Improving flood damage assessments by retrieving building characteristics through automated UAV image processing

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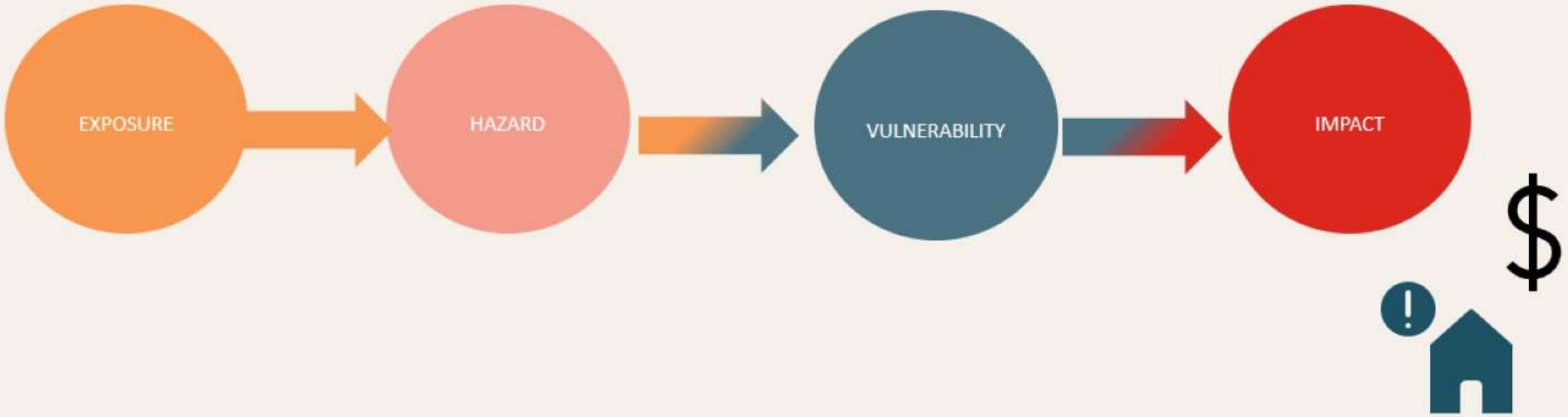
EXPOSURE
HAZARD
VULNERABILITY
IMPACT
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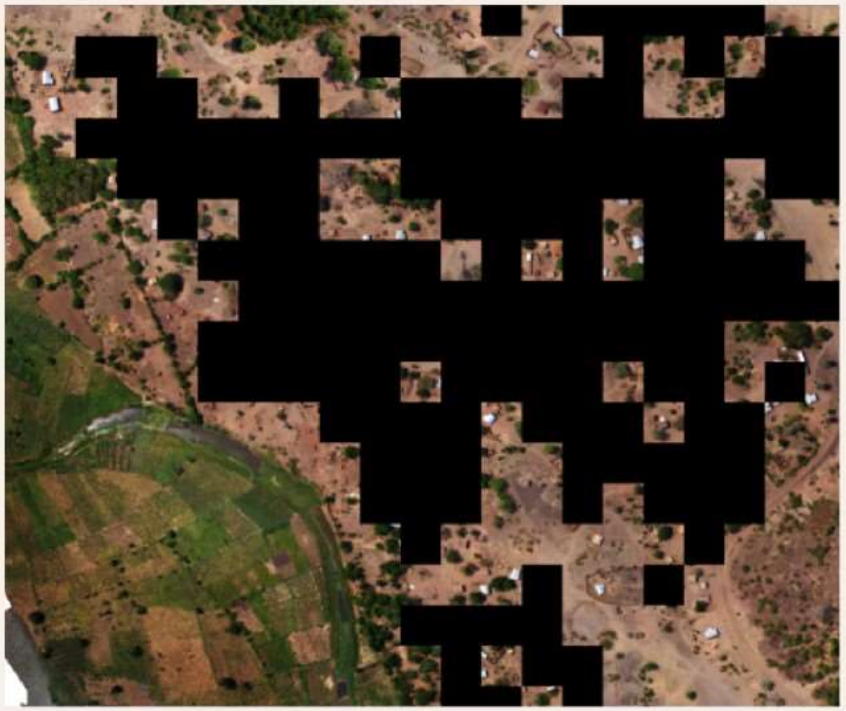
Chikwawa Disctrict in Southern Malawi
N
Legend
Case study
Chikwawa
0
12.5
25
50
Kilometers



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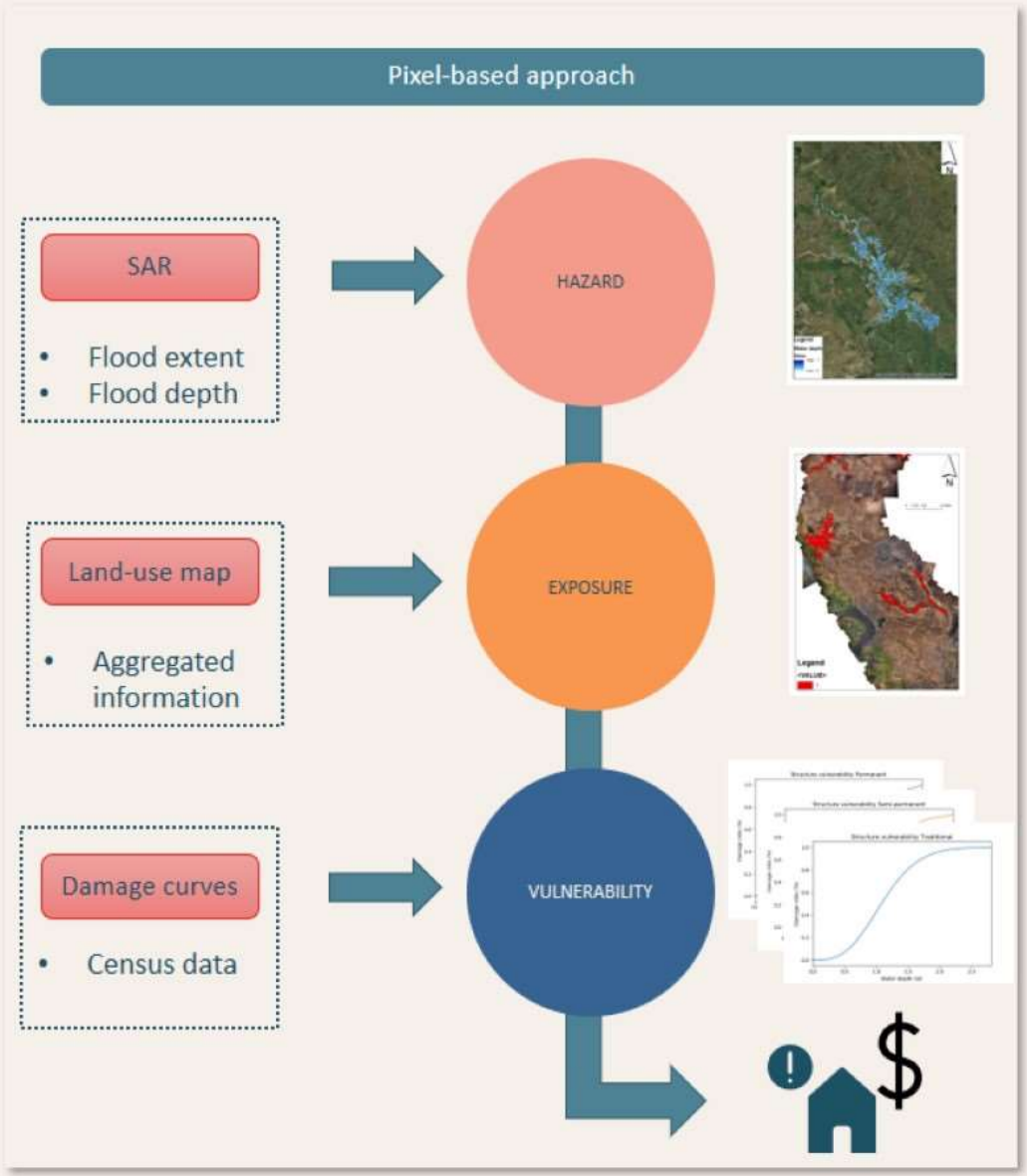
510 AN INITIATIVE OF THE NETHERLANDS RED CROSS

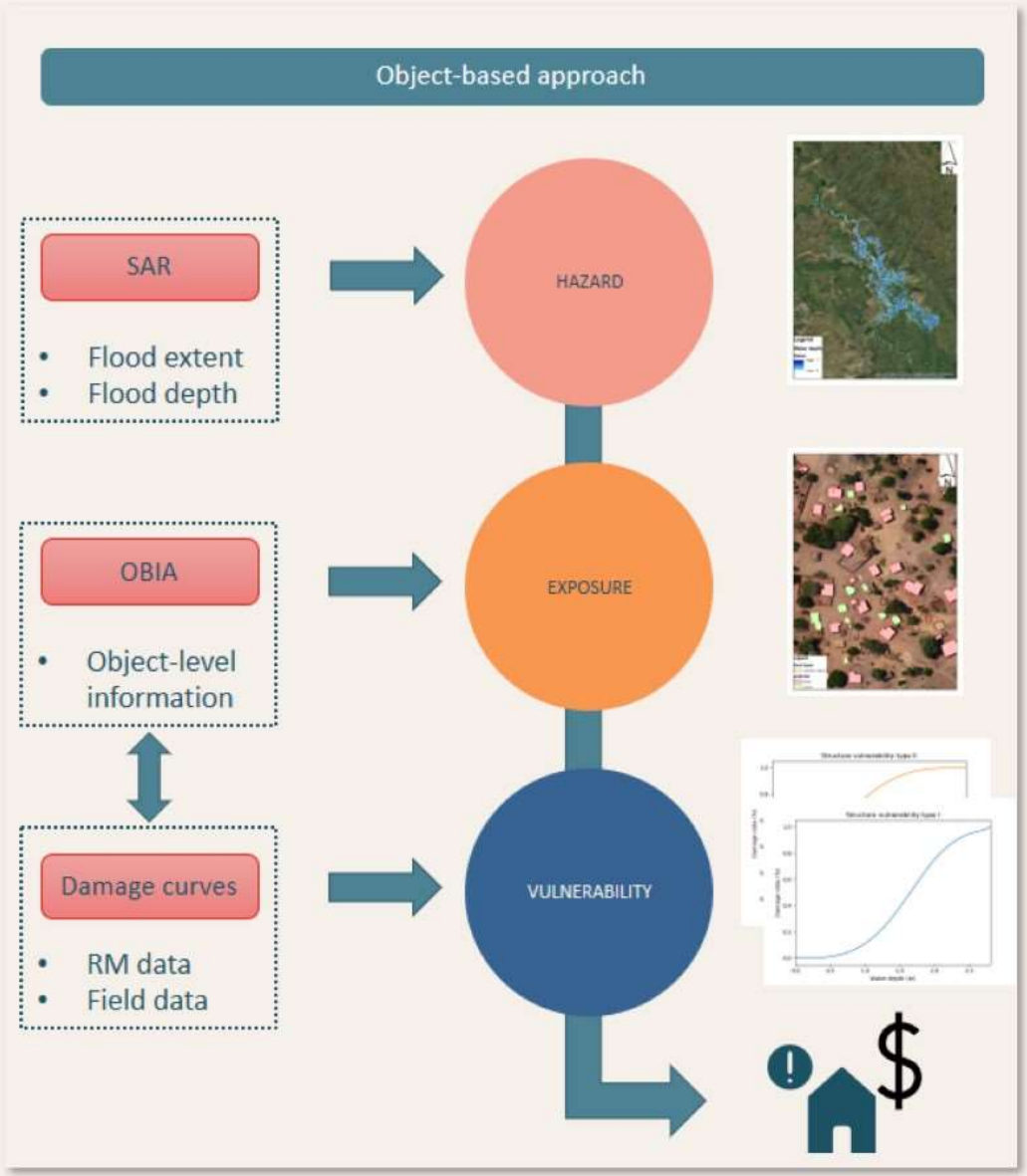
openstreetmap.org

MISSING MAPS

Objective: create flood damage model based on the of the automated image processing of UAV imagery

- Generate flood susceptibly information on object (building) level
- Compare flood damage with a land-use (pixel) model


Pixel-based approach
SAR
Flood extent
Flood depth
HAZARD
Land-use map
Aggregated information
EXPOSURE
Damage curves
Census data
VULNERABILITY


Object-based approach
SAR
Flood extent
Flood depth
HAZARD
OBIA
Object-level information
EXPOSURE
Damage curves
RM data
Field data
VULNERABILITY

Object-based Image Analysis

Segmentation
- Mean-shift

Classification
- Support Vector Machine
- Based on spectral properties and height

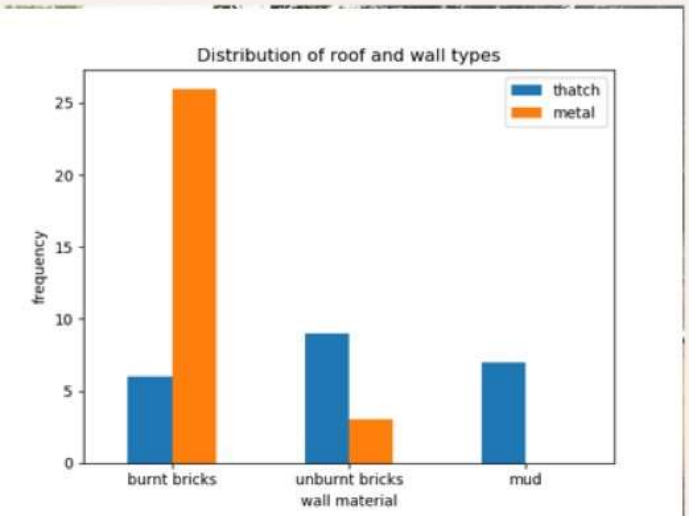
Orfeo-Toolbox

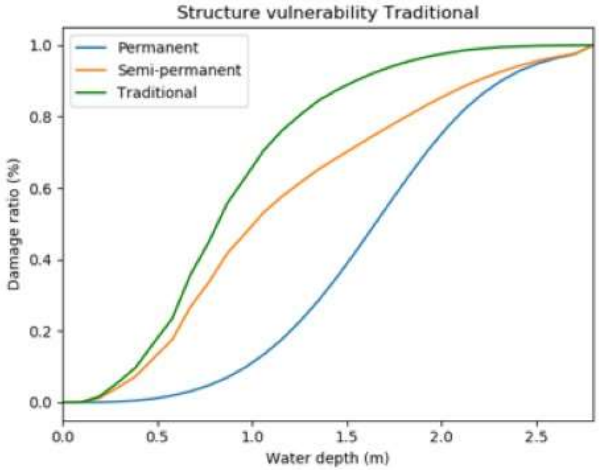
Drone imagery collected by the Netherlands Red Cross/510

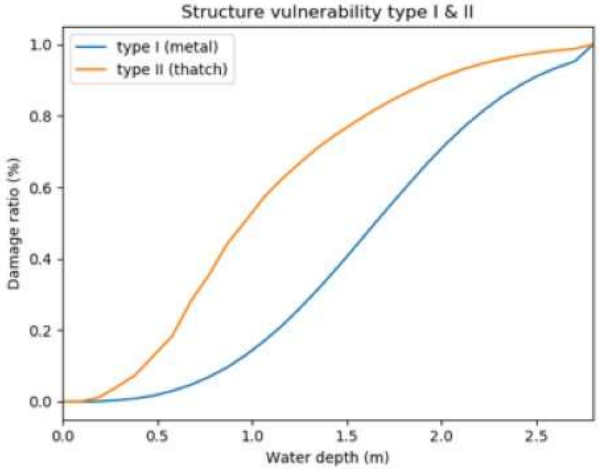
Damage curves

Census data building stock:

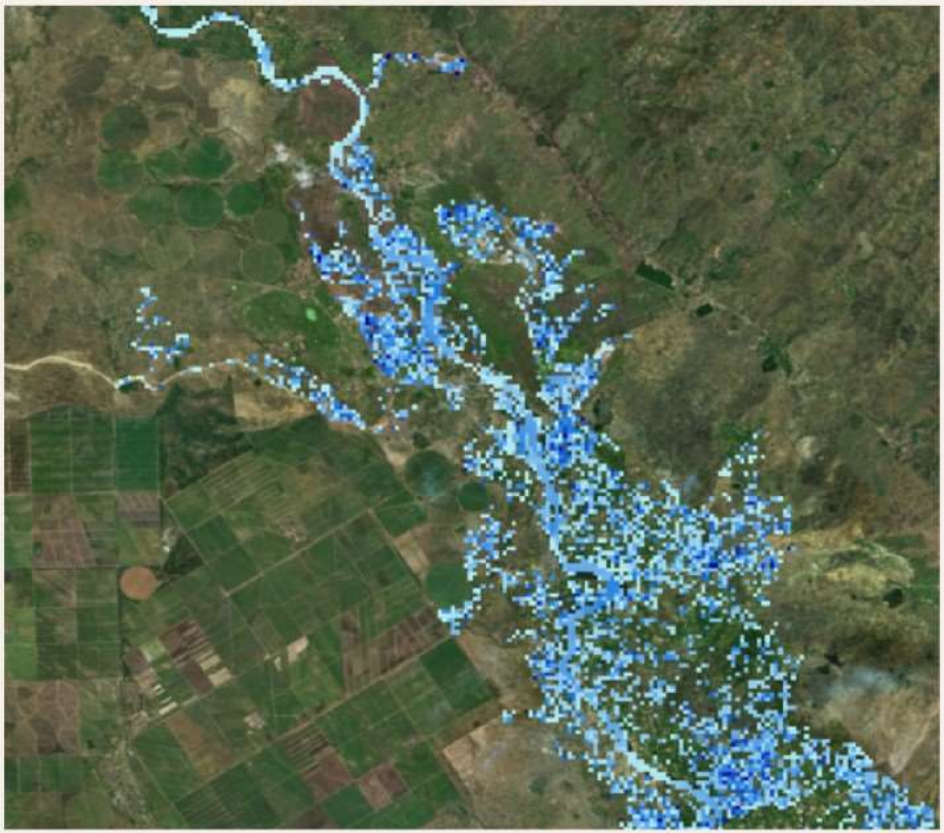
- Permanent
- Semi-permanent
- Traditional







Flood hazard & damage assessment



$$Damage\ [\$] = \sum_{i=1}^{3} damage(i) * ba(i) * rc(i)[\$]$$

Where:

- i = the building typology as determined by the classification
- $Damage(i)$ is the damage represented trough the damage curve, using as input the water depth [m]
- $ba(i)$ is the area of the building in m^2
- $rc(i)$ is the replacement costs per m^2 based on the typology (i)

Performance statistics

Confusion matrix

Actual value \ Prediction outcome	Positive	Negative
Positive	TP	FN
Negative	FP	TN

TP = predicted + manual
FP = predicted x manual
TN = manual x predicted
FN = not detected

Accuracy:
(0 – 1)

$$A = \frac{TP + TN}{TP + FP + TN + TN}$$

F1-score:
(0 – 1)

$$F1 - Score = 2 * \frac{P * R}{P + R}$$

$$R = \frac{TP}{TP + FN}$$

$$P = \frac{TP}{TP + FP}$$

Cohen Kappa:

$$\kappa = \frac{A - Pa}{1 - A}$$

$$Pa = \frac{1}{n^2} \sum_{i=1}^{C} pi + p_+ i$$

Value of K	Strength of agreement
< 0.20	Poor
0.21 - 0.40	Fair
0.41 - 0.60	Moderate
0.61 - 0.80	Good
0.81 - 1.00	Very good

Results & discussion

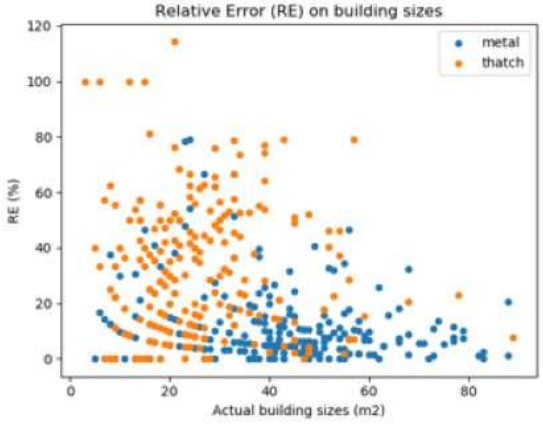
Flood damage

	Object	Pixel	OSM
# of buildings	1466	1514	1352
# flooded	84	90	97
Damage (€)	10,140.-	15,728.-	-

- Difference in exposure (#, and size)
- Approach specific damage curves

OBIA performance

Category	F1-score	F1-score (height)	Accuracy	Kappa
Vegetation	0.91	-	0.77	0.71
Metal roof	0.89	0.90		
Thatch roof	0.53	0.75		
bare ground	0.49	-		
shadow	0.90	-		



Conclusions & Recommendations

Object-based approach using UAV imagery to calculate flood damage

Flood damage:
Object < Pixel

Accuracy results vary among catergories due to spectral similarities

Justify assumptions of roof and wall material with more samples

Combine results of OBIA with homogenous pixels maps scale up

Questions