Are we overlooking the effect of pluvial floods? Revisiting 2015 Cockermouth flood

Dr Manoranjan Muthusamy

LinkedIn - manomuthus

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www.cranfield.ac.uk

Introduction

Background

- Flood events in England are estimated to cause damage losses to residential and non-residential properties of more than £1 billion pounds annually (2008 values) [1].
- Historically, more focus has been given to coastal and fluvial flooding in flood risk management and mitigation with a particular emphasis on river catchment and flood plain management [2,3].
- Restricted knowledge about the extent and impact of pluvial flooding have translated into uninformed and biased predictions of the spatiotemporal occurrence of flooding within urban environments [4,5]
  - Complexity of the flooding processes in urban areas and the associated difficulties of source identifications,
  - Need for high-resolution data, and
  - Different accountabilities and responsibilities compare to fluvial flooding

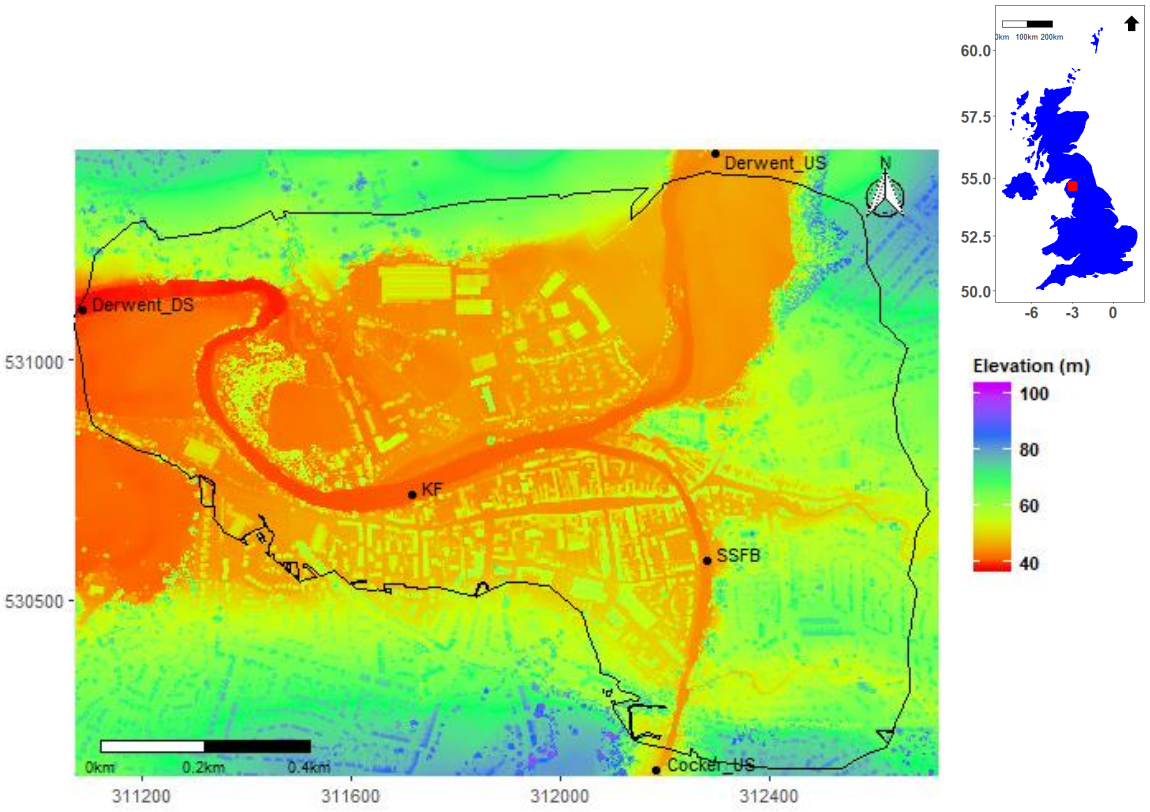
Introduction

Aim and objective

- To develop a comprehensive remote sensing based integrated methodology to quantify the impacts of both fluvial and pluvial flooding in a single event using remote sensing data
- Objectives
  - To model the spatial distribution of pluvial and fluvial flooding using a high-resolution DEM based 2D model for the study site of Cockermouth.
  - To compare the flood extent and damage for different land use types between pluvial and fluvial flooding.
  - To estimate the number of residential properties affected by pluvial and fluvial flooding separately using a combination of model results and UAS data collection

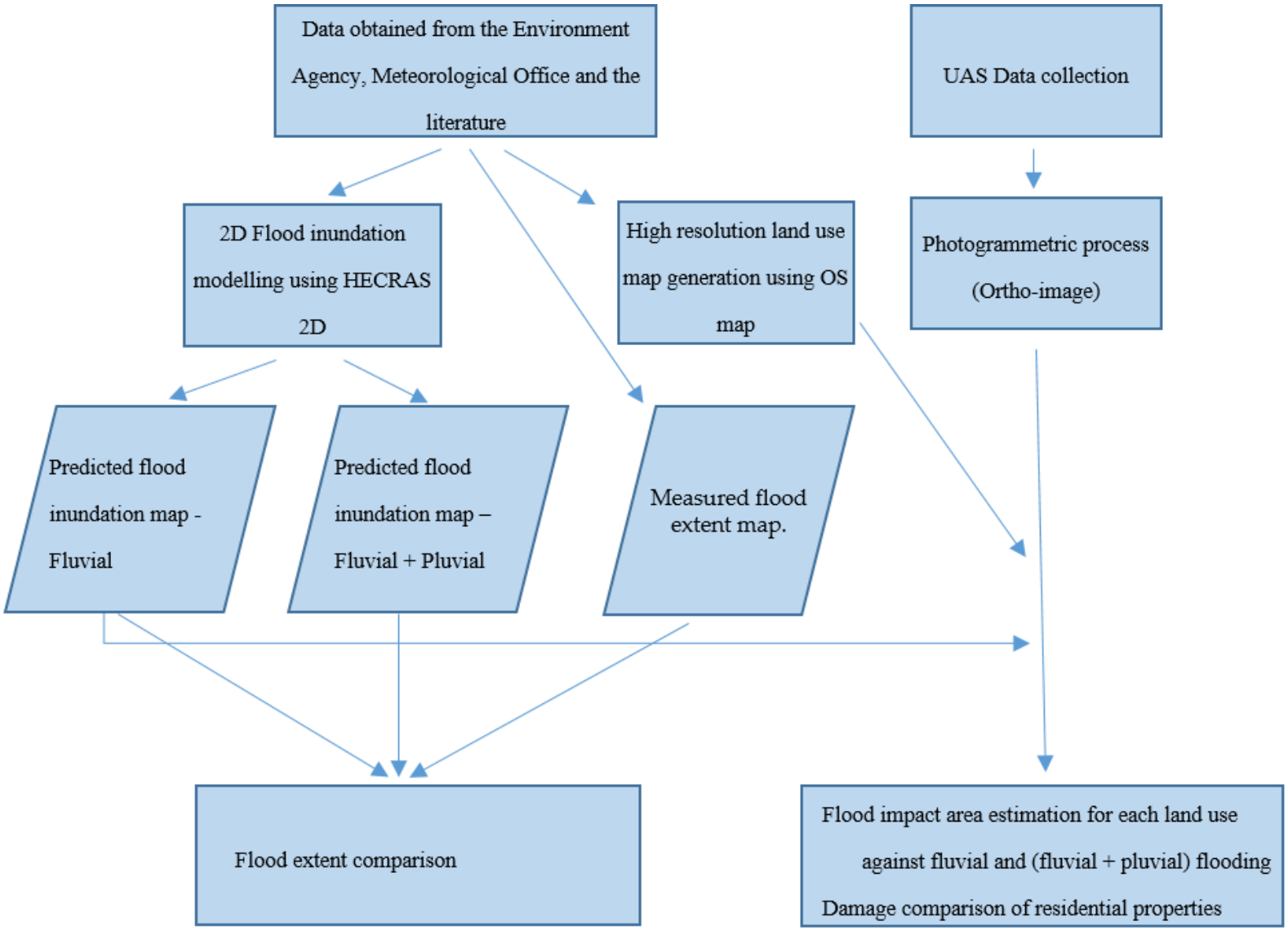
Methodology

Study site and selected event



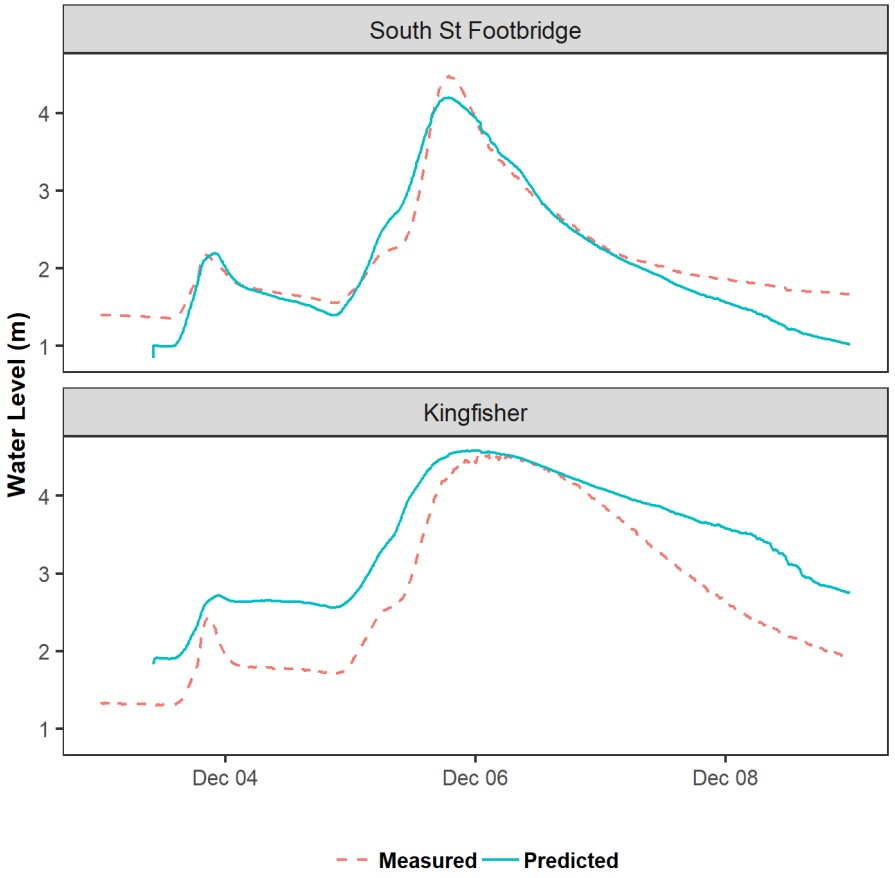
- Population ~ 8800 Households ~ 4000 (2011)
- Multiple floods in recent times : e.g. Three storms in Dec, 2015
- Storm Desmond
  - 5-6/12/2015
  - 300 mm of rain in 24 hrs
  - Damaged 466 properties

Methodology



Results

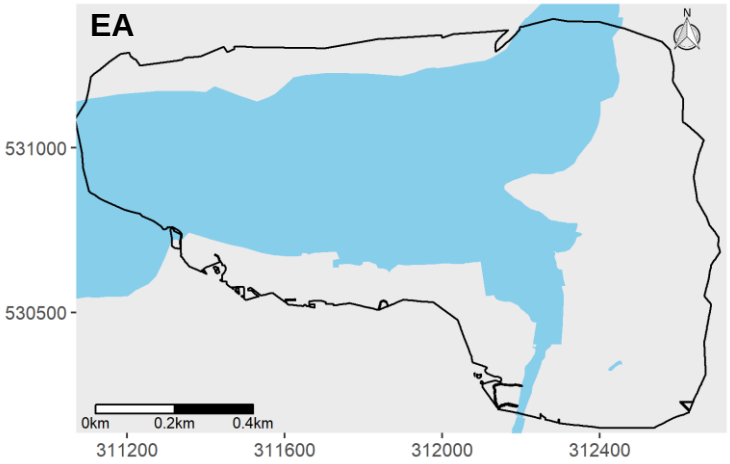
Calibration

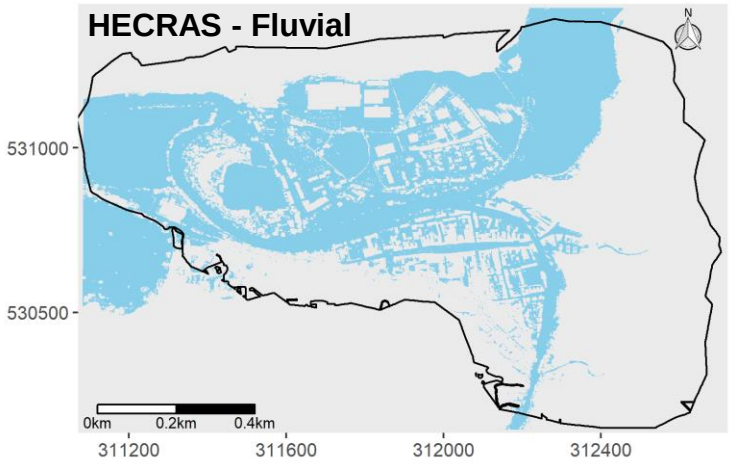


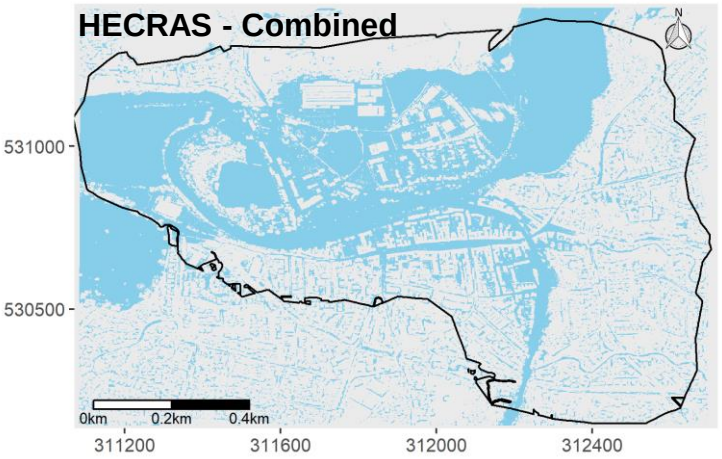
	SSFB	KF
RMSE (m)	0.28	0.69
Percentage error - peak flow	6%	1%

Results

Flood extend comparison

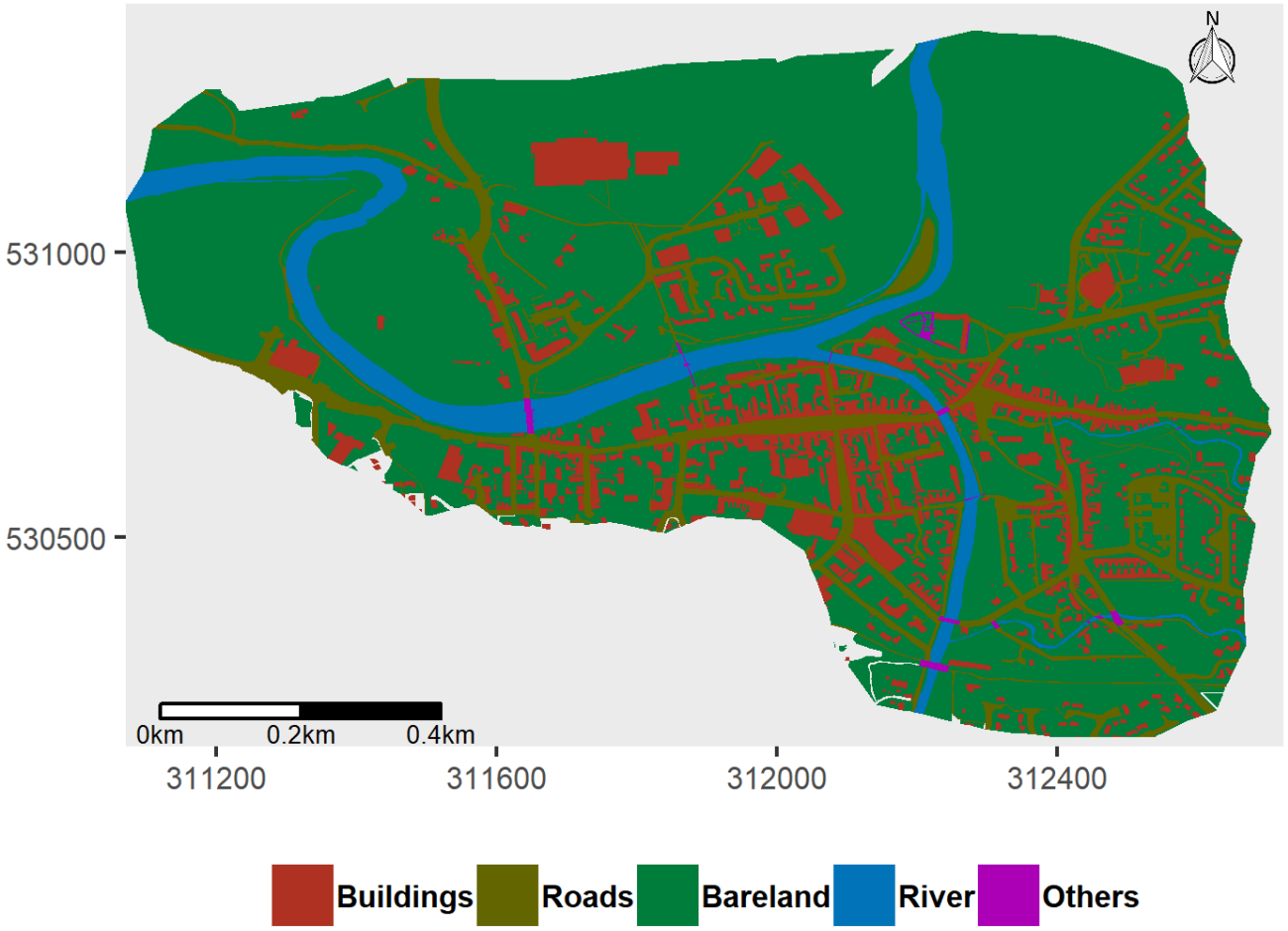






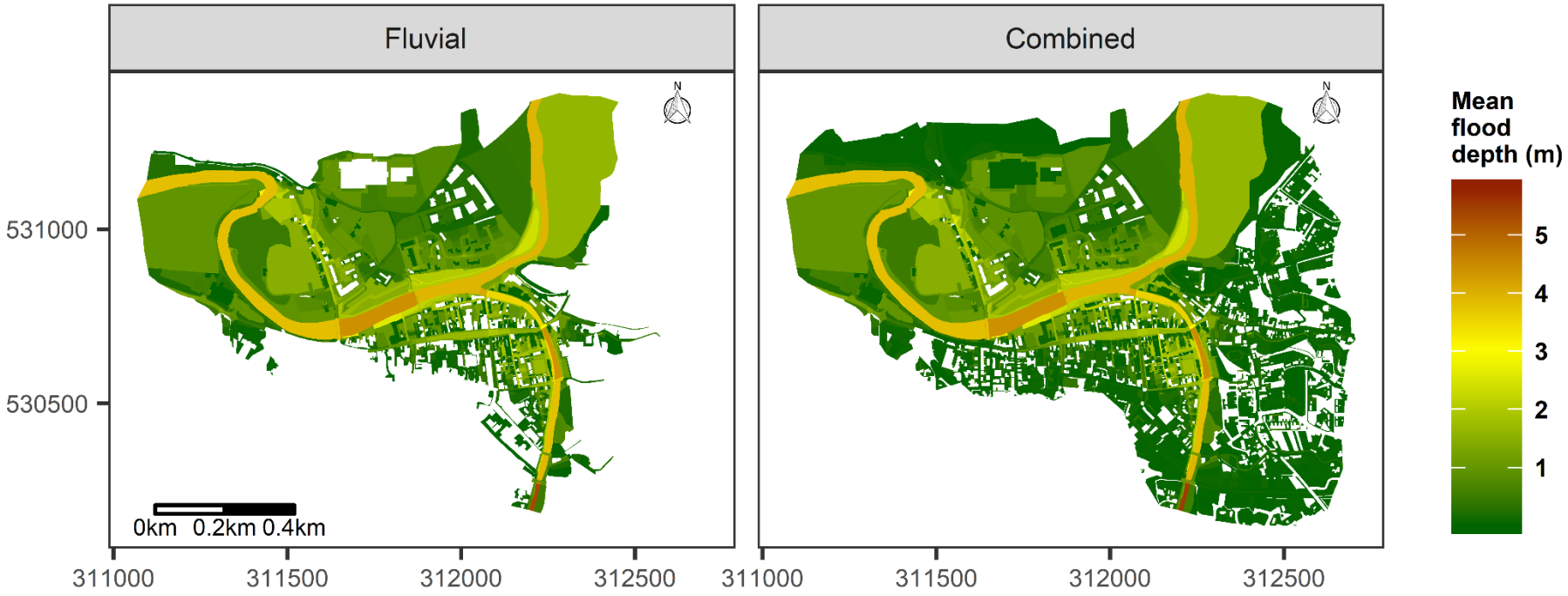
Results

Land use map



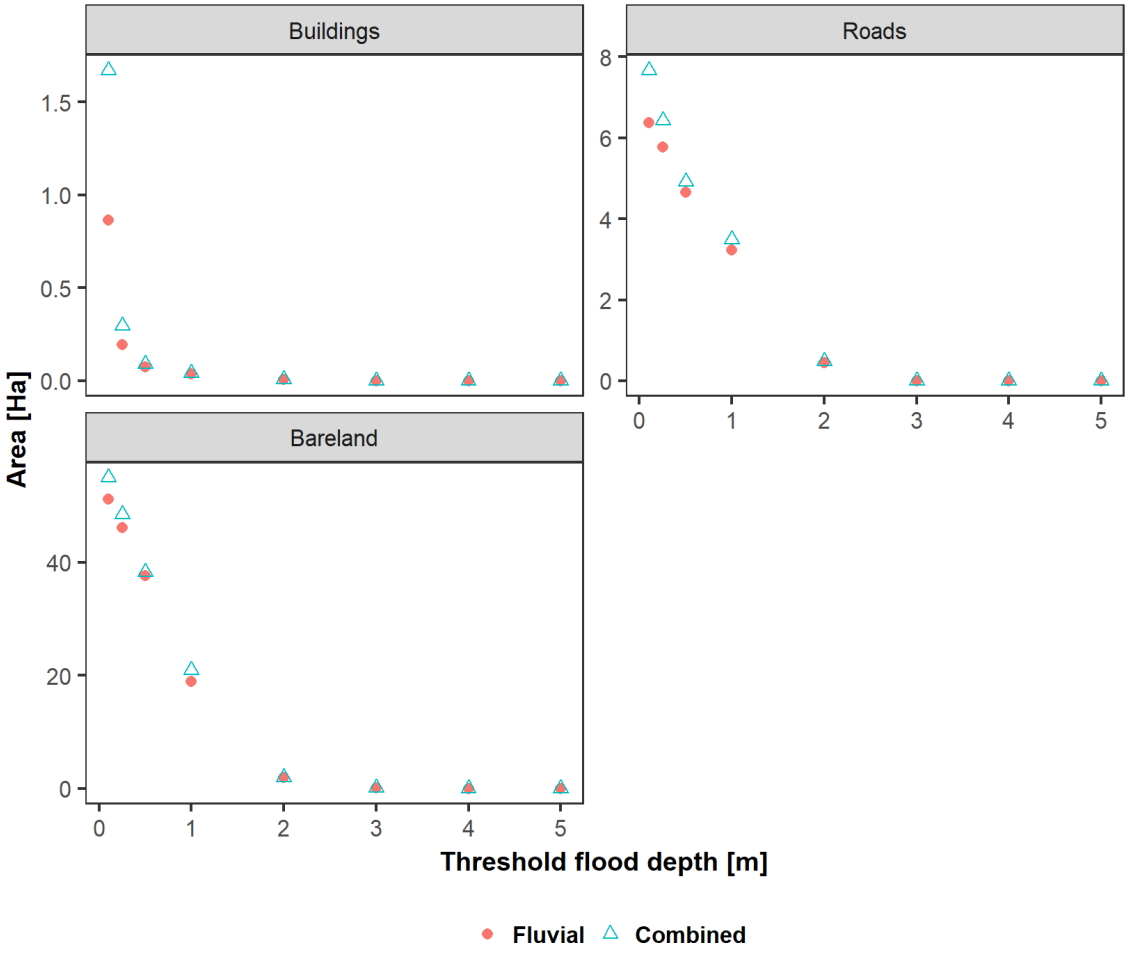
Results

Flood depth comparison



Results

Flood depth comparison



Results

Flood depth comparison

Contribution of pluvial flooding in total flood depth	Number of properties
0 (Fluvial flooding only)	16
(0%, 25%]	84
(25%, 50%]	41
(50%, 75%]	11
(75%, 100%)	10
100% (Pluvial flooding only)	51
Total	213

Discussion

- Very little information exists yet on the validation/accuracy of pluvial flooding predictions due to the difficulties in collecting data during and after events.
- Data from the Environment Agency included properties affected by flooding from all sources - no differentiation between fluvial and pluvial impacts.
- Through the use of UAS, it may be possible in future to calibrate pluvial flood extents including depth information more accurately.
- One of the main challenges - how best to represent the drainage network in the model?
  - Open drainage can be represented in a DEM but not the closed network
  - Possible to use models with 1D- 2D coupling

Conclusions

- Results show that the contribution of pluvial flooding should not be ignored even in a catchment where pluvial flooding is the major cause of the flood damages.

- Potential for improvement
  - Validating pluvial model predictions using UAS data,
  - Improving pluvial and fluvial model calibration using temporally collocated data derived from UASs and
  - Capturing temporal and spatial dynamics in the topography at a micro-topography level using UAS data.

- Such an improved remote sensing based methodology could readily be adapted at a reasonable cost to a new catchment, at least in countries where remote sensing data is freely available.

Reference

1. Environment Agency Flooding in England: A National assessment of flood risk. 2009, *36*.
2. Sterna, L. Pluvial flood damage modelling - Assessment of the flood damage model HOWAD-PREVENT, Delft University of Technology, 2012.
3. Houston, D.; Werritty, A.; Bassett, D. *Pluvial (rain-related) flooding in urban areas: the invisible hazard*; 2011;
4. Rivas Casado, M.; Irvine, T.; Johnson, S.; Palma, M.; Leinster, P. The Use of Unmanned Aerial Vehicles to Estimate Direct Tangible Losses to Residential Properties from Flood Events: A Case Study of Cockermouth Following the Desmond Storm. *Remote Sens.* 2018, *10*.
5. Douglas, I.; Garvin, S.; Lawson, N.; Richards, J.; Tippett, J.; White, I. Urban pluvial flooding: a qualitative case study of cause, effect and nonstructural mitigation. *J. Flood Risk Manag.* 2010, *3*, 112–125.

Thank you!

Questions?