Advancing runoff flood risk mapping: Spatialized peak flows along concentrated flow paths in Wallonia (HYDRAXES)

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Wallonie service public SPW

Introduction

Accurately representing water flows at a regional scale is essential for hydrological assessments, particularly in the context of extreme weather events such as floods. The increasing frequency of high-intensity rainfall events, driven by climate change, poses a growing threat to both human settlements and agricultural lands [1]. The devastating floods of 2021 in Wallonia and neighboring regions highlighted the urgent need for improved runoff flood risk assessment. In response, the Walloon Public Service (SPW) has launched the HYDRAXES project (in collaboration with UCLouvain).

Research Objectives

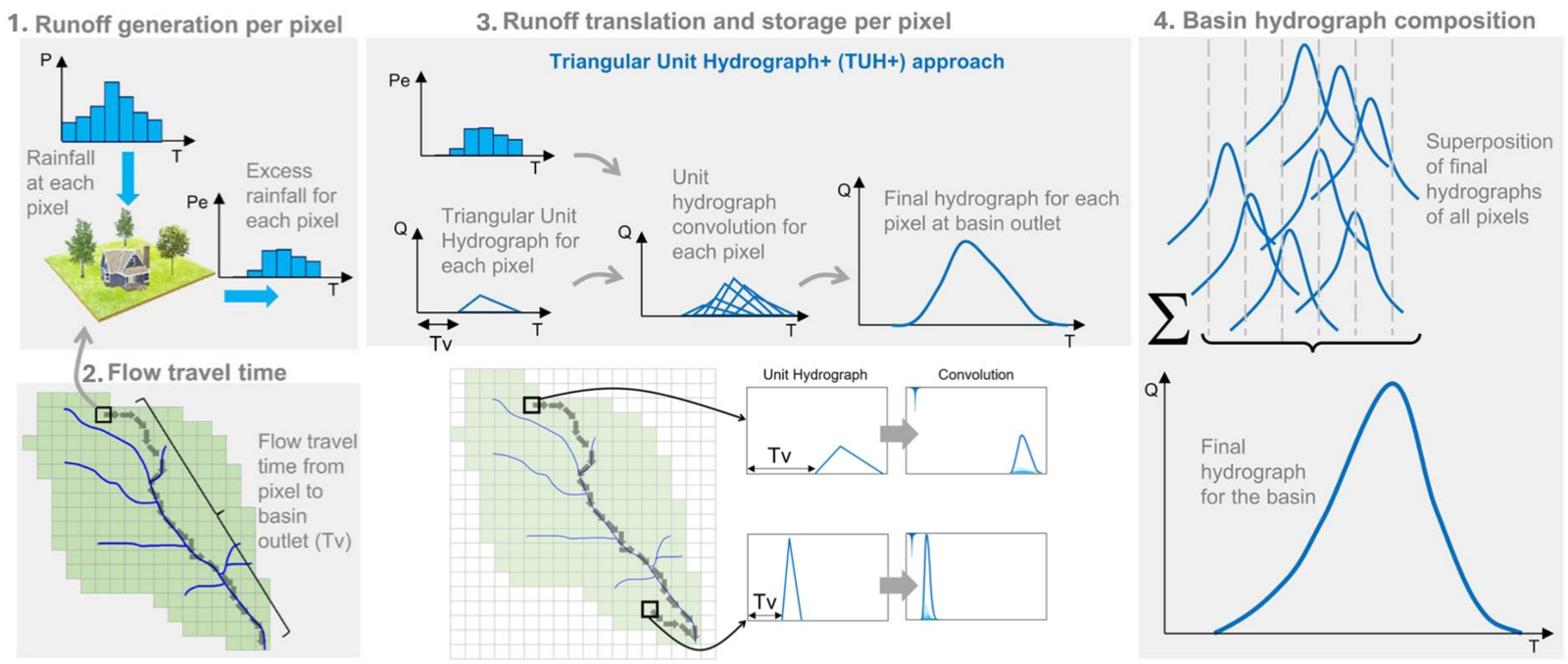
1. Improving the methodology for calculating the risk of flooding by runoff along concentrated flow paths.
2. Improve the accuracy of estimates of runoff volumes and travel times, which determine peak flows.

Method configuration

❖ Old method: NRCS-TUH [2]

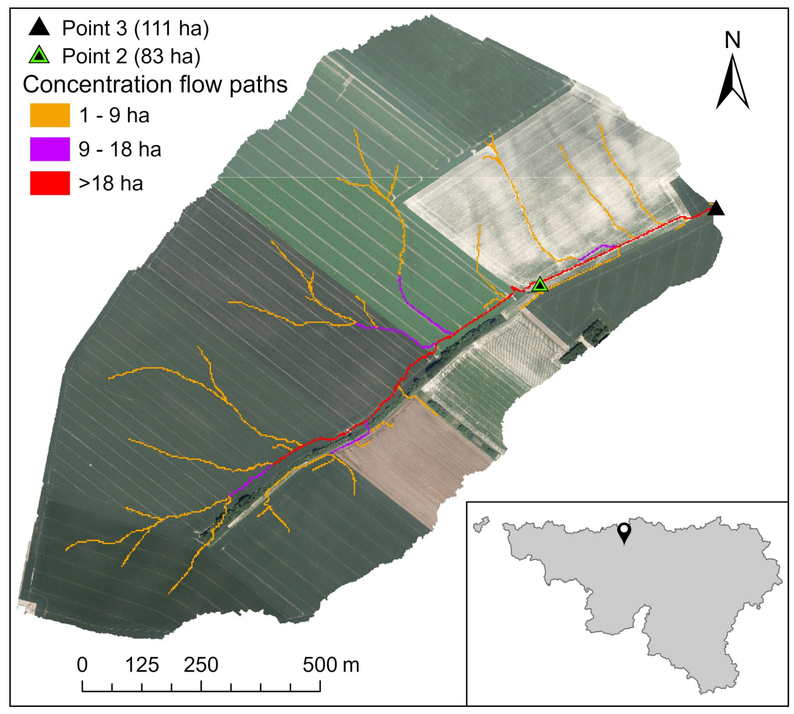
- SCS method (Runoff volume) & triangular unit hydrograph (Runoff transfer)
- Calculation of peak flow at outlet
- Redistribution of peak flow in proportion to flow accumulation

❖ New approach: Distributed hydrological model – HIDROPIXEL [3]



Validation Area

Experimental gauged catchment at Chastre



09/01/2022

Rainfall: 14.1 mm

Rain duration: 590 min

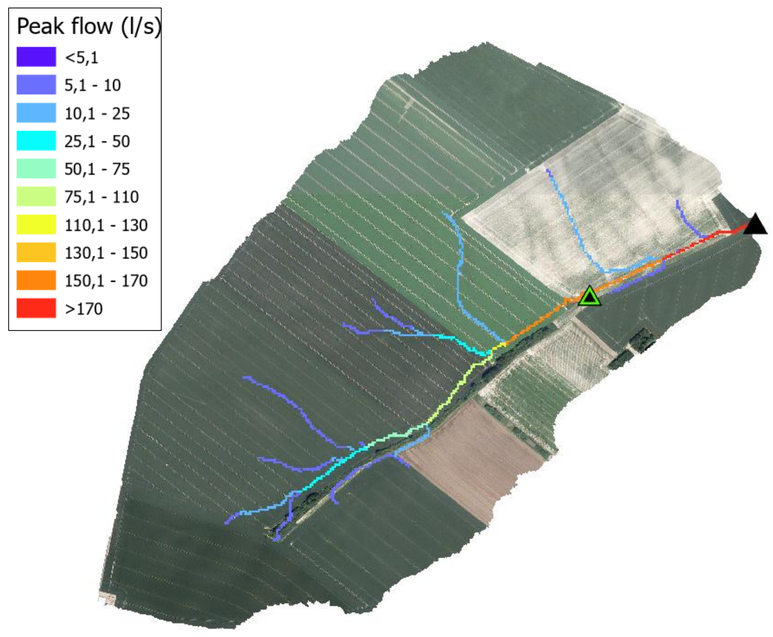
Results

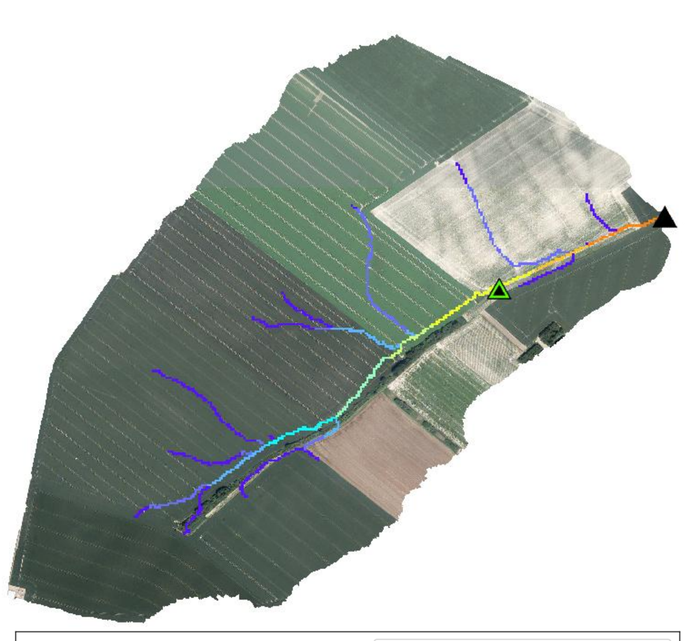
1 Spatial Validation of Peak Flow Estimations

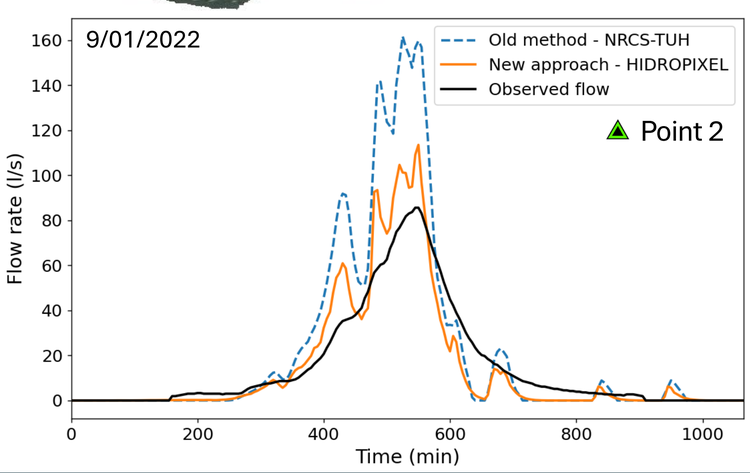
➢ Of the 27 rain events tested, HIDROPIXEL performed better in 75 % of cases.

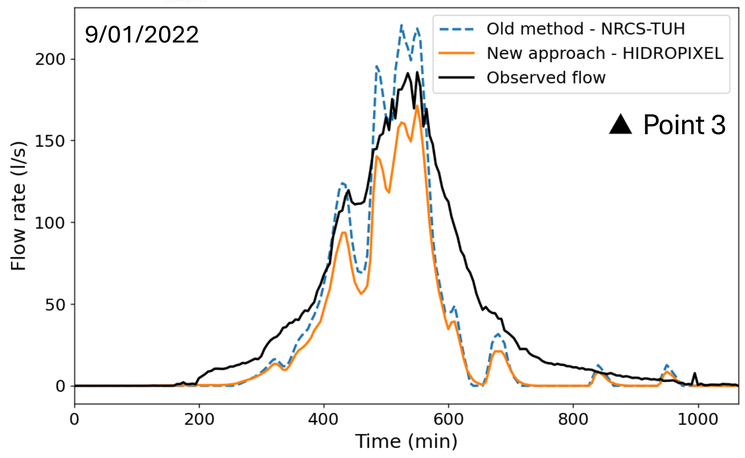
❖ NRCS – TUH

❖ HIDROPIXEL

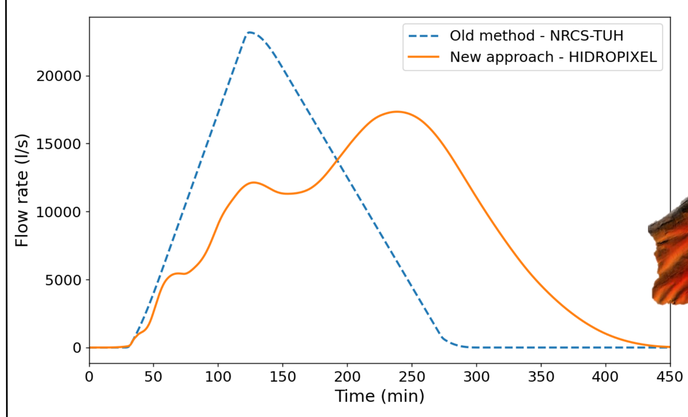




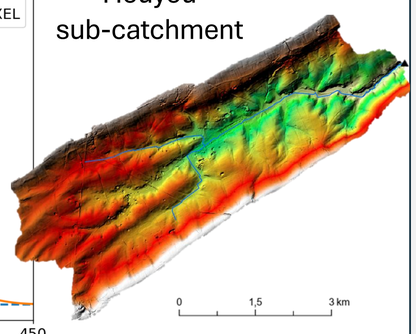


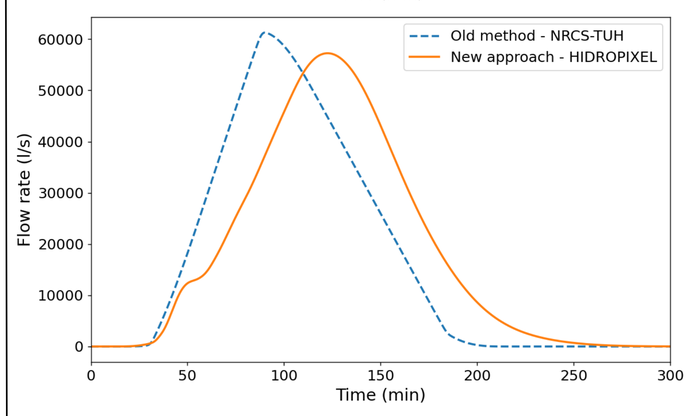


2 Assessing the Potential of HIDROPIXEL for Runoff Transfer Modelling

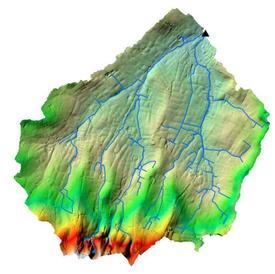


Houyou sub-catchment





Scheldt sub-catchment



- HIDROPIXEL incorporates the **spatial heterogeneity** of the catchment—including variations in land use, soil type, and topography—to more accurately model and transfer runoff.
- HIDROPIXEL's hydrographic curve better reflects the morphological characteristics of the catchment area (e.g. the density of the hydrographic network).

Conclusion & Outlook

- **Conclusion**: HIDROPIXEL is a simple but powerful spatial distribution method that shows potential for accurately simulating runoff transfer in catchments.
- **Outlooks:**
  - Integrate runoff obstacles in the modelling (hedges, fascines, ditches, etc.).
  - Reduce the calculation time of the method.

[1] Panagos, P., Ballabio, C., Meusburger, K., Spinoni, J., Alewell, C., & Borrelli, P. (2017). Towards estimates of future rainfall erosivity in Europe based on REDES and WorldClim datasets. *Journal of Hydrology*, *548*, 251-262.

[2] USDA-NRCS. (2010). Part 630 Hydrology National Engineering Handbook. *USDA-NRCS (United States Department of Agriculture-Natural Resources Conservation Service), (Chapter 15) Time of Concentration*.

[3] Lima, D. M., da Paz, A. R., Xuan, Y., & Piccilli, D. G. A. (2024). Incorporating spatial variability in surface runoff modeling with new DEM-based distributed approaches. *Computational Geosciences*.