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Cliff change detection using Siamese KPConv deep network on 3D point clouds

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1. Motivations

Context:
- Cliffs cover 52% of the world’s coastline [1]
- Cliffs erosion likely to increase with sea level rise [2]
- Endangering nearby populations and infrastructures

Challenges:
- Working directly on raw 3D point clouds to avoid the loss of information when rasterizing the vertical cliffs
- Randomness of natural cliffs (unlike buildings in urban areas)
- Being able to study vertical or very steep cliffs

2. Objectives

Explore the efficiency of Siamese KPConv deep learning algorithm over raw 3D point clouds (PCs) for change detection and categorization on coastal cliff faces.


4. Study area

Petit Ailly cliffs are rocky limestone cliffs in Varengeville-sur-Mer (Normandy, France), 40 m high and monitored since 2010 every 4-5 months. Figure modified from [5]

5. Data

Terrestrial Laser Scanning (TLS): Riegl® VZ-400
- Accuracy: 5 mm
- Precision: 3 mm (at a range of 100 m)

Terrestrial Photogrammetry (TP)
- Nikon D800 reflex camera
- 35 mm focal length
- Overlap > 60%
- Camera positions close to each other and > 20 m from cliff face

5 different 3D point clouds derived from 2 methods...

... Forming 4 pairs of PCs, manually annotated by 3 experts.

- Unchanged
- Erosion
- Accumulation
- No data to compare

6. Results

7. Conclusion

First study experimenting a deep learning method on vertical cliffs without rasterization of PCs for 3D change detection

82.03% of mIoU over 3 classes of interest (unchanged area, erosion and accumulation)

⇒ Experimental with the Siamese KPConv algorithm on 3D point clouds from satellite stereo-restitution with lower density (∼2.7 pts/m² with Pléiades images)

⇒ Automation of the monitoring of coastal changes, advocated by governments and coastal observatories in order to improve the management of the associated risks

References