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rbisGIS

Efficient Constrained Delaunay Triangulation implementation in Java for spatial hydrological analysis

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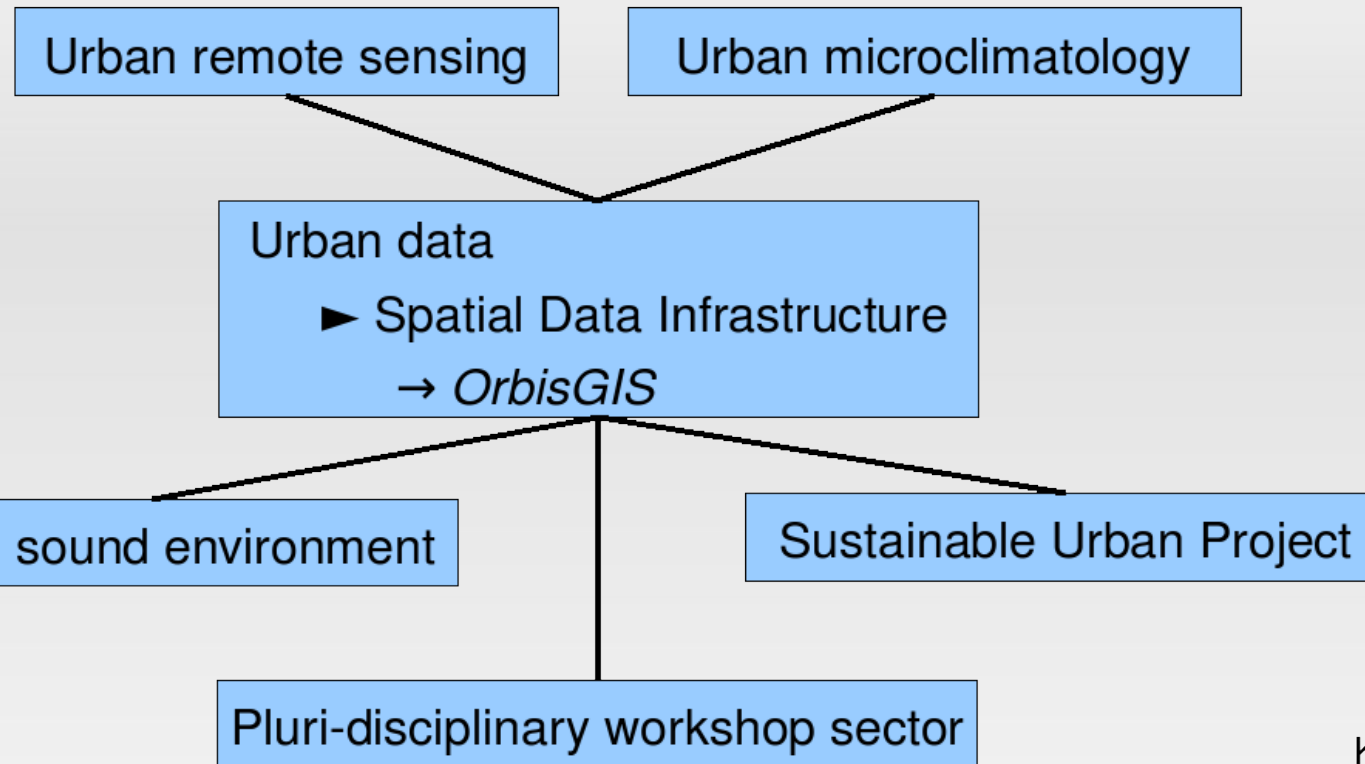


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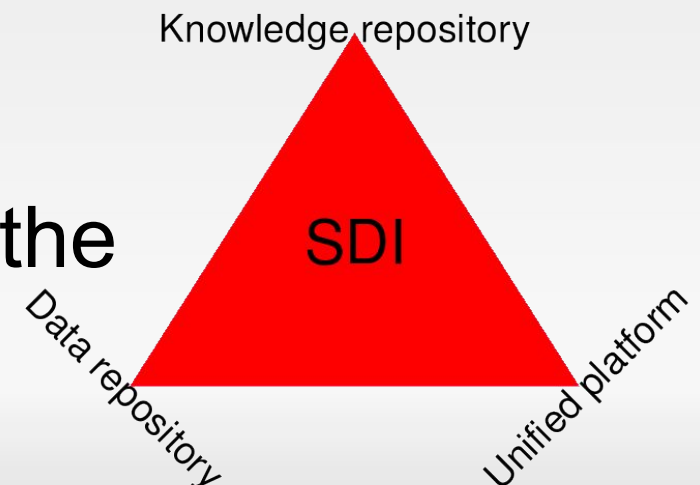


- Context – purpose - methodology
- *OrbisGIS* platform,
- 2D constrained Delaunay triangulation,
- The topographical graph
- Conclusion

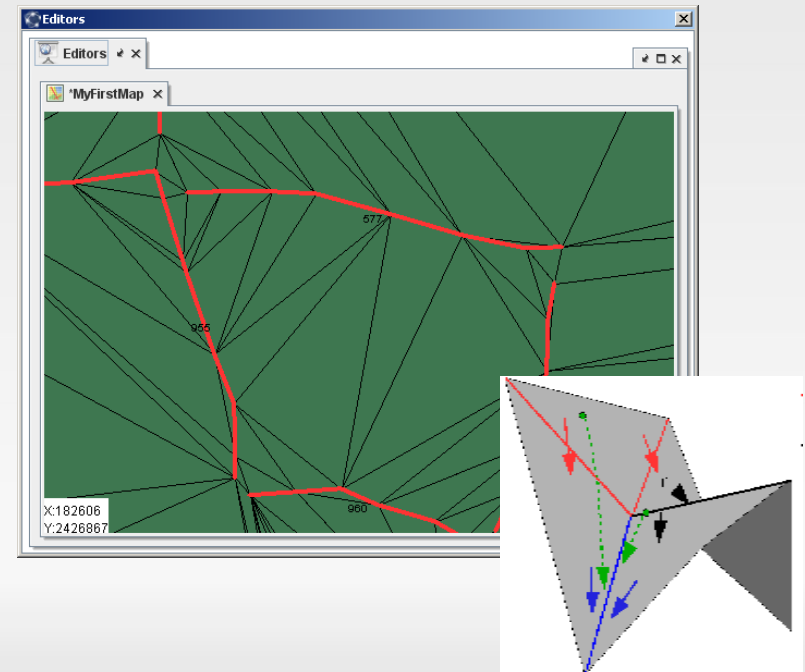
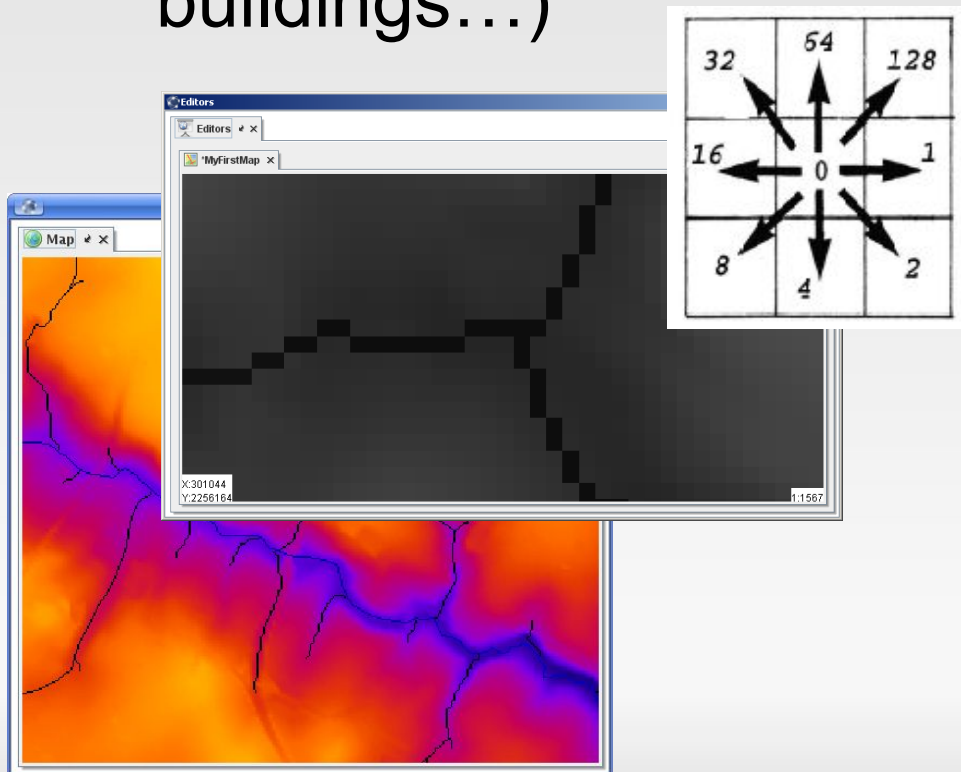
The context



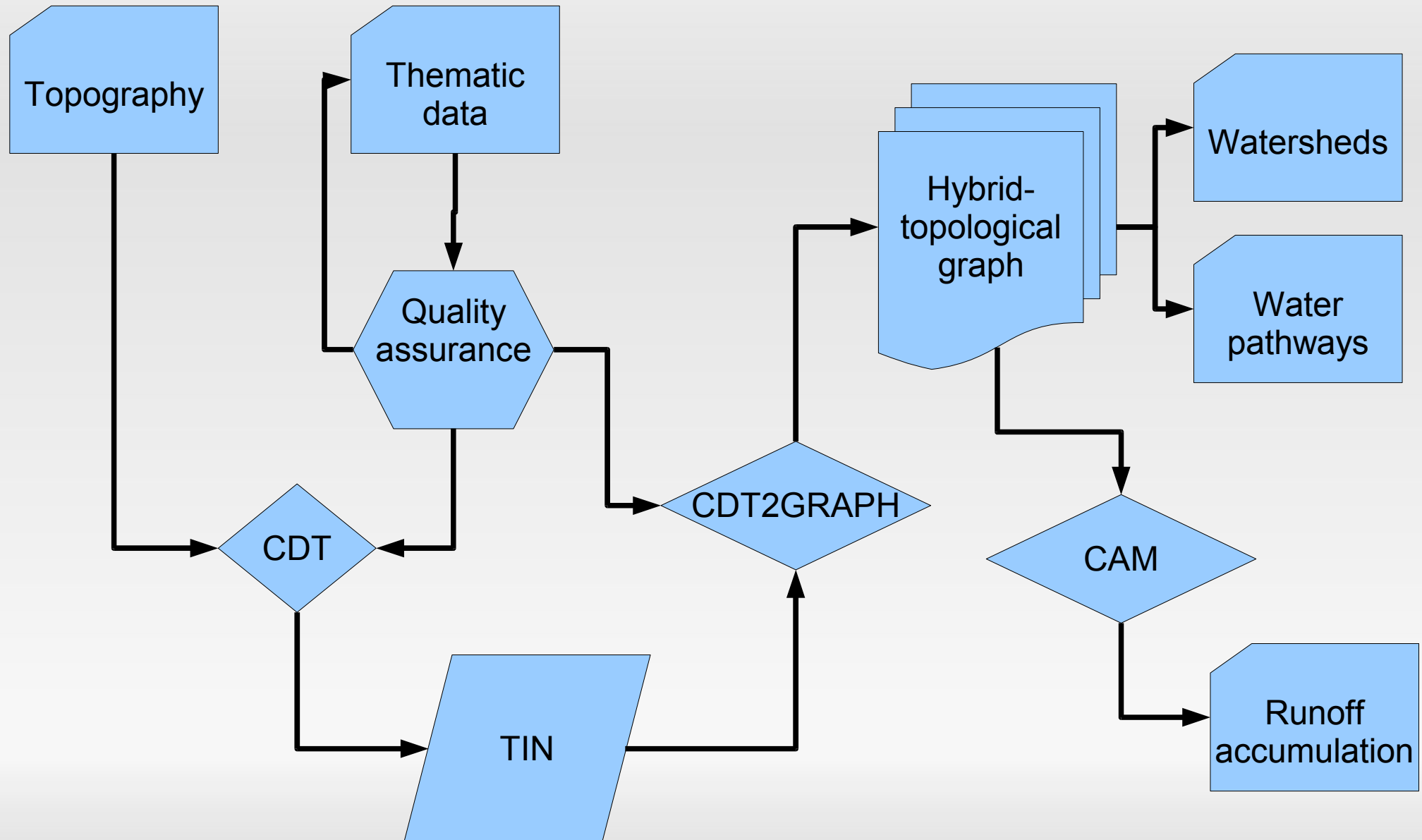
- ANR Project *AvuPUR*: Accessing the Vulnerability of Peri-Urban Rivers



- TIN approach vs classical grid hydrology analysis:
 - Take into account urban artifacts (heterogeneous objects, strong space's partition, roads, pits, buildings...)



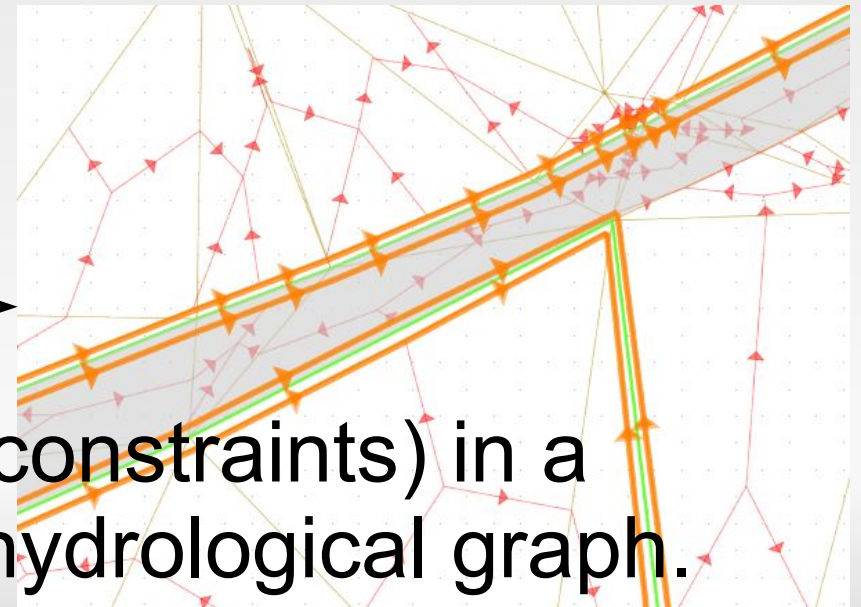
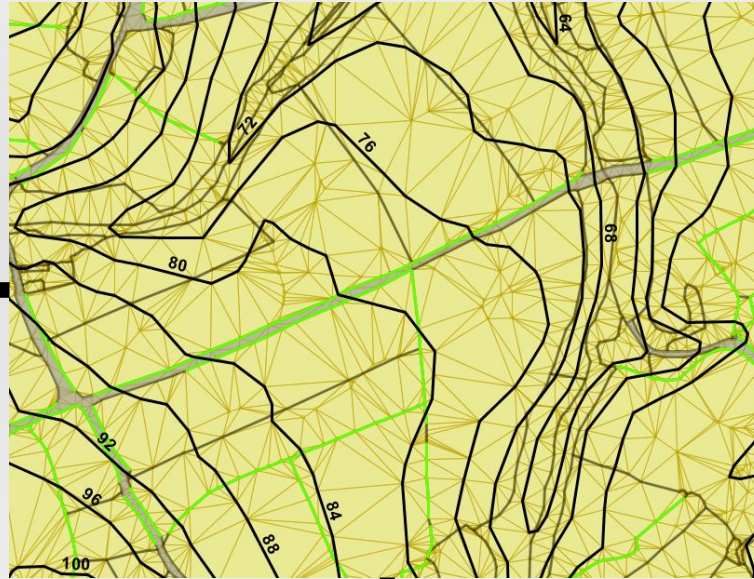
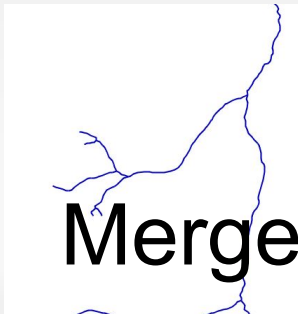
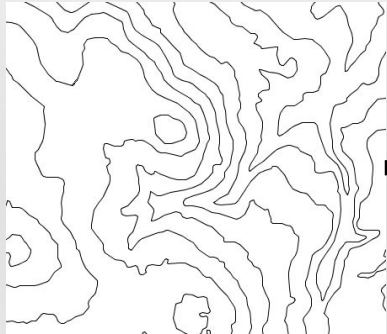
The objectives



The methodology



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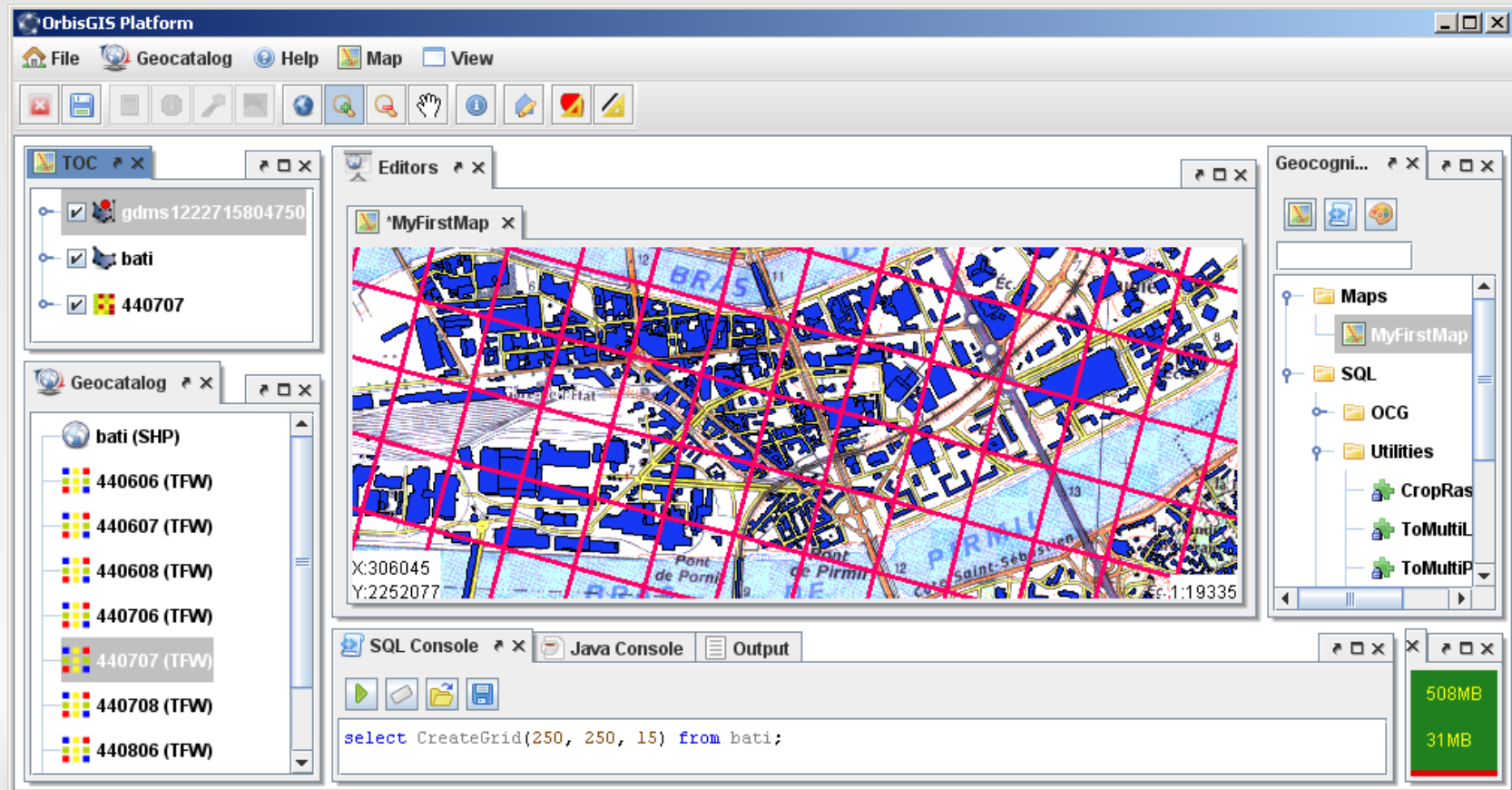


Merge data (topography & constraints) in a topographical & constrained hydrological graph.

The platform...



- A scientific GIS, GPL licensed, 100% pure Java, based on the *GDMS* engine (a spatial SQL language):



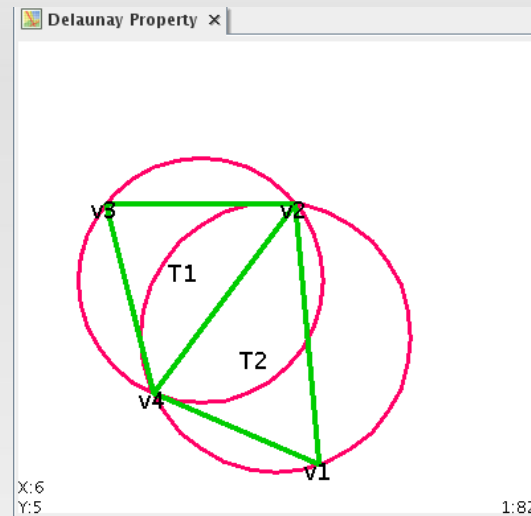
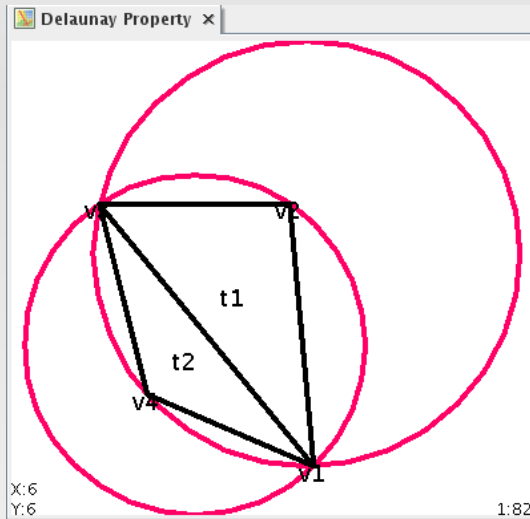


- a mesh is a partition of a domain into elementary bounded cells where 2 cells are disjoint or share a lower dim. portion of space,
- main goals of a mesh generator:
 - control: the number of vertices, the cell shape criteria, the linear constraints...
- Input:
 - a Planar Straight Line Graph (set of vertices and edges... such as iso-height lines),
- Output:
 - a set of triangles without adding *Steiner points*,

CDT properties...



- local empty circum circle property,

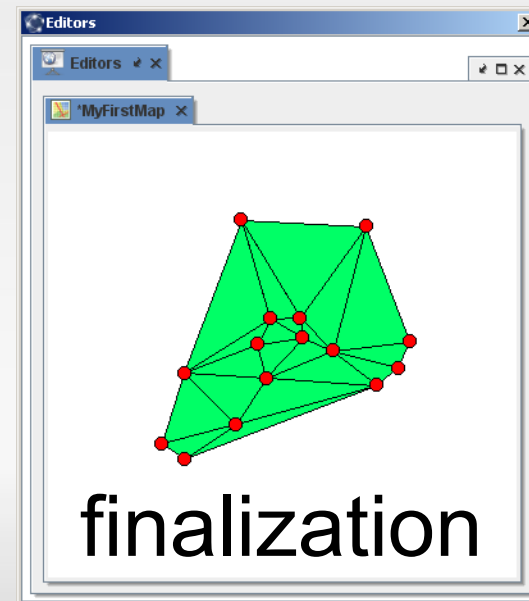
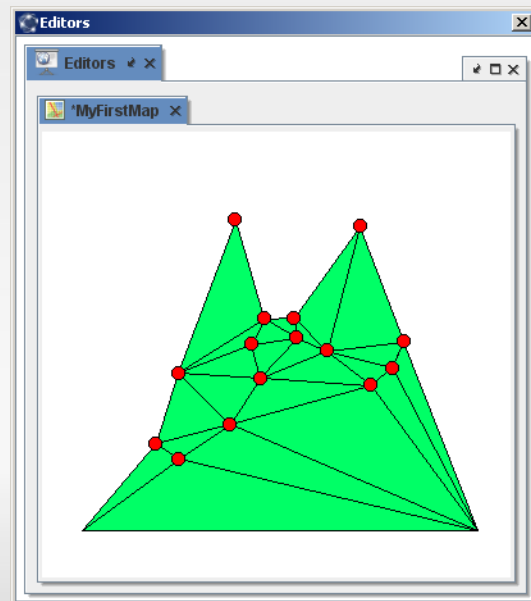
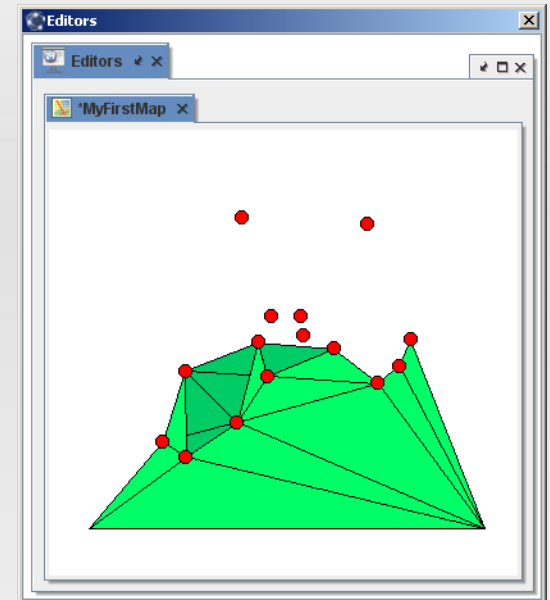
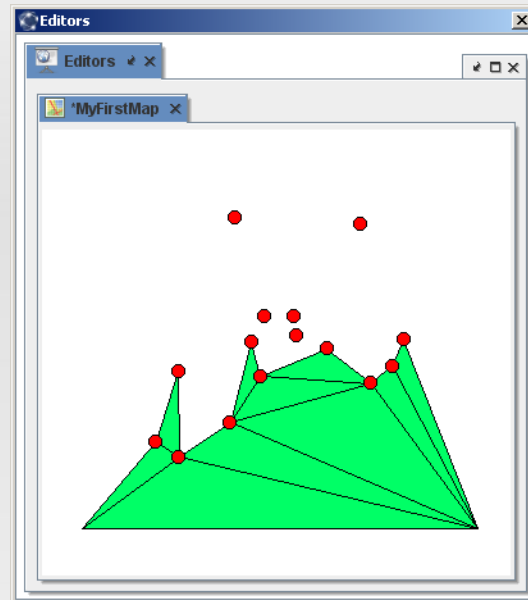
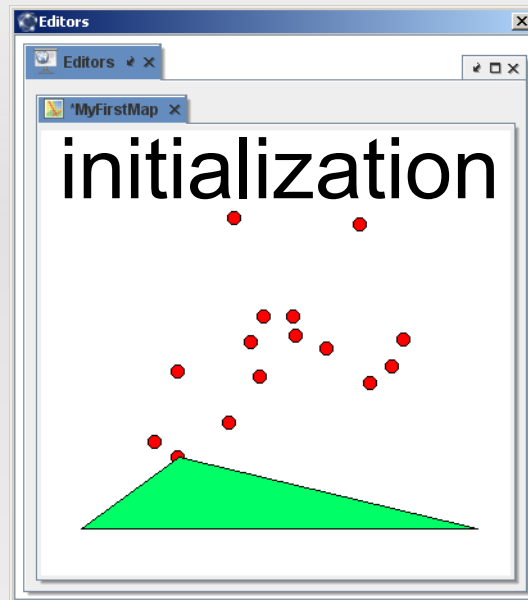


⇒ max. the
min. angle
property,

- produced triangulation is unique (assuming careful handling of the degeneracies),
- external edges of the triangulation corresponds to the convex hull of the input constraints.

Sweep-line algorithm

Domiter & Zalik (IJGIS, 2008)

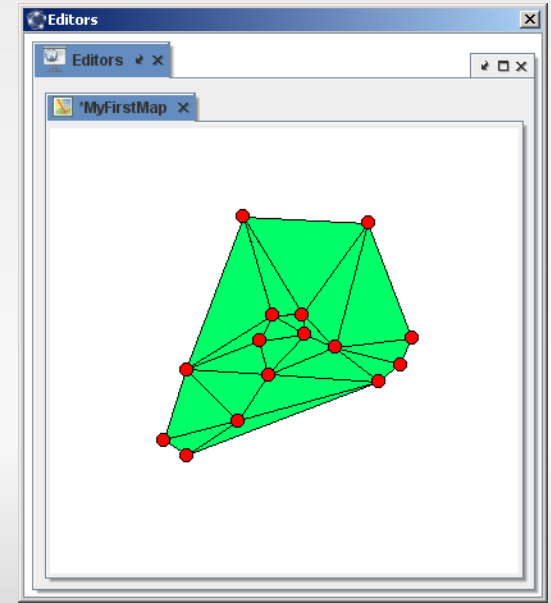
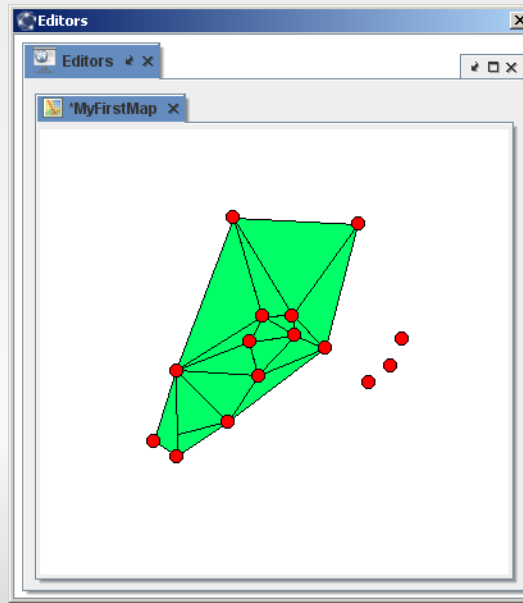
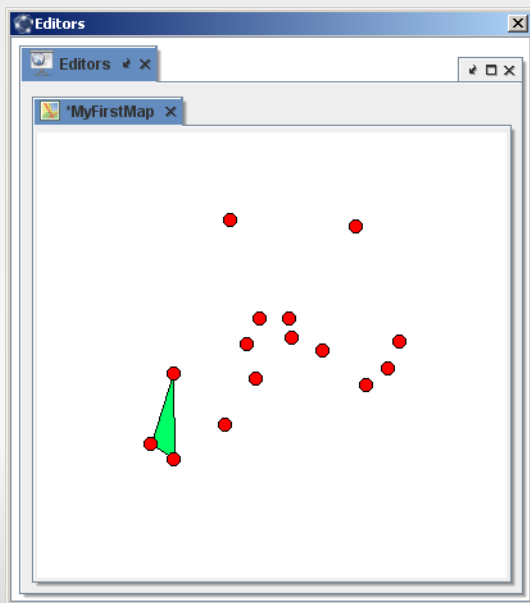


M Michaud's implementation

source: Y. Egels (IGN/ENSG)



- Sort input set of vertices according to x axis,
- Create a 1st triangle with the 3 first vertices,
- Sweep the vertices each by each and create (and legalize) a new triangle with each visible edge of the convex envelop of existing triangles,



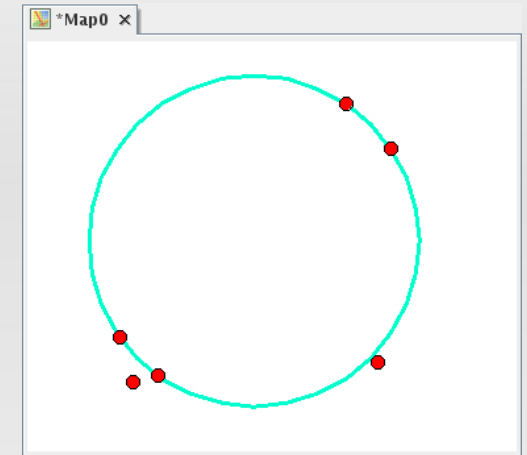
- Intel® Core™ 2 duo E6750@2.66GHz, **100k vertices** randomly distributed:
 - M Michaud's implementation: **7s** (0.7s) ;
 - M Davis' implementation: **13s** ;
 - WaterBugExtension/TINBuilder OpenJUMP's plugin
 - P Austin's implementation: **61s** ;
 - Our own implementation of D&Z sweep-line algorithm (without adjacencies): **134s** !

- Intel® Core™ 2 duo E6750@2.66GHz, **29460 vertices** and **13350 edges**:
 - M Michaud's implementation: **1.7s** / 0.2s ;
 - M Davis' implementation: ?s ;
 - WaterBugExtension/TINBuilder OpenJUMP's plugin

Some evaluation tools



- select **CheckDelaunayProperty()** from t;
- select **Geomark()** from dp;
 - \Rightarrow exhibit all the degeneracies / co-cyclic vertices (spatial bookmarks = stored map area extents),
- select **QualityMeasuresOfTIN()** from t;

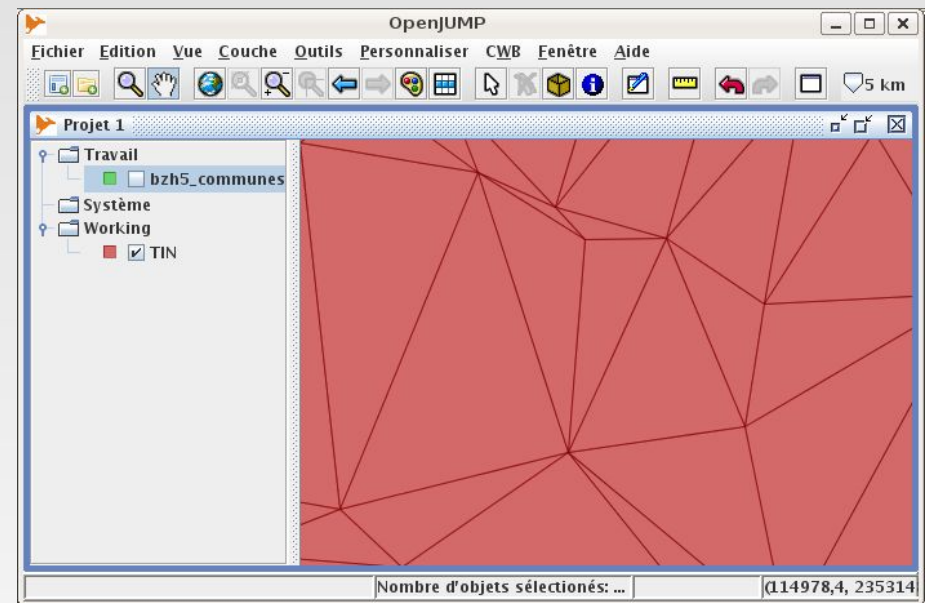
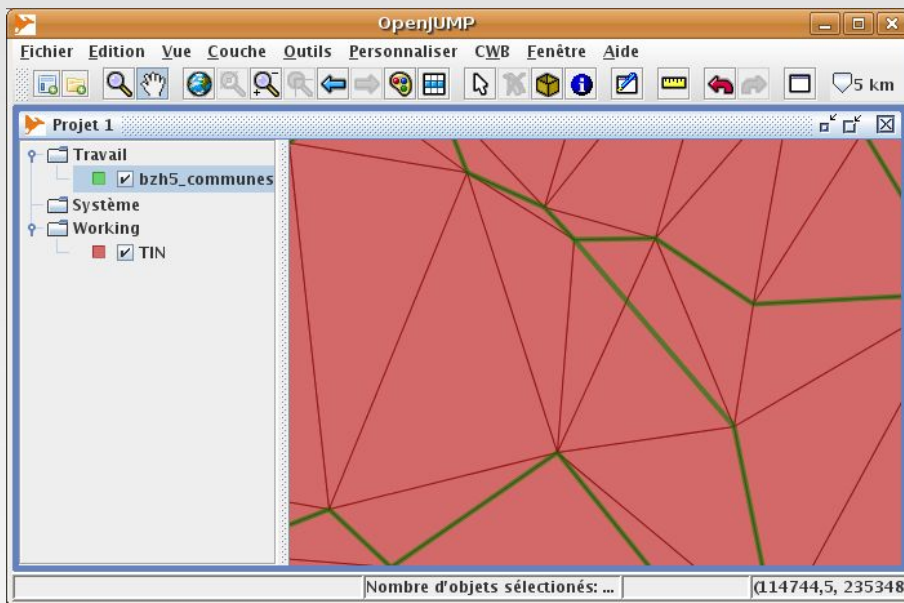


Result from : select QualityMeasuresOfTIN() from t				
label	min	max	average	standard ...
angles	0,003	179,989	60	29,811
perimeters	3,414	8 458	109,133	66,646
areas	0,5	6 274,5	500,18	440,402
circum radius	0,707	2 232 234,501	128,076	10 225,25
edges length	1	4 229	36,378	26,035

Some CDT impl. that does not match our criteria



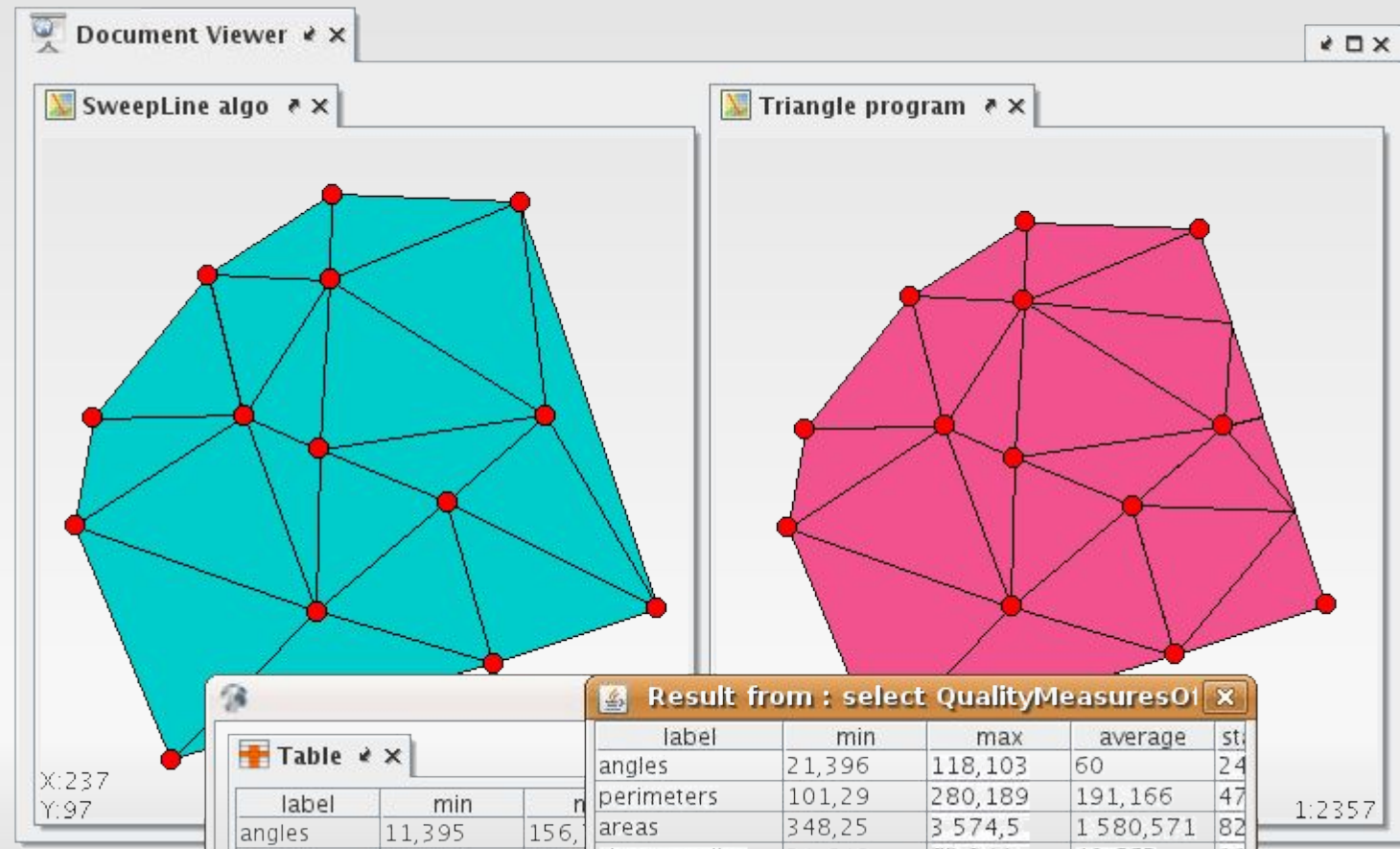
- in M. Davis TINBuilder implementation:



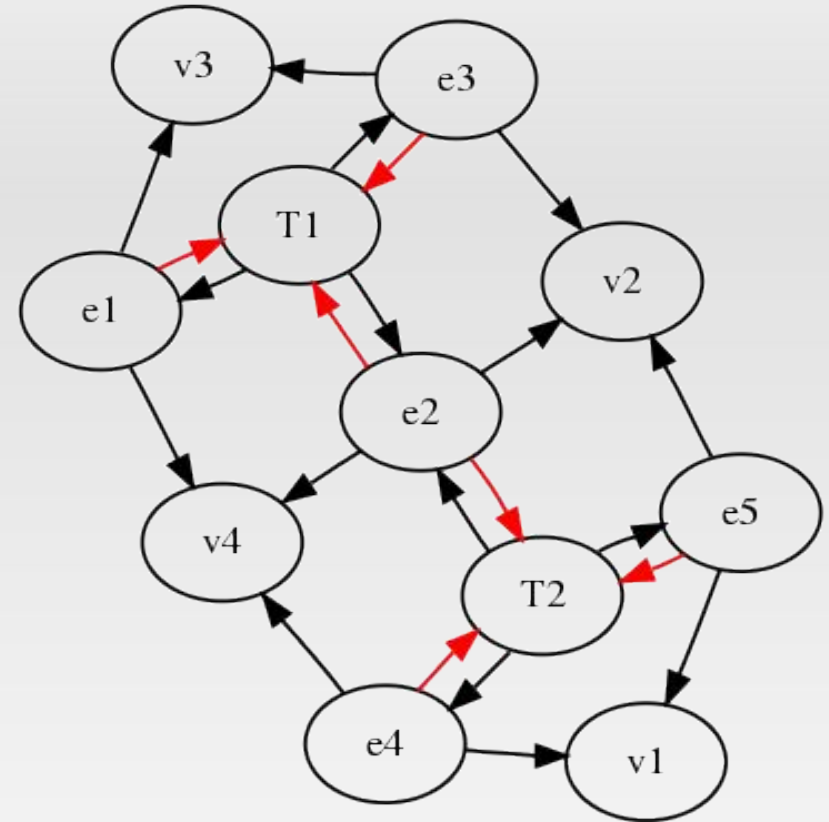
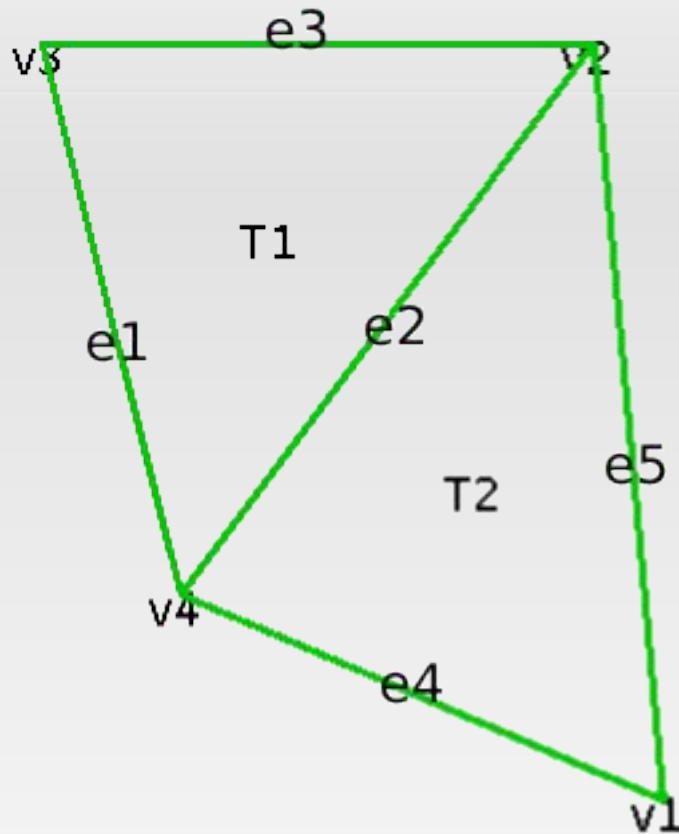
Need of refinement...



- The influence of the Delaunay refinement algorithm on the triangulation. Shewchuk's implementation introduces some *Steiner* points to obtain a greater min. angle:



From TIN to graph



- starting from a planar triangulation (each vertex embeds its own elevation) \Rightarrow topographical network structure

Future works



- Delaunay Triangulation refinement,
- CAM implementation,
- Multi-scale sensitivity of the model...
- And, of course, the CAM to obtain the runoff accumulation!

**To learn some more &
try it by yourself...**



**... a FOSS scientific GIS platform developed
by a French research institute:**

<http://orbisgis.cerma.archi.fr/>

... and hosted by a French academic forge:

<http://sourcesup.cru.fr/projects/orbisgis>