality.
Distributed ouputs like maps are harder to interpret and compare than a single value.

5 Conclusion

The implementation of STREAM as a GIS project facilitates the use, the output and the visualisation of distributed data. On this case study, STREAM has been coupled with SENECAM (river network quality model) for which it models upstream processes and river pollution by eroded materials.

Other applications may concern wider basins, over a longer period of time, vegetation growth applications...

References
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