Conventional Urban Change Detection: The Impact of Spatial Resolution

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1 Background Information

- **Change detection** is the analysis of changes between data of the same region at different moments in time [1] (see figure 1)
- Can be done with **remotely sensed data**, such as satellite images [1]
- Change detection in **urban areas** for example useful for urban planning purposes [2]
- **Various change detection algorithm types** [1]
- Here: **Conventional non-classification algorithms** that detect binary "change" or "no change" per pixel
- Datasets vary in **spatial resolution** which is the area a pixel covers on the Earth surface [3]
- There are different **challenges** depending on the spatial resolution

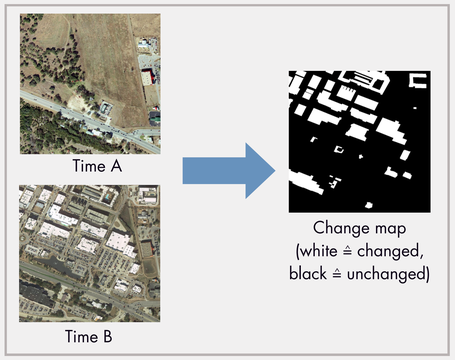

Figure 1: Concept of Change Detection (images from LEVIR-CD [4])

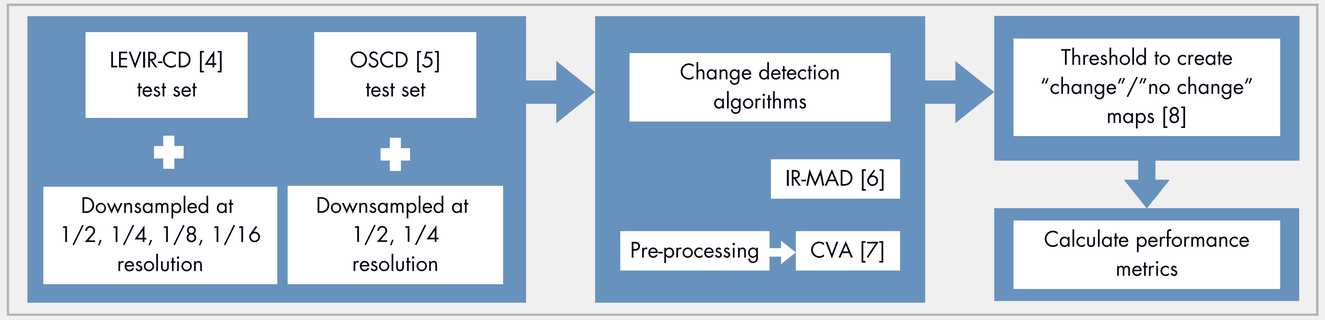

Figure 2: Flowchart of the methodology

2 Research Question

> "How does **spatial resolution** impact non-classification **conventional** pixel-based techniques in the **urban change detection** context?

3 Methodology

- Urban change detection datasets LEVIR-CD [4] and OSCD [5] are taken at their **initial and multiple downsampled resolutions** in total ranging from **0.5 m/px** to **40 m/px**
- Two change detection algorithms are considered:
  - **Change Vector Analysis (CVA) [6]**: Computes the change vector between the images
  - **Iteratively Reweighted Multivariate Alteration Detection (IR-MAD) [7]**: Creates linear combinations of each image and reduces redundant correlated information between images before taking their difference
- To label pixels as "change" or "no change", an unsupervised **thresholding algorithm** is applied [8]
- **Performance metrics** (see table 1) are calculated, and the results of the algorithms are analysed over the different spatial resolutions
- A change detection toolbox is used for the data loading and change detection [9]
- Figure 2 shows a flowchart of the methodology

4 Results

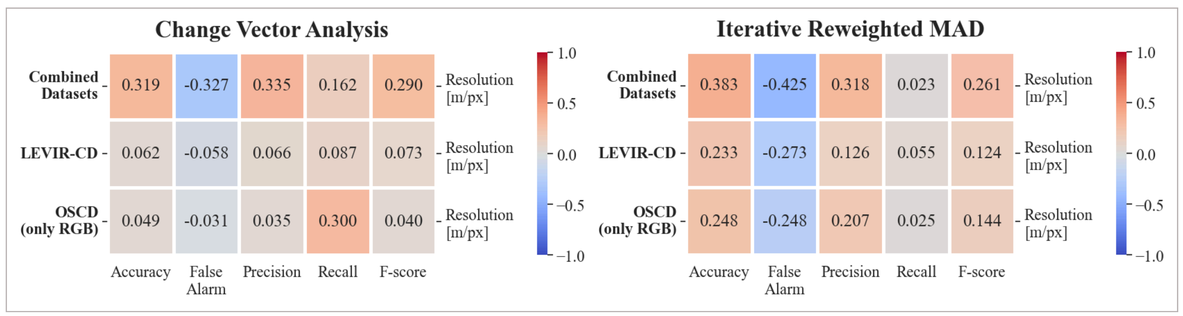

Figure 3: Correlations between metrics and spatial resolutions per algorithm, for combined and individual datasets

Metric	Explanation
Accuracy	Portion correctly identified as "change" or "no change"
Precision	Portion identified as "change" that was correct
Recall	Portion of "change" correctly identified as "change"
F-score	Harmonic mean of precision and recall
False Alarm	Portion of "no change" incorrectly identified as "change"

Table 1: Metrics used to evaluate algorithm performance [10,11]

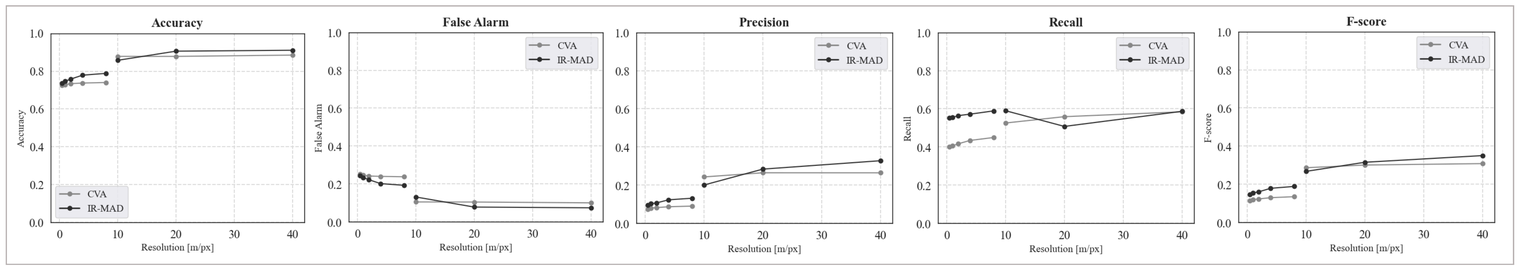

Figure 4: Mean metric values over spatial resolutions (LEVIR-CD 0.5 m/px up to 8 m/px; OSCD 10 m/px up to 40 m/px)

5 Conclusions

- Trends towards **improved performance for lower resolutions** in terms of all metrics, to **varying degrees**
- Dataset specific properties seem to have an impact
- **For CVA:**
  - **No clear trend** involving all metrics for individual datasets
  - Pronounced difference in metric values between datasets
- **For IR-MAD:**
  - **More consistent trends** in most metrics
  - Exception is **recall**, the portion of "change" correctly identified as "change"
- Overall, **low capability** of finding the changed areas due to simplicity of algorithms

6 Limitations & Future Work

- **Small size** of experiment limits:
  - Knowledge of **causes** for trends
  - **Generalisability** of results
- **Influencing factors need to be analysed:**
  - Image size (pixels)
  - Amount of "change"/"no change" pixels in ground truth
- **Extending the experiment** by adding:
  - Different algorithms
  - Improved pre-processing steps
  - More datasets

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