Quantification of Discharges and Mapping of Surface Runoff in the Jura

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Context
- Surface runoff caused significant damage in the Jura and Jura-Bernois during the summer of 2021.
- The surface runoffs were generated by storms occurring on already saturated soils.
- The frequency of such non-fluvial flood events is predicted to increase due to climate change.
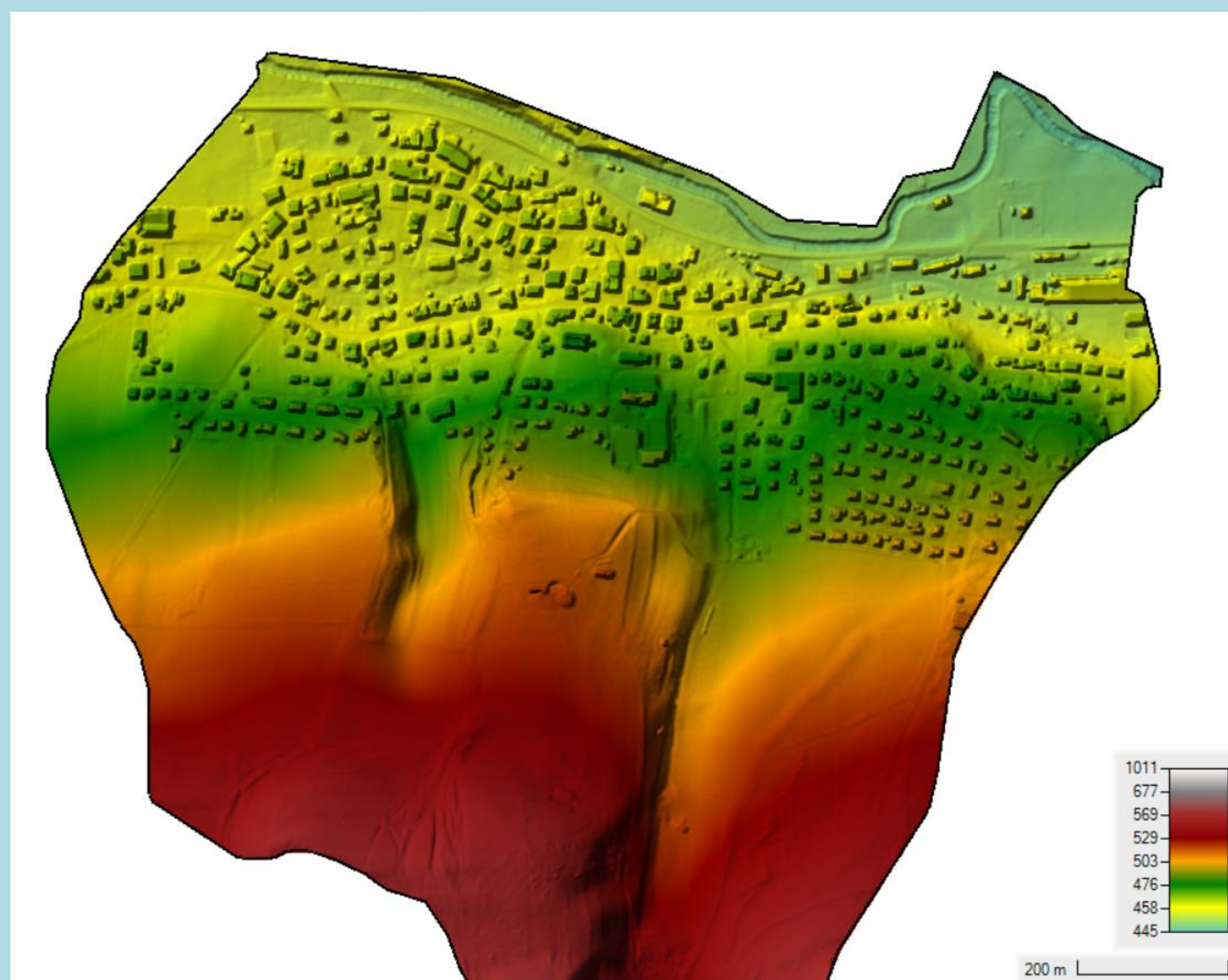
Objectives
Develop simulations of the runoff in each watershed using two software (HEC-RAS and PC SWMM).

Case studies
- Courfaivre (JU) → 10/07/2021, La Combatte and La Combe watersheds.
- Corgémont (BE) → 22/06/2021, North watershed.

Methodology

1. Topography and buildings

Fig. 1: Topographic data obtained from Surface3d (from the Federal Office of Topography). Terrain points and building points are merged into a unified Digital Terrain Model (DTM)

HEC-RAS uses the building block method to incorporates buildings, elevating blocks from ground level to rooftop height. PC SWMM uses the building hole method, representing buildings as holes in the computational grid.

Rainfall spatial variability is significant during storms, so the rainfall data is increased accordingly compared to the data recorded in the station.

2. Precipitation
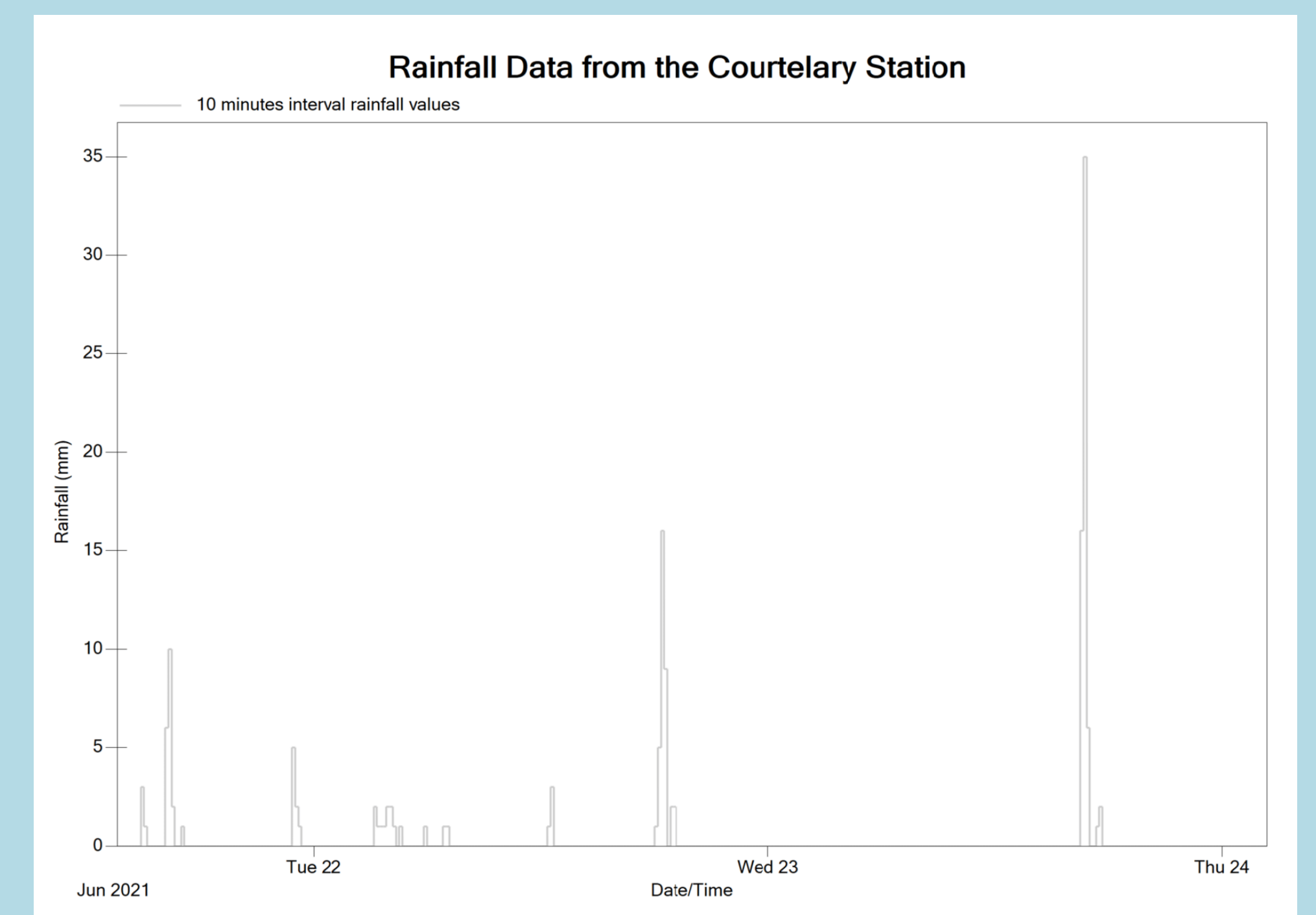
Fig. 2: Precipitation data is sourced from nearby MeteoSuisse station.

3. Infiltration
The SCS (Soil Conservation Service) method is used to parameterize infiltration. Each sub-catchment is assigned a curve number based on soil and land cover data. A higher curve number represents a surface that generates more runoff.

4. Soil data
The acquisition of soil data, particularly pertaining to the designated areas, presents inherent difficulties and is not readily accessible. The availability of pertinent data obtained from the Federal Office for the Environment (FOEN) remains limited.
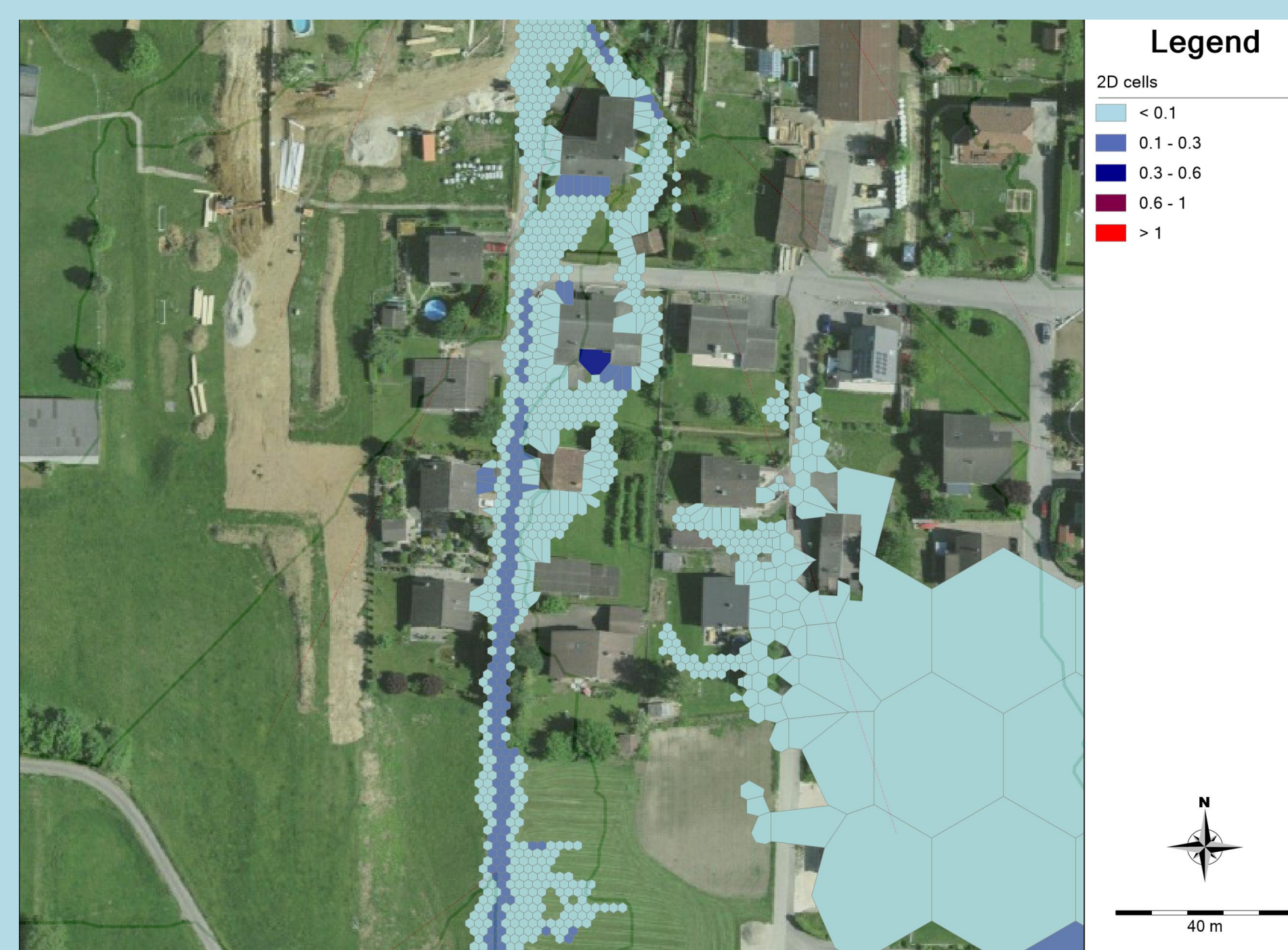
5. Land cover and roughness data
Data comes from the local cadastral information for Corgémont, and a combination of Corine Satellite land cover data and Jura zoning information is used for Courfaivre
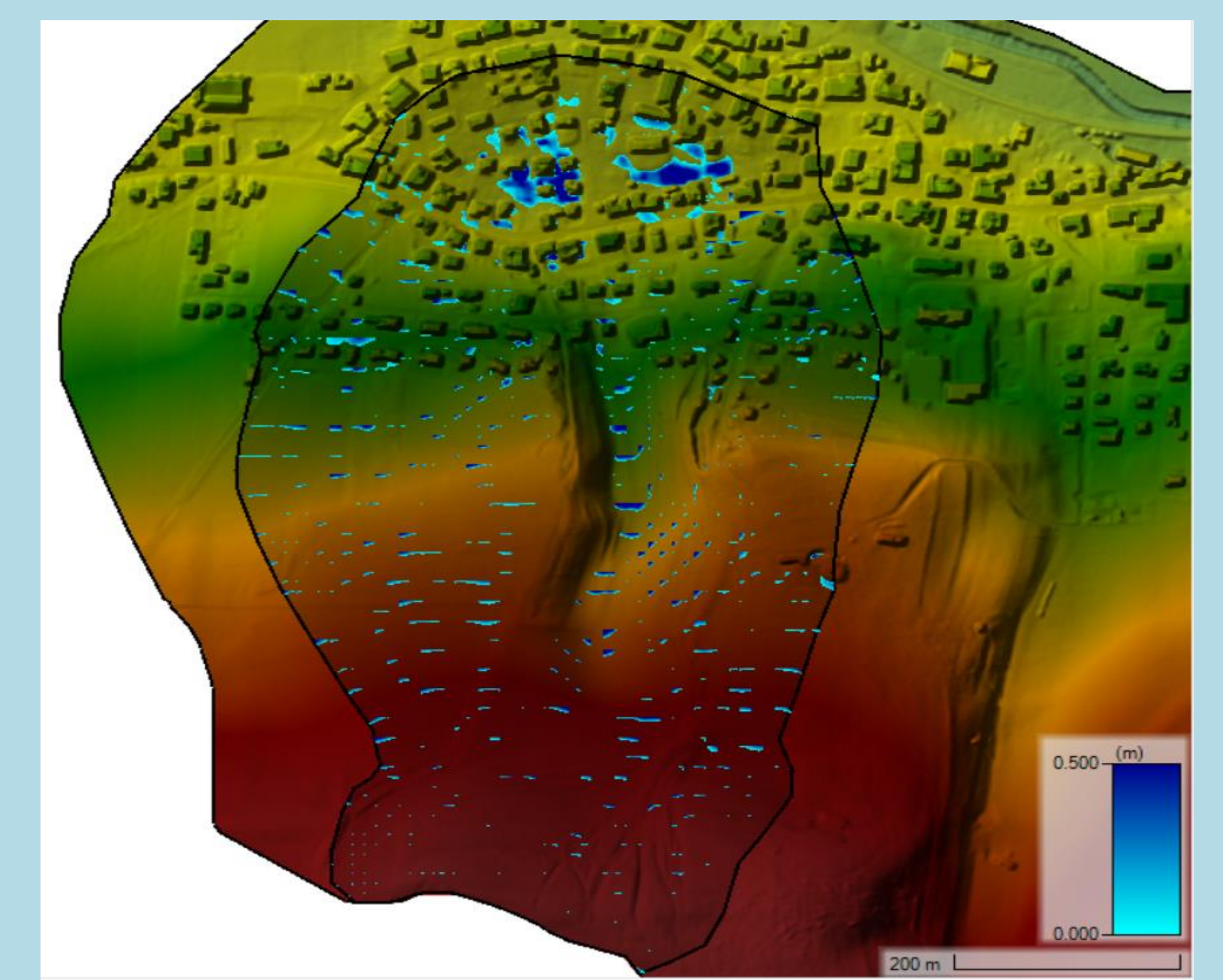
Results
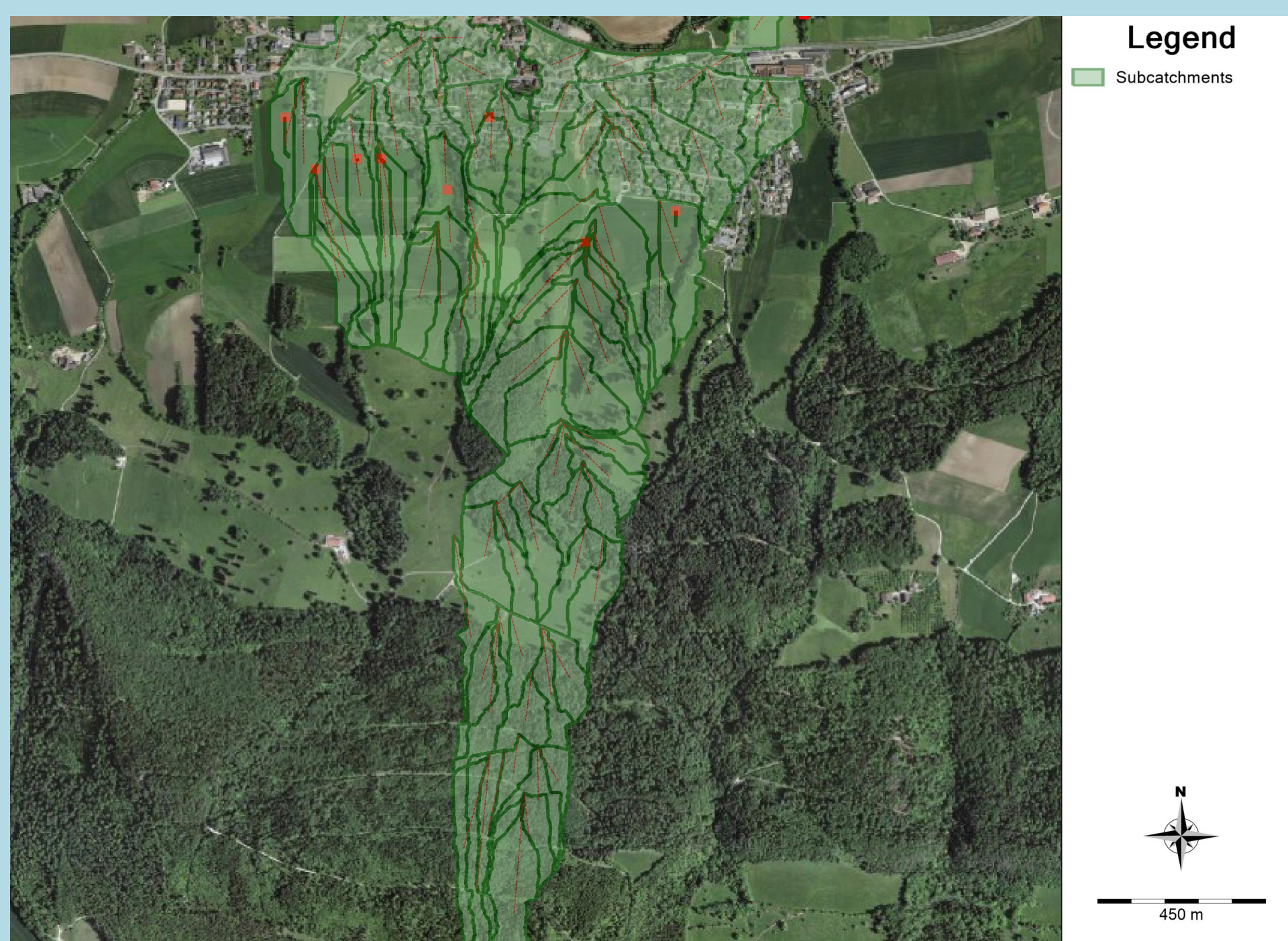
Fig.3: PC SWMM subcatchments of the La Combe catchment for Courfaivre.

Fig.4: Close up of the PC SWMM simulation for Courfaivre (La Combe) showing maximum water height (m)

Fig.5: HEC-RAS 2D simulation for Courfaivre (La Combatte) showing maximum water height (m)

Validation method
Two methods are used to evaluate simulation accuracy:
1) Comparing the model with observed runoff data from summer 2021 to assess realism qualitatively.
2) Comparing model-estimated discharge with hazard maps. Adjustments are made if the discharge significantly exceeds hazard map estimations

Discussion
- PC-SWMM is found to be more user-friendly compared to HEC-RAS 2D.
- Field data is crucial for accurate surface runoff modelling, especially considering the impact of small fences/walls.
- The SCS method shows promise for parameterizing infiltration, but further analysis and comparison with alternative methods are needed.

Conclusion
The simulations of the events are mostly satisfying, and sensitive areas can be identified. However, field data is essential to further improve the simulation and enhance the correspondence of the model with the actual site. In order to obtain better water height values and accurately scale the runoff, soil data should be more effectively incorporated to enhance infiltration parameterization.