Mapping surface flow pathways in urban areas using UAV-based thermal imaging in combination with flooding experiments

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A) Introduction

In recent years, heavy rainfall events and flash floods lead to widespread damage to public and private infrastructures in Germany. During extreme rainfall events technical measures are often overloaded or misdesigned, so that emergency runoff pathways can be designated as an element of water-sensitive urban development.

GOAL: Our goal is to develop a workflow to improve **high-resolution digital mapping of surface flow pathways** in urban areas using **UAV-based thermal imaging in combination with flooding experiments**.

B) Problem & Study Concept

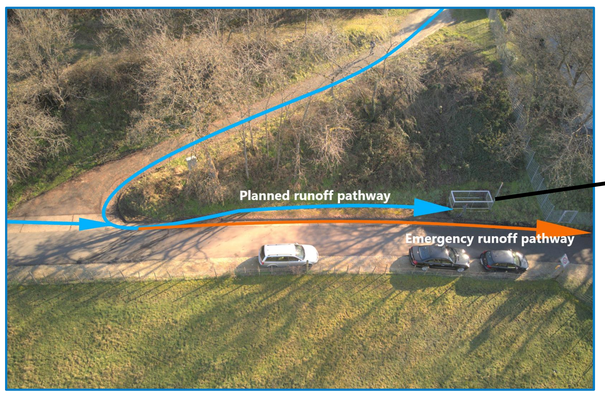

Fig. 1: Drone photo of a dysfunctional drainage section within Trier-Filsch.

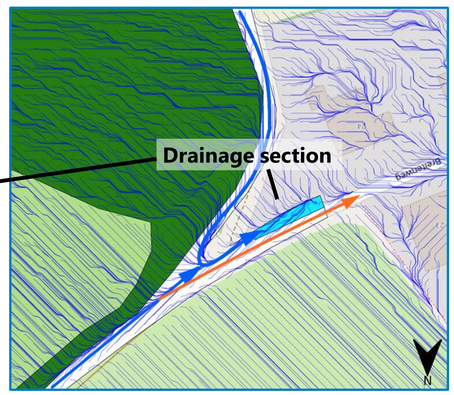

Fig. 2: Surface runoff pathways, calculated in GIS - based on a 1x1m digital elevation model (DEM).

- Surface runoff flows through infrastructure → emergency flow pathway along road
- Runoff pathways are normally calculated with GIS → low spatial resolution DEM leads to inaccurate planning
- **Is it possible to map exact surface flow pathways using drone data without manually measuring?**

→ **Combining visual** (RGB) **and thermal** (infrared) **imaging** → high-resolution mapping of surface flow paths using infrared surface temperature

C) Result –Workflow for mapping flow paths with drone data

Step 1 Dysfunctional drainage sections

Step 2 Drone data (RGB images)

Step 3 3D Model & DEM

Step 4 Flooding experiment

Step 5 Drone data (thermal images)

Step 6 Extract flow path using thermal images

Step 7 Input flow path in DEM (Thalweg)

Step 8 Scale up to extreme discharges & water levels

Step 9 GIS dataset of flow pathways & flood-prone infrastructures

Fig. 3: Dysfunctional drainage section within Trier-Filsch.

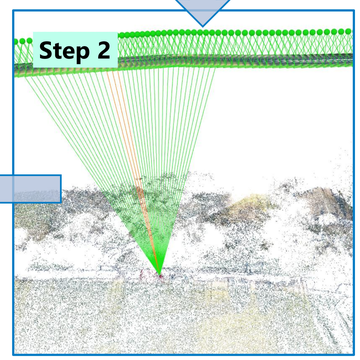

Fig. 4: Generating tie points for 3D-Model with Structure from Motion method.

Fig. 5: 3D-Model generated with Pix4D.

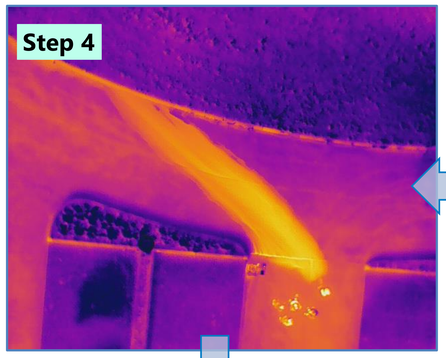

Fig. 6: Water is released as a thermal marker of the emerging surface flow pathways.

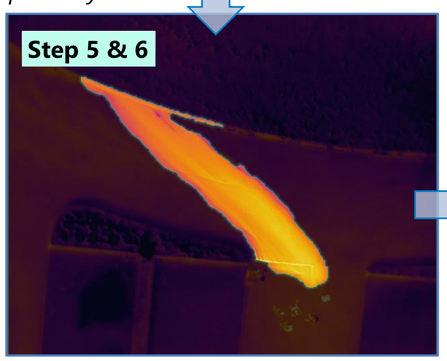

Fig. 7: Flow path extraction using infrared surface temperatures from thermal images.

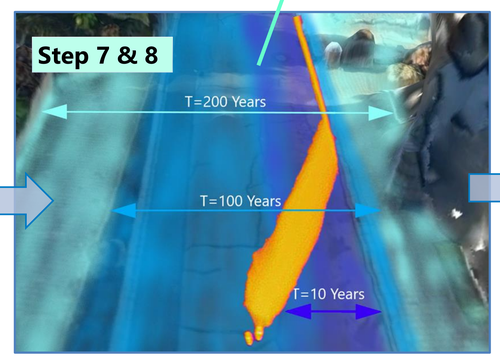

Fig. 8: The flow paths are scaled up in a DEM to potentially occurring water levels during extreme discharges.

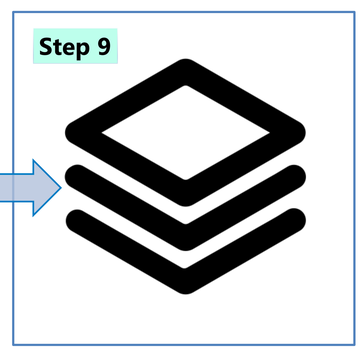

Fig. 9: High Res. GIS dataset of emergency flow pathways for flood-prone objects based on extreme discharge probability.

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Federal Ministry of Education and Research

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