EARTH CASE STUDY

Using Definiens eCognition to detect storm losses in Swiss alpine forest areas from high resolution satellite data

In Switzerland thirty-one percent of the area is covered by forests which are of vital importance and playing multifunctional roles. Forest management as well as forest monitoring with remote sensing data have a long tradition in Swiss research work (Kellenberger, 1996). Especially since hurricane Lothar struck many parts of Switzerland on December 26th, 1999 the public interest in forest management is growing. In this study a digital classification approach using the software Definiens eCognition was tested. The investigation was based on the detection of storm losses in Swiss alpine forest areas using high resolution satellite data.

Background

Until recently, most traditional classification approaches are based exclusively on the digital number of the pixel itself. Thereby only the spectral information is used for the classification. But recent research has shown that pixel-based approaches for classification of remotely sensed data are not very suitable for the analysis of very high resolution images (e.g. Ikonos). Essential limitations arise through this way of thinking (Steinocher, 1999).

The goal of this study was to find a method to detect storm losses in Swiss alpine forest areas using an object-oriented classification approach in order to overcome the limitations mentioned above. The classifications were performed for two georeferenced satellite images representing different spatial resolution. First for the multispectral Ikonos (4m), and second for the Spot (10m) in the sharpened mode. The testsite is located in the region of Bern (Central Switzerland) and covers an area of 220 km2. The forests are of deciduous forest, mixed forest, and coniferous forest - mainly depending on the altitude. Hurricane Lothar especially struck the lower parts of the region in any exposition and slope and caused different types of damage.

Method

First of all, the two satellite data sets and the thematic layer of the forest mask were imported in their original pixelsize using the subset selection mode. In a 1st step all bands of the two data sets and the thematic layer were segmented in different levels (scale factors 10 - 20 - 50) representing the level of detail. The entire classification process is described below and shown in figure 1. In a 2nd step the class-hierarchy and class-description were defined. The distinction between forest and non-forest areas is based on the thematic layer containing the forest mask. The object class forest area was subdivided into the classes possible forest and possible forest damage. Training-samples for both subclasses were collected. In a 3rd step the entire images were classified - based on the classification hierarchy. The correlation to one of the subclasses was performed by a nearest-neighbour function which was calculated on the base of the training-samples. Further a classification based segmentation was performed (4th step). In many cases image objects of interest cannot be extracted following a relatively general homogeneity criterion. For this reason structure groups were built with the desired classes that were defined in the class hierarchy. All neighbouring objects belonging to the same object class were merged to super objects (figure 2). The result of this step was a new segmentation level. In a 5th step this new level had to be reclassified by building a new class hierarchy. This classification hierarchy is based on a formulation of knowledge and concepts. Before one can use the membership functions for an enhancement and refinement of the the classification (6th step) - Image Object Information had to be studied precisely. The adjusting

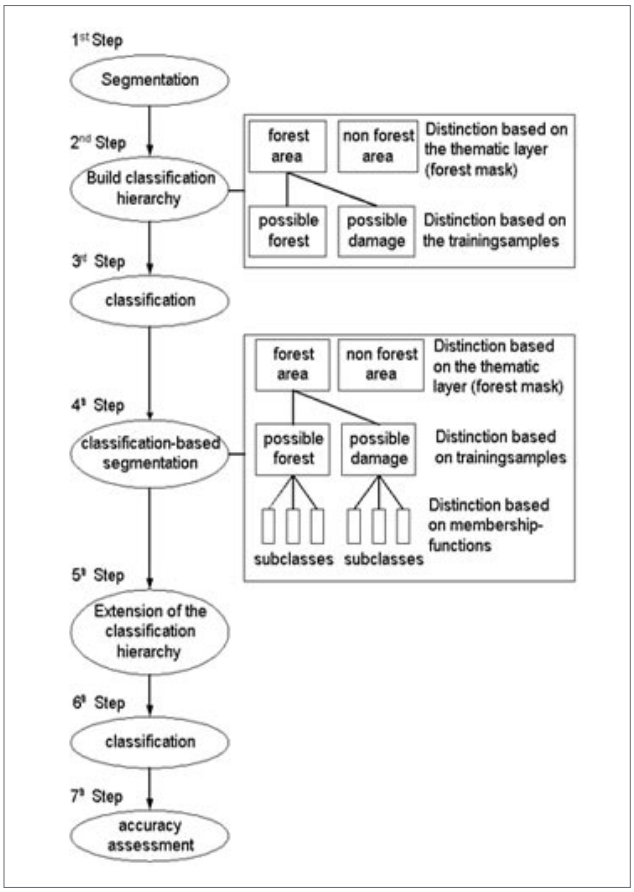

Figure 1: CIR aerial photograph (2.60 km by 2.68 km)

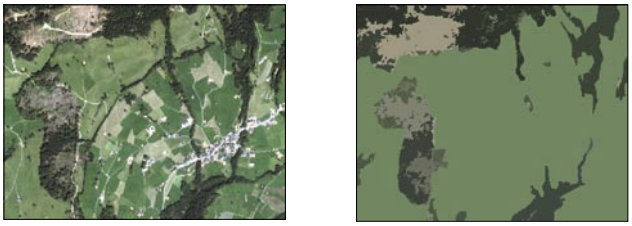

Figure 2: Original image of Ikonos in comparison with the merge of the class non-forest area to super objects (right side)

of the parameters, e.g. Object Area, Relation to neighbouring class Objects, and the Shape parameter Length/Width allowed an elimination of border effects that were classified as damages before. Figures 3 and 4 visualize the elimination of border effects for Spot. Figure 5 shows classified storm losses
Finally, in a last 7th step the classification was imported into Erdas Imagine© where the accuracy assessment was performed. The accuracies both for the Ikonos image and the Spot image turned out to be very satisfactory. The groundtruth is based on aerial photo interpretation.

Conclusion

The above mentioned study was performed using the Definiens eCognition version 1.0. The same study was picked up again using version Beta 2.01 within the Beta testing campaign of Definiens Imaging. To summarize, both versions lead to similar results. However, the latter offers a more user-friendly interface and easily enables the import of different types of data sets The classification process used in this study lead successively to a satisfactory result. The possibility of a classification based segmentation obviously improved the classification result obtained in the 3th step. Further on the use of membership functions enabled iteratively to reduce misclassified pixels and kept them to a minimum. It has to be mentioned that this study also revealed that a satisfying classification is only assessed by including external GIS-data to determine the rough boundaries of the forests. Otherwise parts of urban areas or bare agricultural land may have the same reflectance as storm losses and therefore are missclassified. To sum up, this study showed that the usage of Definiens eCognition is a helpful tool for classifying storm losses since it handles the high level of detail and the associated high texture for both data sets in a satisfactory way. Nevertheless it has to be taken into account that hurricans in Switzerland in general tend to appear during the winter half year - but, in contrast to that, in regions with deciduous forest, the image-data has to be obtained from the vegetation period.

Figure 3: Figure 3: The use of the forest layer and membership functions minimize misclassified storm losses and lead to satisfactory results

Figure 4: Eliminated border effects (pink) along the tree line using the membership functions

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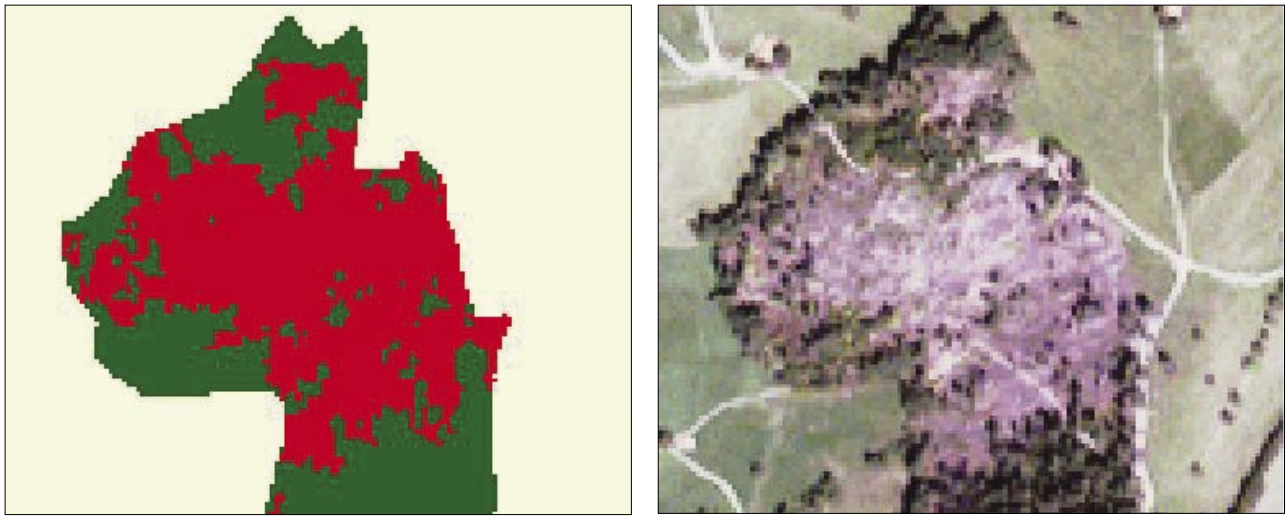

Figure 5: Classification of storm losses compared to the original Ikonos image © SpaceImaging Europe2000

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Founded in 1994 by Nobel Laureate Prof. Dr. Gerd Binnig, Definiens is a multi-national organization with headquarters in Munich, Germany and offices in the US and UK.

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