Sand beach displacement in Skagen

Analysis of the coastal changes in northern Denmark based on Sentinel 2 images

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1. Abstract

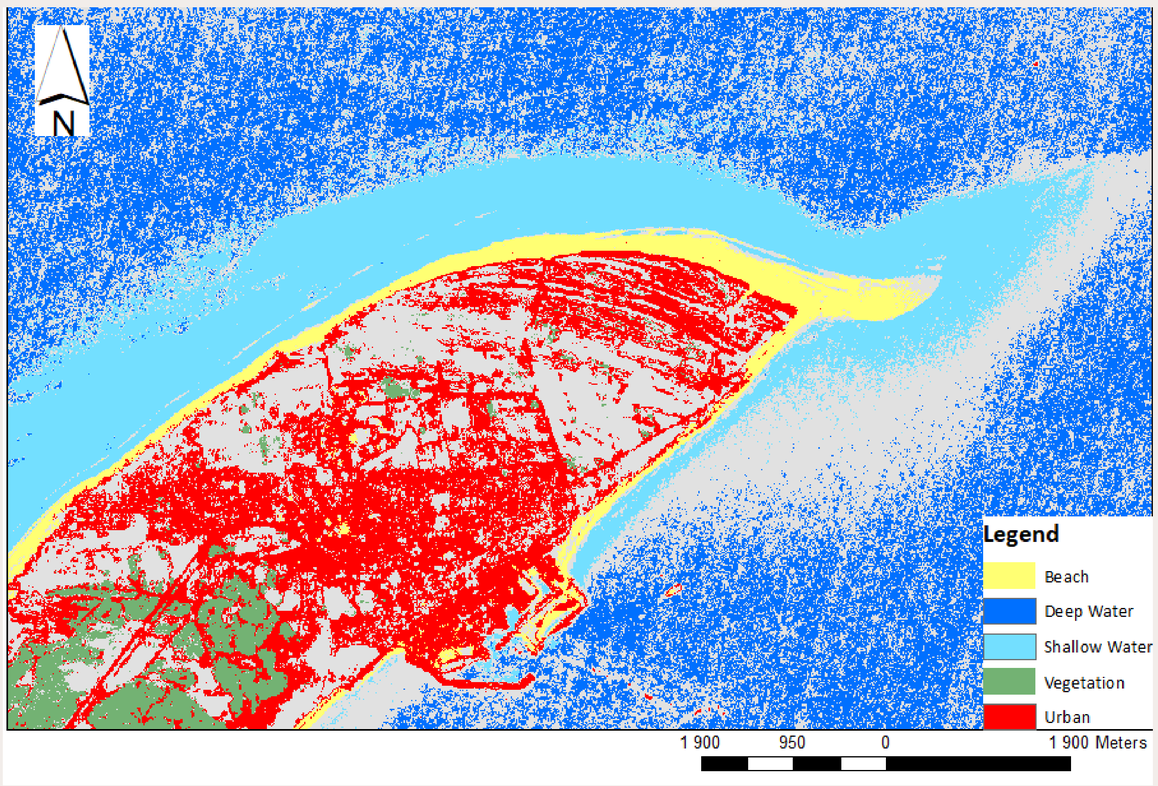
Coastal cities are often threatened because of to changing coastlines. Skagen is a small town in northern Denmark. Due to it‘s location coastal protection strategies like rock armours are installed to protect parts of the local beach.
Remote sensing data was used to detect an eroding or an accumulating shoreline. In the future this could be used to trace coastal changes and develop adaptation strategies.

2. Workflow

1. Download data
   - 2 Sentinel
   - images from 2015 and 2020
2. Preprocessing
   - atmospheric correction
   - pansharpening
3. Classification
   - pixel-based classification of northern Denmark
4. Change detection
   - beach displacement from 2015 to 2020
5. Interpretation

3. Method

SENTINEL 2 Data form the year 2015 and 2020. SENTINEL 2 Data was chosen because of its higher spatial resolution compared to LANDSAT 8. A low cloud cover was important for choosing the satellite image. Downloaded data needed to be preprocessed. This was done by an automated process.
After the preprocessing is completed a classification and changed detection was performed. For the classification and change detection arcGIS and QGIS was used.

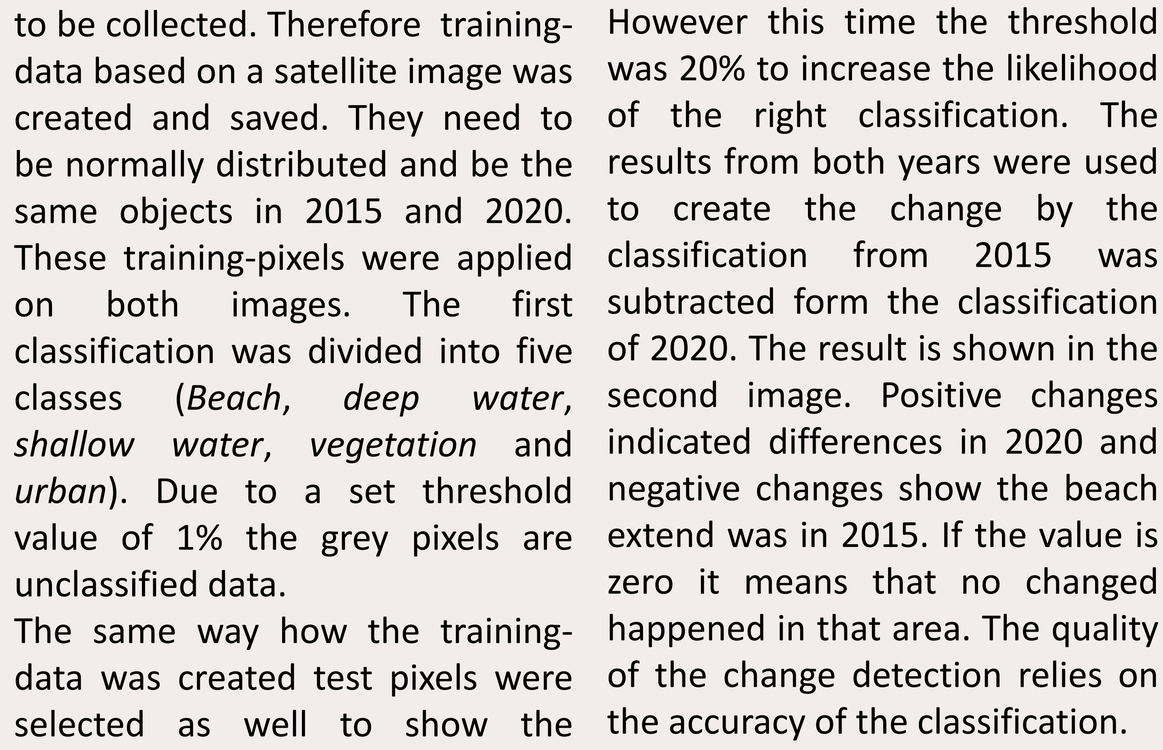


4. Maximum Likelihood Classification (ML)

ML is one of the most reliable and commonly used methods. It classifies pixels in the most likely class (CAMPBELL 2011) .
The upper image shows the result of a ML classification. To preform this method training data needed to be collected. Therefore training-data based on a satellite image was created and saved. They need to be normally distributed and be the same objects in 2015 and 2020. These training-pixels were applied on both images. The first classification was divided into five classes (*Beach*, *deep water*, *shallow water*, *vegetation* and *urban*). Due to a set threshold value of 1% the grey pixels are unclassified data.
The same way how the training-data was created test pixels were selected as well to show the accuracy of the classification.

5. Change detection

Based on the ML a change detection was preformed.
However it wasn‘t necessary to use all the classes. Therefore a second classification was preformed with only these classes (*shallow water* and *beach*). However this time the threshold was 20% to increase the likelihood of the right classification. The results from both years were used to create the change by the classification from 2015 was subtracted form the classification of 2020. The result is shown in the second image. Positive changes indicated differences in 2020 and negative changes show the beach extend was in 2015. If the value is zero it means that no changed happened in that area. The quality of the change detection relies on the accuracy of the classification.



6. Interpretation

Different from what expected the beach doesn‘t erode but actually accumulates sand during the time period of 5 years. Single pixels that changed could be detected.
The classification itself works well for sand *beach* areas and *water*. The differentiation between *urban* and *vegetation* areas proved to be difficult for this classifier. Perhaps an object-based approach would improve the result. Since this work focuses on the binary distinction between beach and none-beach areas, an accurate division between urban places and vegetation wasn't important. The classification of the *sand beach* worked, but sometimes it could get mixed up with *shallow water* due to inaccurate training data.
Further uncertainties derive from the accuracy of the classification itself. In this case an accuracy assessment can‘t tell that much about the reliability of the classification because the data collection. The method of collected ground truth data could be improved It‘s better to use mapped data instead. That way the test pixels would be that uncertain.

A higher spatial resolution from for example aerial photographs could improve the quality of the analysis as well.

7. Conclusion

A pixel-based classification is useful to detected change of coastal areas. Nonetheless is better ground truth data needed to preform an accurate classification. As further research an object- based classification could be preformed.
Change detections like this one can be used to understand coastal changes and can be helpful to find adapting strategies for urban areas.

REFERENCES

Campbell, James B., and Randolph H. Wynne. *Introduction to Remote Sensing, Fifth Edition*, Guilford Publications, 2011. ProQuest Ebook Central, https://ebookcentral.proquest.com/lib/christianalbrechts/detail.action?docID=843851.

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