

Conditional simulation with point values

An application to rainfall field

Jean-Marie Lepioufle

GIS i Vassdrag – Trondheim - 20.01.2010

Outline

- 1- The rainfall process in a Distributed Hydrological Model
- 2- Kriging, an interpolation method to provide a rainfall scenario
- 3- Conditional simulation, a method to provide rainfall scenari
- 4- Conclusion
- 5- Questioning about the impact of rainfall input to the output (runoff at the outlet)

Outline

1- The rainfall process in a Distributed Hydrological Model

2- Kriging, an interpolation method to provide a rainfall scenario

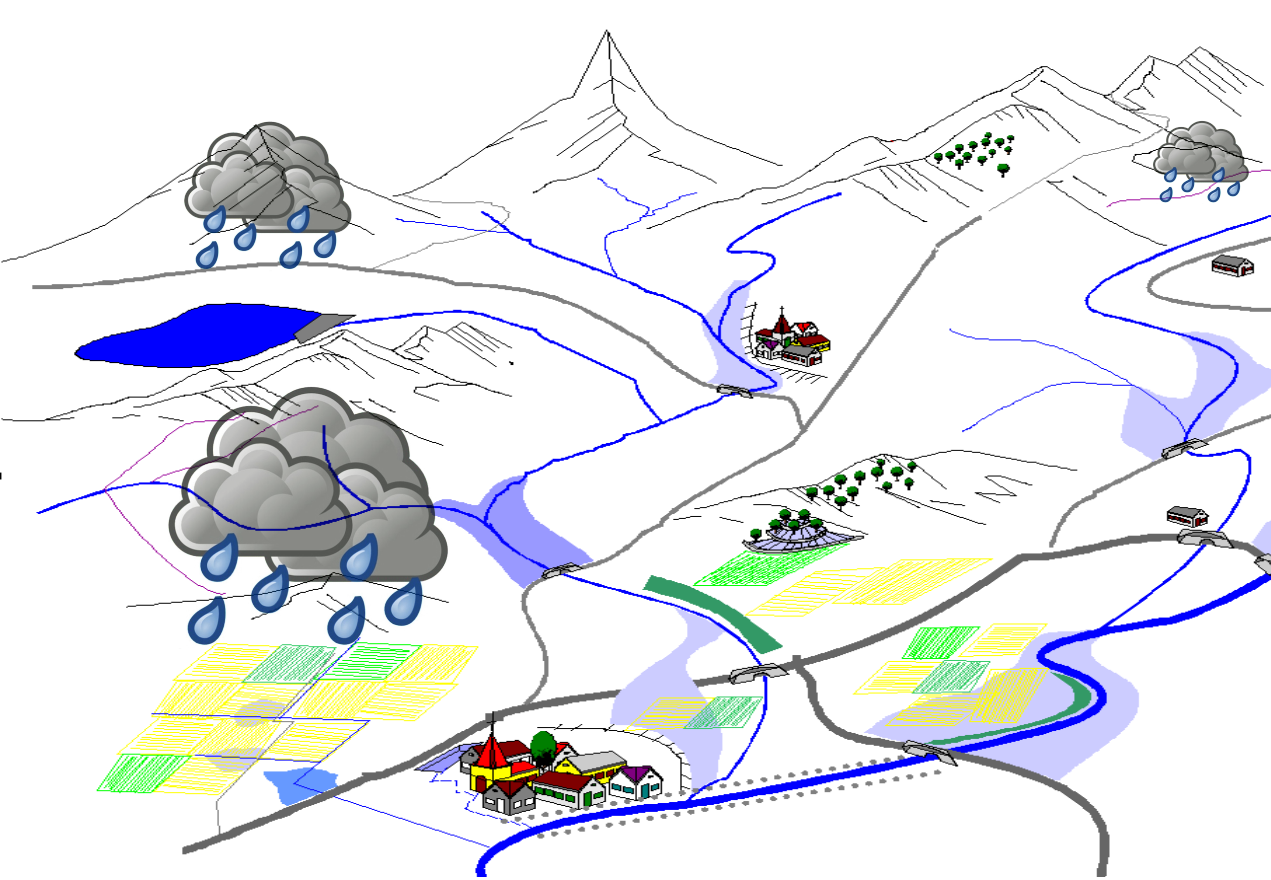
3- Conditional simulation, a method to provide rainfall scenari

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1- The rainfall process in a Distributed Hydrological Model

Practical issue : land development



Good water resources management :

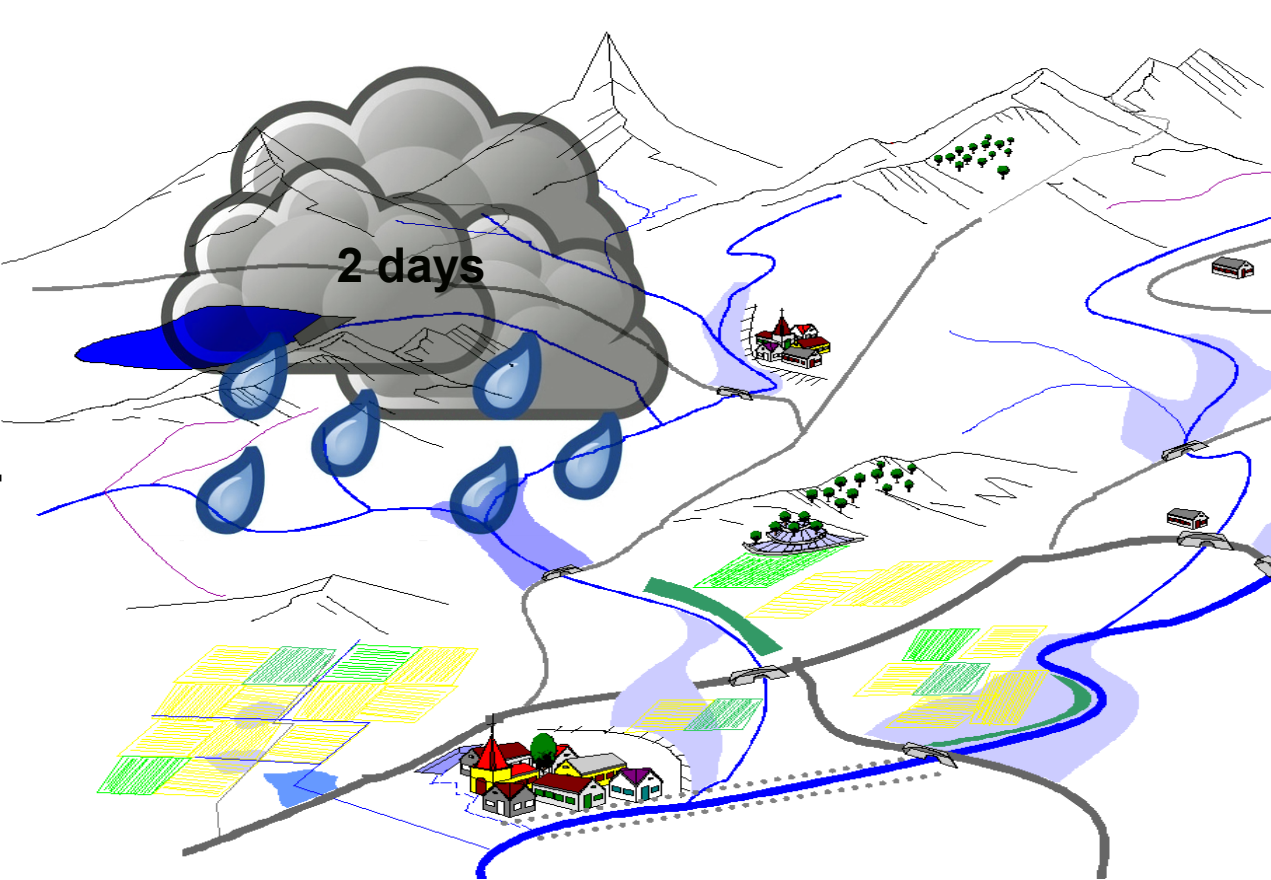
Predicting floods

Predicting impact of land management on the hydrological process

Optimizing the water resources

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Good water resources management :

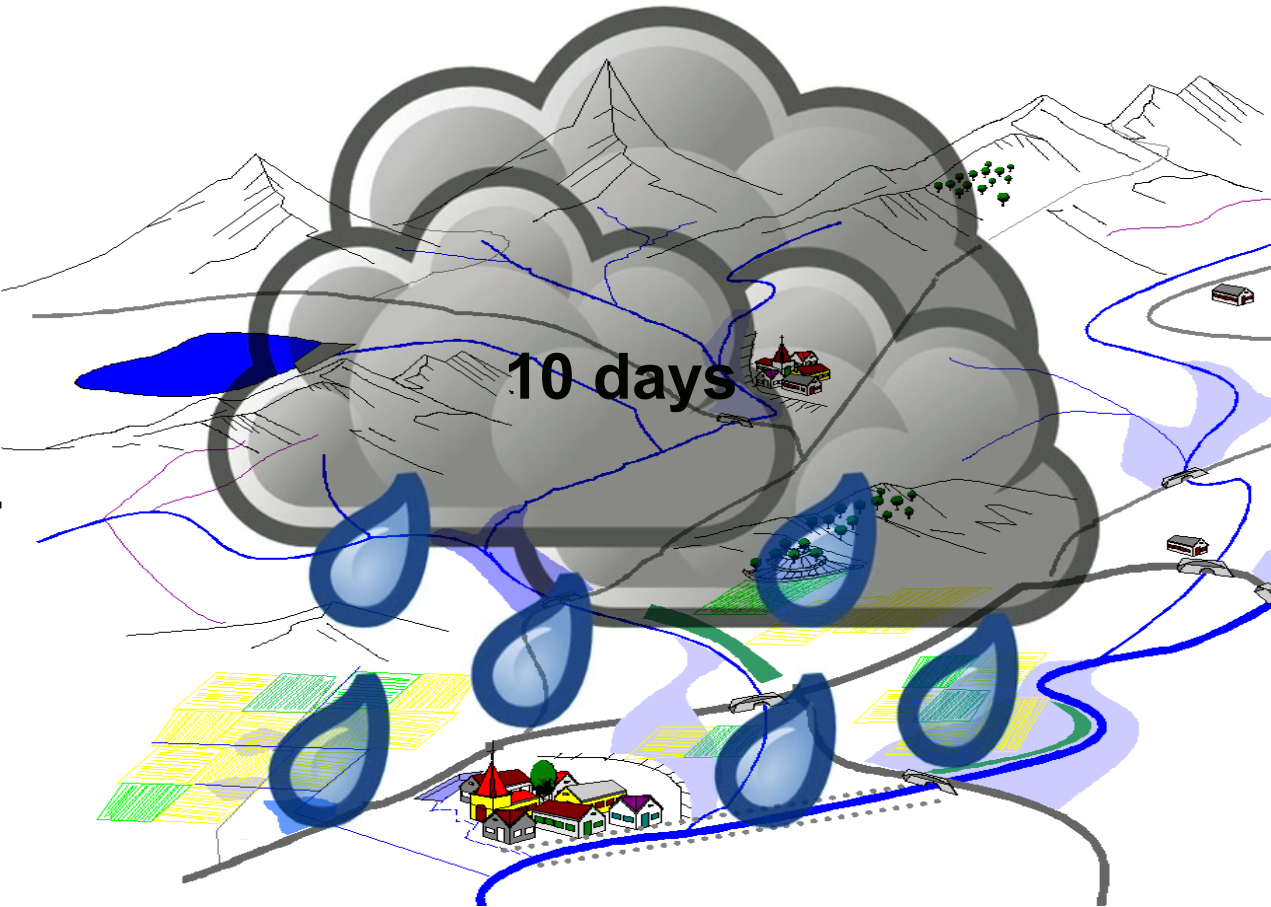
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Good water resources management :

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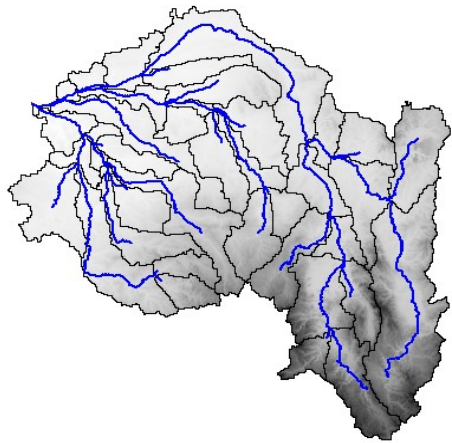
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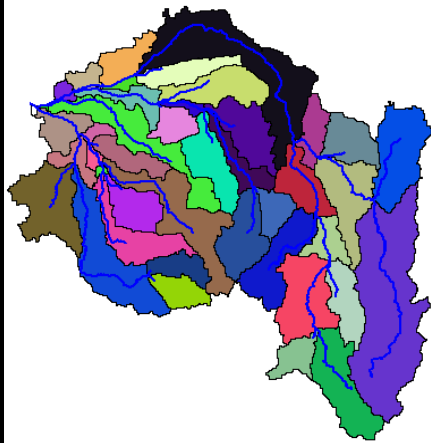
1- The rainfall process in a Distributed Hydrological Model

Hydrological distributed modeling

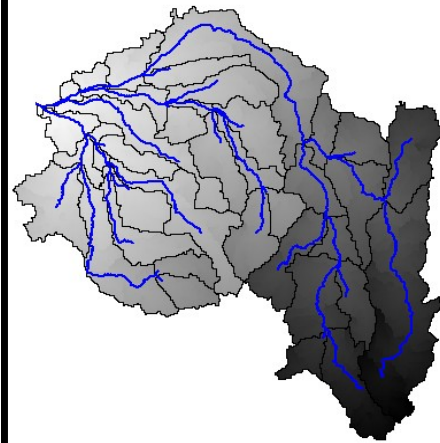
Ex : Loire Basin, France



Digital elevation model

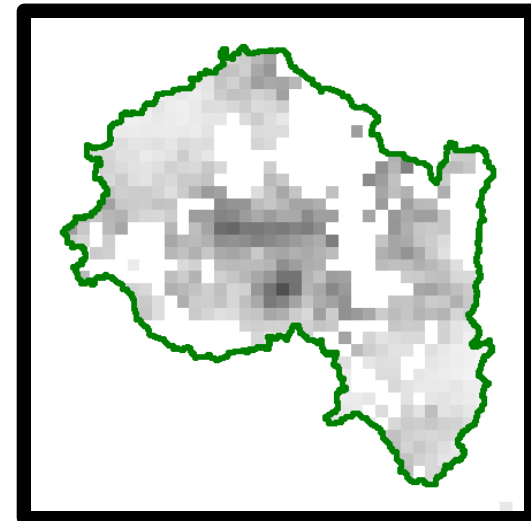


sub-basins



Distance to the outlet

...



Rainfall fields

NEED : To build a rainfall object which provides spatial distributed rainfall fields evolving in time

Stochastic approach : geostatistics

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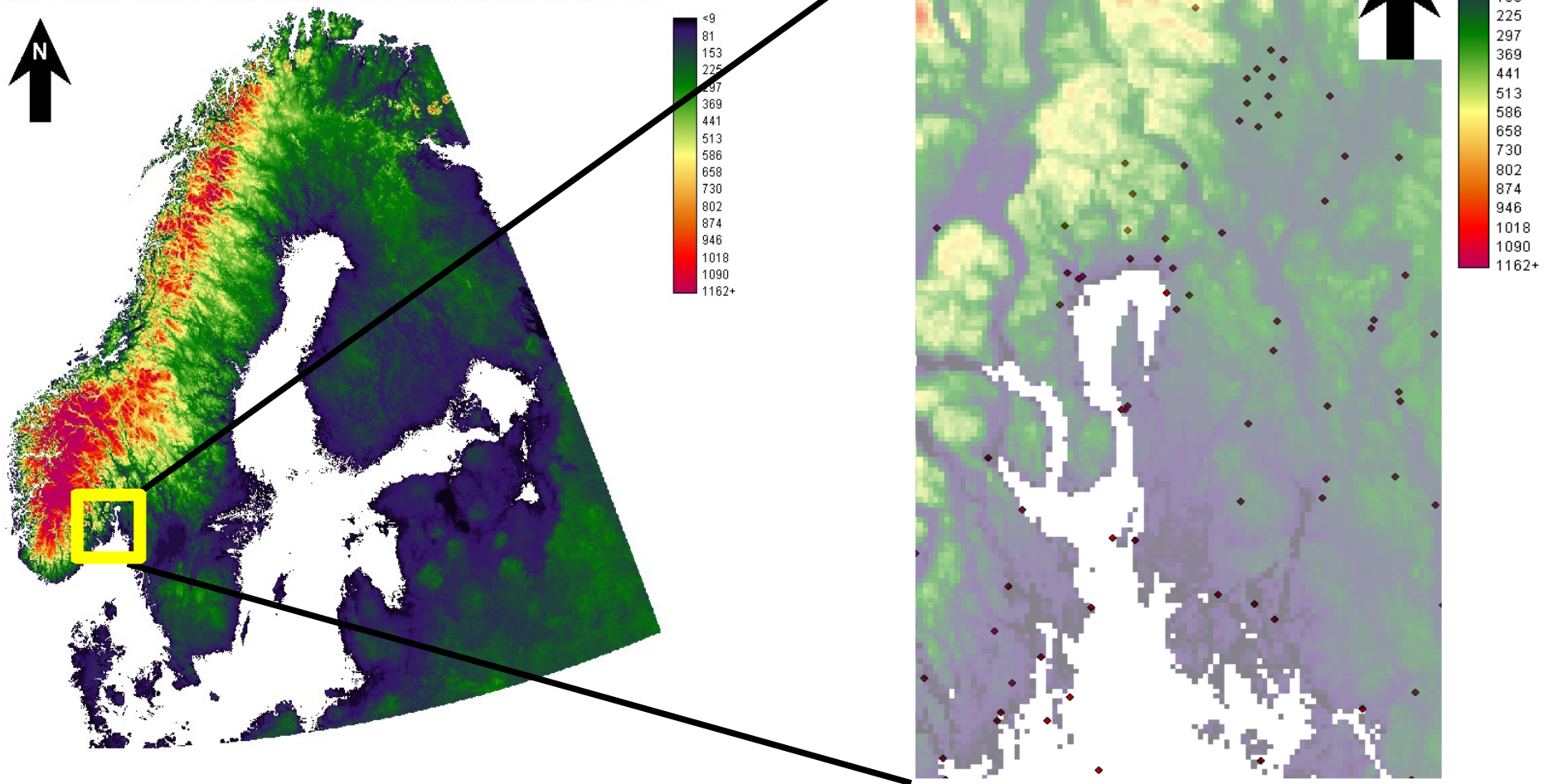
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2- Kriging, an interpolation method to provide a rainfall scenario

Illustration on a region gathering Oslo, Akerhus, Østfold, Vestfold

78 raingauges (eKlima - MetOffice), daily data from 1970 to 2008

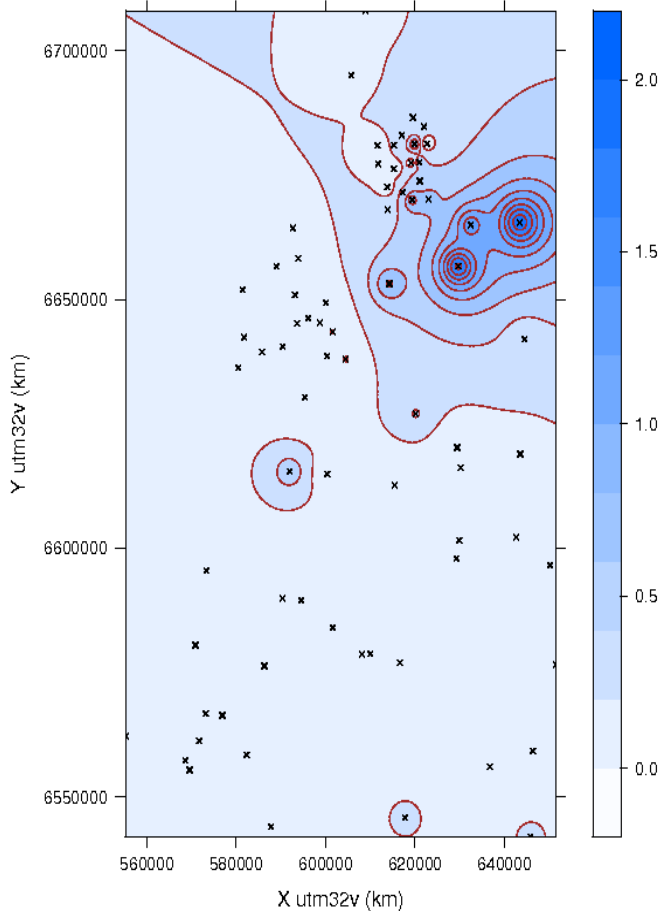
EnFO km-DEM fra DCW, UTM-32 Norden. Koordinater sjekket.



2- Kriging, an interpolation method to provide a rainfall scenario

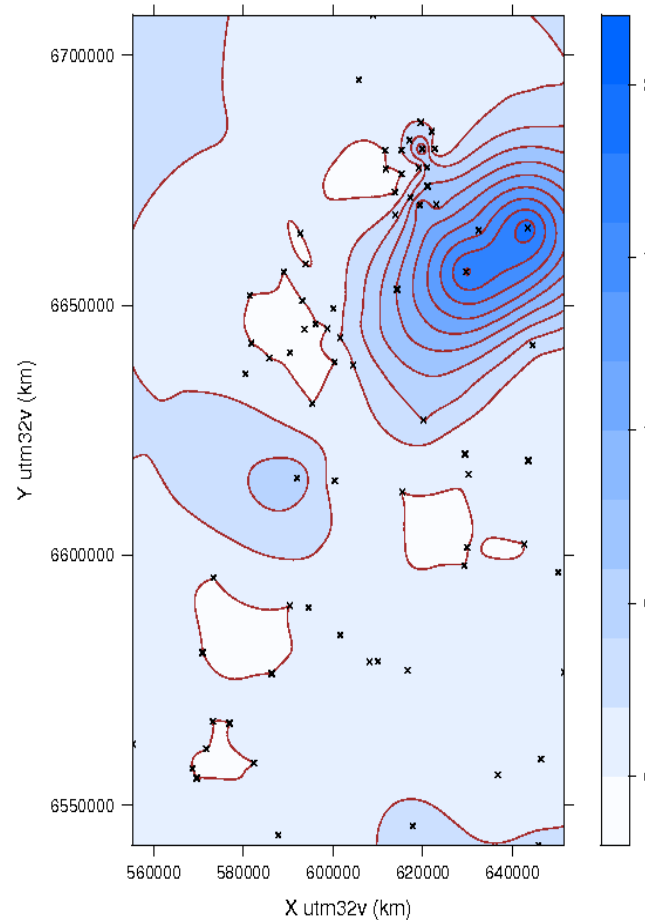
Optimal Interpolation : kriging

Inverse – Distance :
“Not optimal interpolation”
Rainfall, 1970–01–01 (mm/day)

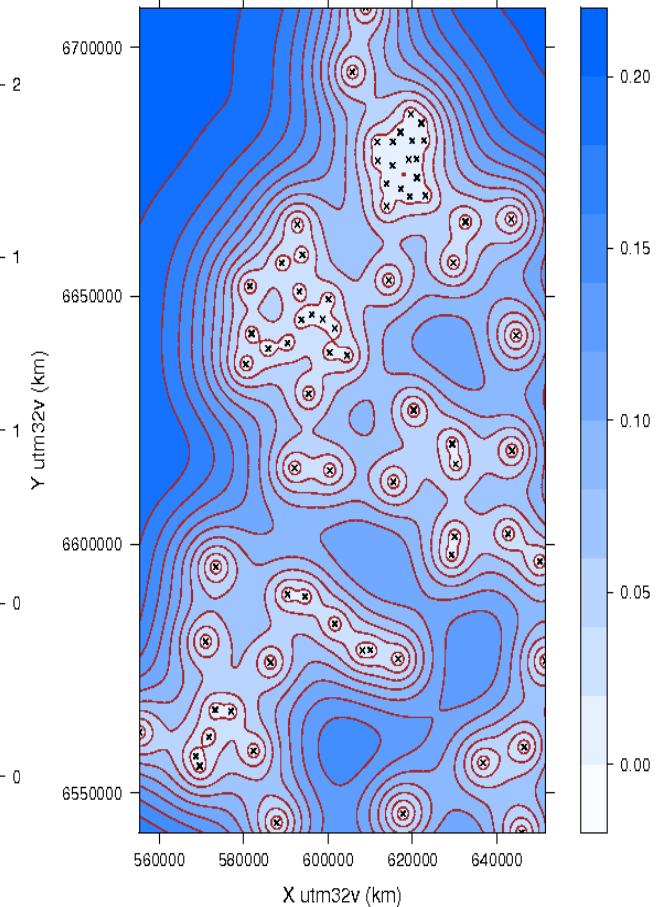


Kriging : Optimal interpolation

Rainfall, 1970–01–01 (mm/day)



Prediction error, 1970–01–01 (mm/day)



2- Kriging, an interpolation method to provide a rainfall scenario

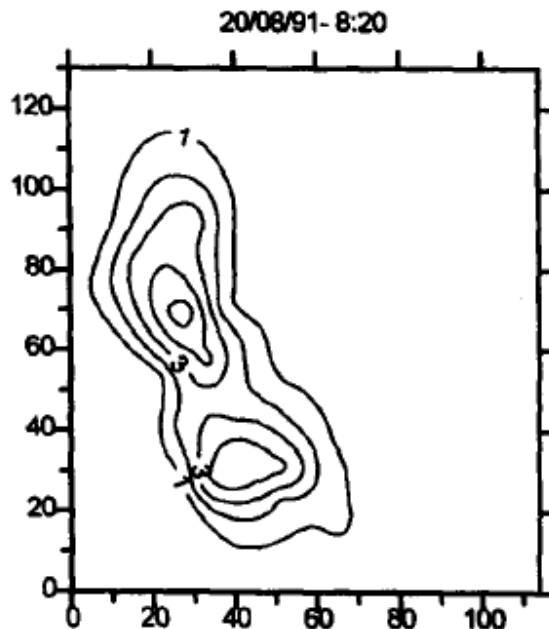
Space-time kriging

3D-kriging, dynamic kriging and lagrangian kriging

Amani et al, 1997

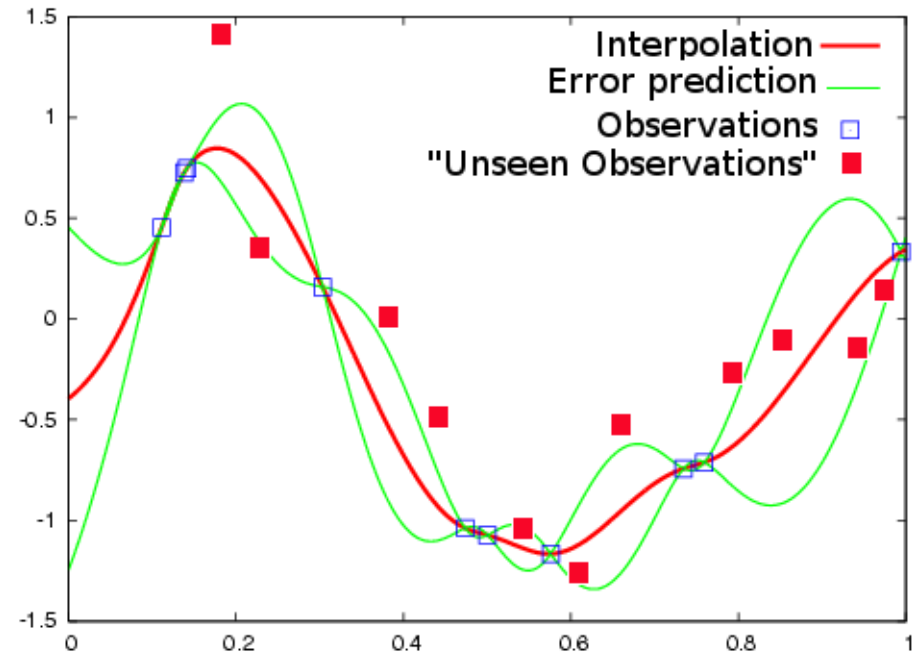
Lebel and LeBarbé, 1997

Ali et al, 2003



Amani et al, 1997

But (interpolating) kriging=Smoothing



Academic example, from Wikipedia

Outline

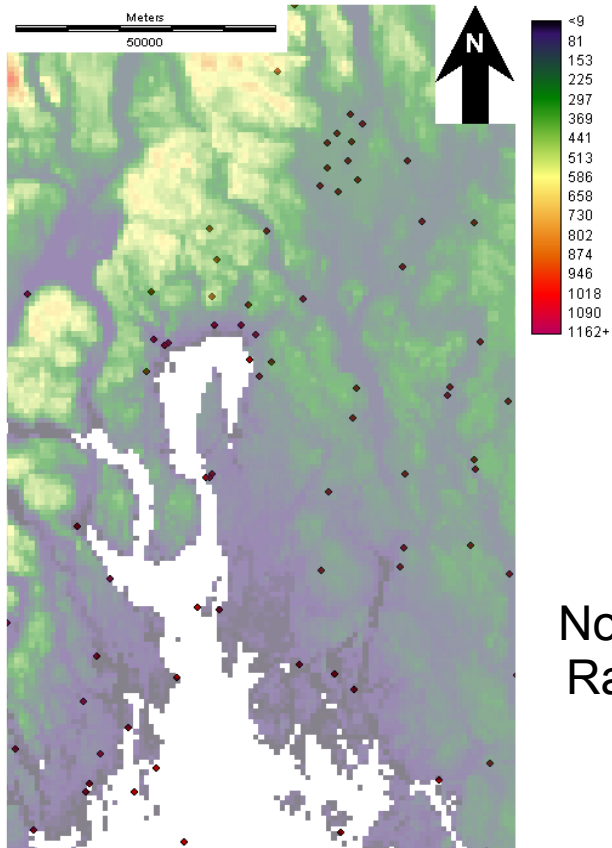
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3- Conditional simulation, a method to provide scenari

Conditional simulation with point values, interesting for reanalysis

Daily rainfall, from 01/01/1970 to 31/12/2008

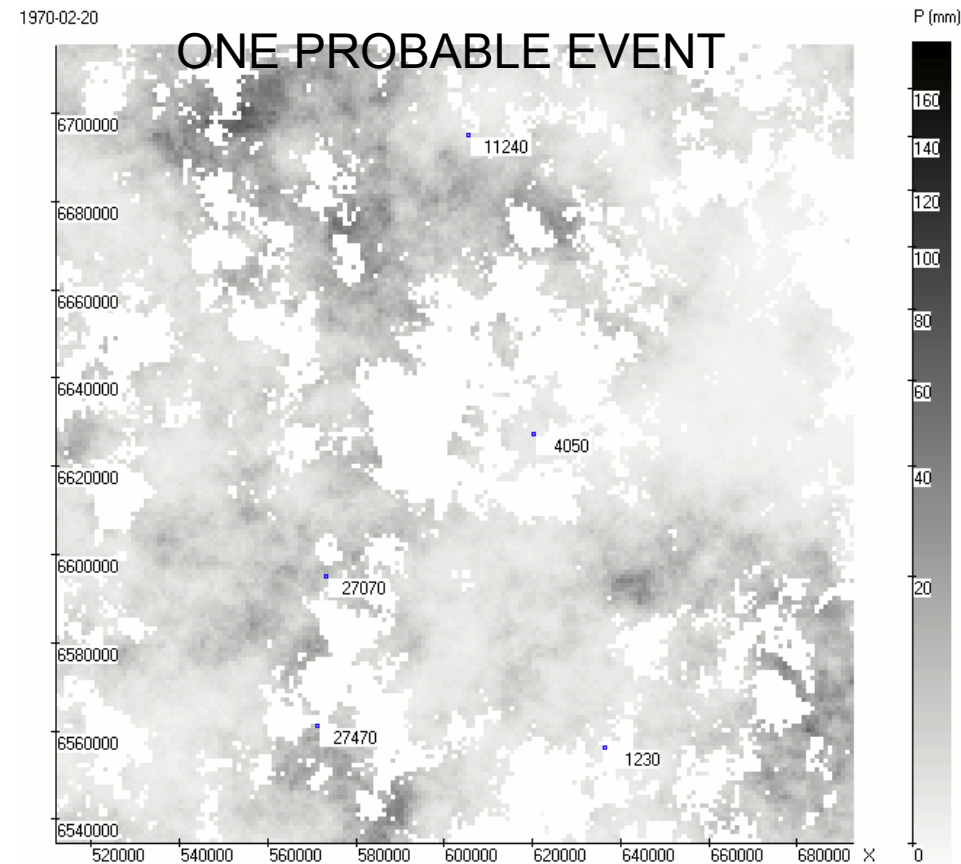
Regions : Oslo, Akerhus, Østfold, Vestfold



m, σ^2, γ, U

Non-zero Rainfall
Rainfall indicator

Conditioning with 5 raingauges



rainfall generator developed by
Etienne Leblois, Cemagref Lyon, France

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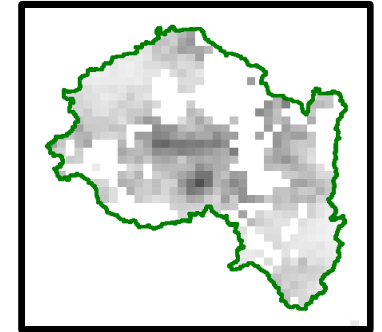
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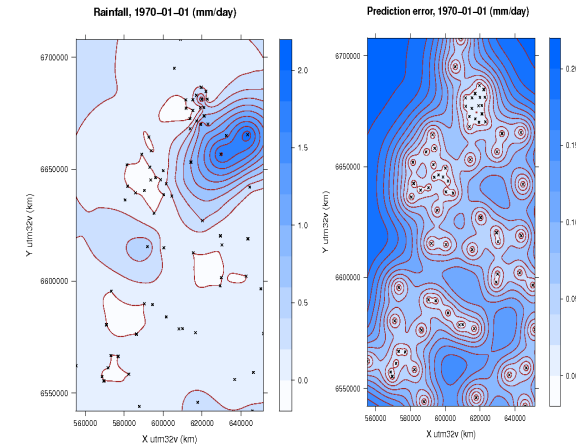
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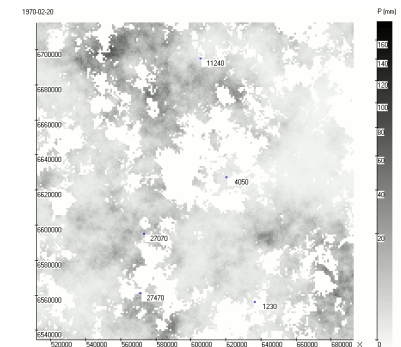
In Distributed Hydrological Model, the rainfall object have to provide realistic space and time rainfall process.



Kriging is an optimal interpolation method with known uncertainty, but it provides only smooth and unique scenario.



Conditional simulation provides several equiprobable scenarios. Useful for reanalysis



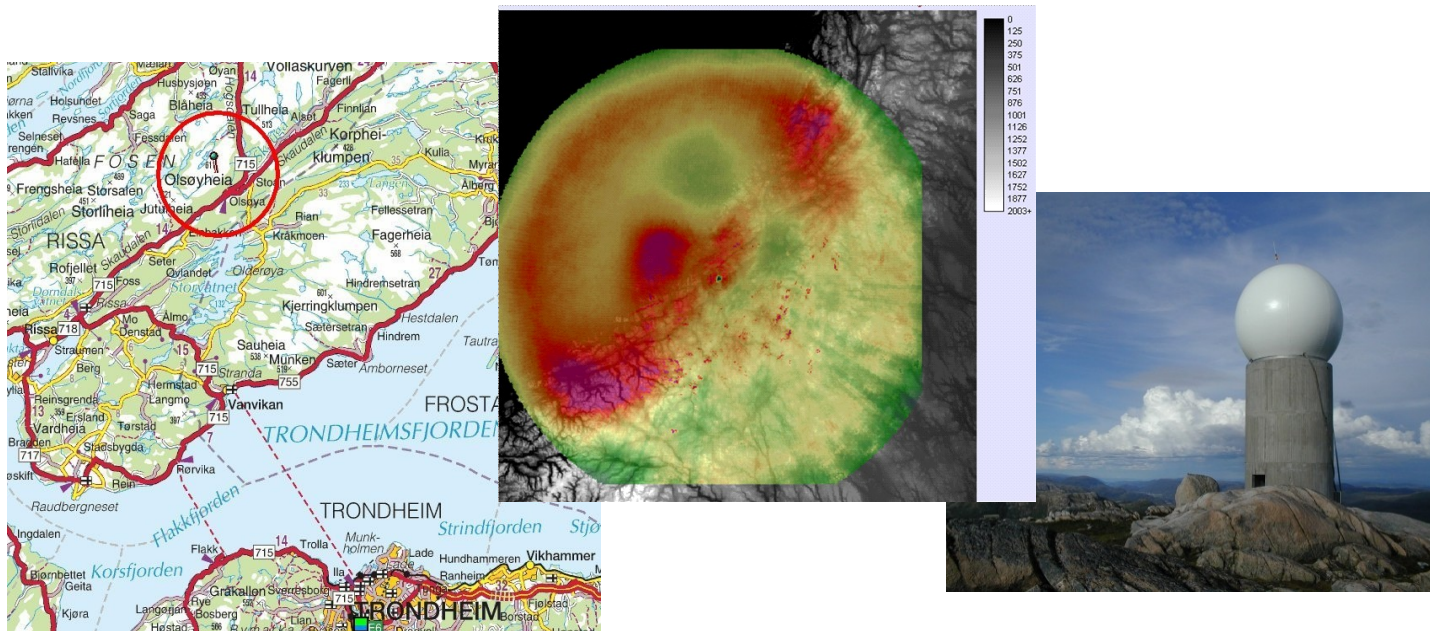
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Improvement in the conditional simulation

- Intermittency, Non-homogeneity of rainfall statistical characteristics due to orography, precise advection

Hierarchical Bayesian conditioning

- using radar as external data. Both rainfall and radar : hourly time resolution



Radar in Rissa (MetOffice)

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Impact of a better rainfall prediction over a catchment in order to simulate runoff at the outlet

How big is the benefit with space-time rainfall simulation ?

How big is the sensitivity of the runoff output to the rainfall input ?

Is there a limit resolution?

- **Coarser mesh when simulating rainfall events**
- **Irregular mesh (higher resolution where the rainfall process is gentle, low resolution where the rainfall process is uncertain - orography)**
- **Areal mean rainfall**

Thank you

**Conditional simulation with point values
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