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Topography-based surface water modeling in Julia, with infiltration and temporal developments

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DOI: 10.xxxxxx/draft

Software

- Review
- Repository
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Submitted: 01 January 1970
Published: unpublished

Summary

Describe high-level functionality and purpose of the software, for a diverse, *non-specialist* audience.

Similar to an abstract.

Statement of need

Clearly illustrates the research purpose of the software and places it in the context of related work.

- flooding, both in the sense of urban flash floods and large-area flooding is becoming increasingly common due to climate change.
- Planning in a way that mitigates against flooding requires holistic thinking, as it cannot be done efficiently at the site level. Easy to use tools that can do analysis on a wide geographical scale is important to facilitate collaboration between stakeholders.
- open source alternative
- topography-based modeling is typically static, and doesn't take infiltration or temporal developments into account. On the other hand, PDE-based modeling is very computationally heavy. We here propose a solution that is based on topography (and remains computaionally lightweight), while having a certain ability to model temporal developments.
- A model of infiltration is important when analysing/designing countermeasures

Functionality

- Static analysis including delineating hierarchies of traps (lakes) and intermittent rivers, identify watersheds, estimate flow intensities
- Terrain characteristics and infrastructure (buildings, sinks, rivers/waterbodies)
- Infiltration
- Time-series (infiltration, weather evolution)

All input data is based on raster grids (topography, stencils, weather)

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Principle of topography-based analysis

Spill regions and flow graph

While the input data is based on raster grids, these are converted internally to directed graphs, which are the basis for analysis.

Grid cells become nodes, and directed edges are identified using the 4-point or 8-point stencil (reference).

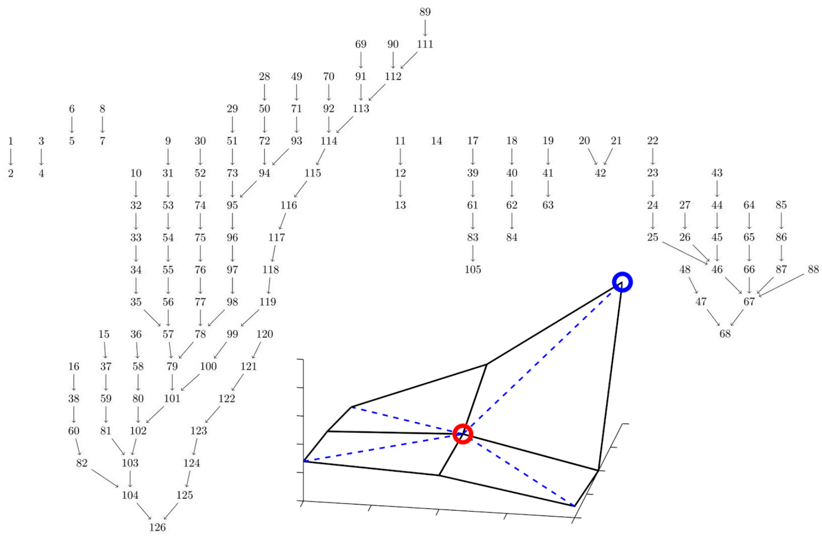

Figure 1: Upnode

Properties that can be deduced from graph analysis: - connected components represent watersheds - the root of each tree represents either the bottom of a trap, or the domain boundary - flow paths are traced by following the graph - flow intensities at a given node can be computed by integrating upstream nodes, multiplied with precipitation intensities above these node This is the upnode.

Topological structure of lakes and rivers

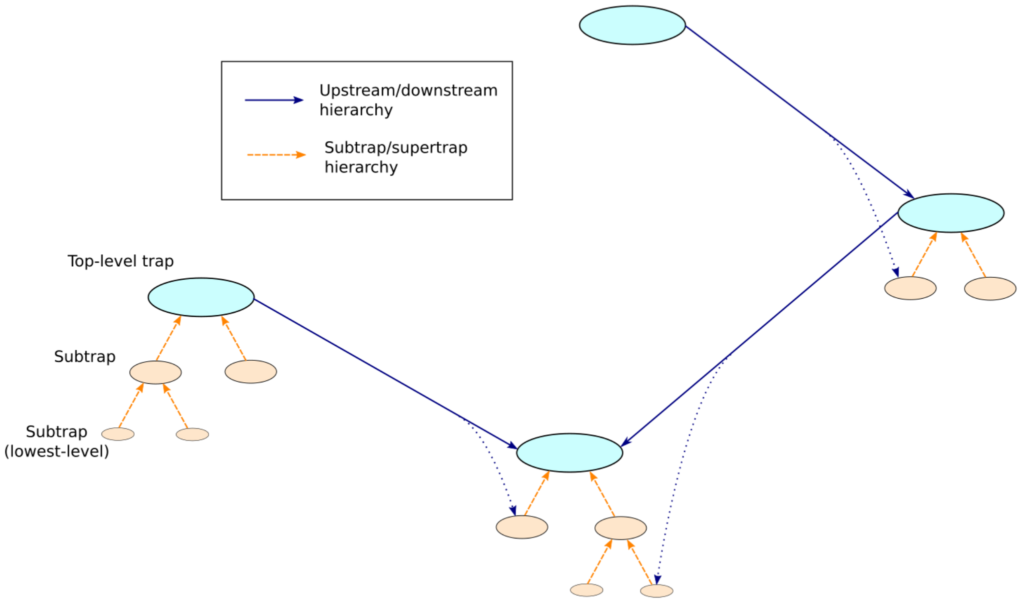

Figure 2: Trap structure

This is a trap structure.

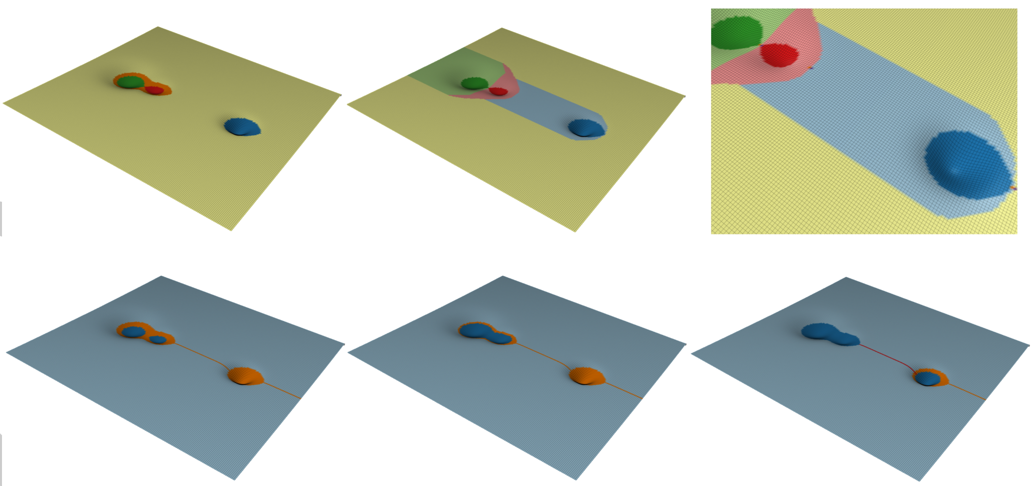

Figure 3: Matrix

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Example

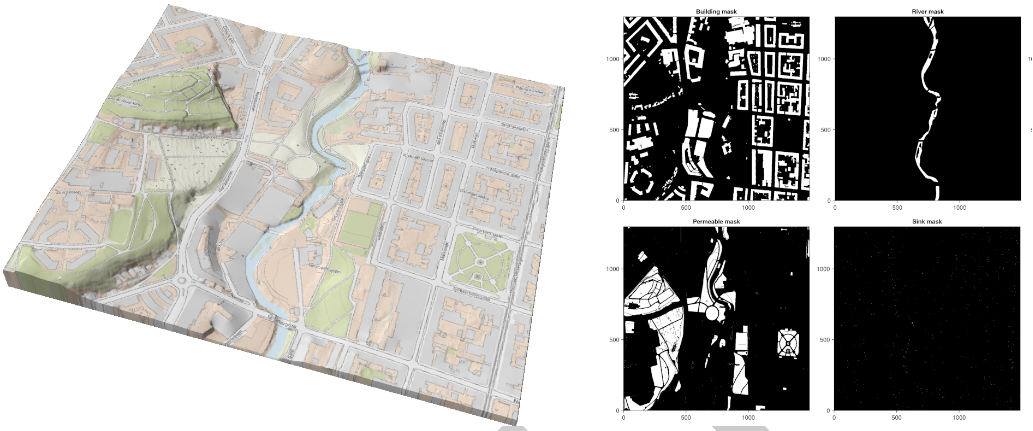

Figure 4: Vulkan area, central Oslo.

This can be referenced using Figure 4.

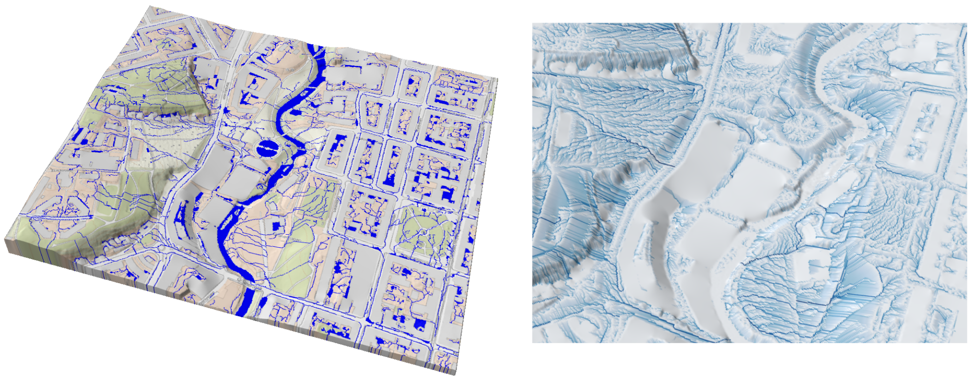

Figure 5: Vulkan analysis

Acknowledgments

- Kartverket Pearson et al. (2017) test

Mention (if applicable) a representative set of past or ongoing research projects using the software and recent scholarly publications enabled by it. - SWIM/SWAMP - SurbArea

References

- Bok om hydrological modeling
- Some paper explaining the 4 and 8 stencils
- The NVE hydrological tool
- SWMM
- MikeSHE
- Scalgo

List of key references

Pearson, S., Price-Whelan, A. M., & Johnston, K. V. (2017). Gaps in Globular Cluster Streams: Pal 5 and the Galactic Bar. *ArXiv e-Prints*. http://adsabs.harvard.edu/abs/2017arXiv170304627P