LAND USE CLASSIFICATION IN BAVARIA FROM AERIAL PHOTOGRAPHS AND ERTS-1 IMAGERY

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ZUSAMMENFASSUNG

ERTS-MSS-Aufnahmen von Bayern werden nach einem Analogverfahren mit Hilfe eines Farbabtasters maschinell verarbeitet und ausgewertet. Dazu ist es notwendig aus den S/W-Bildern der drei Kanäle MSS 4, 5 und 6 ein Farbbild zusammenzusetzen. Man erhält bei Abtastung des Bildes die radiometrischen Werte der drei Spektralbereiche gleichzeitig für jeden Bildpunkt. Diese werden in einem Farb-Prozeßrechner miteinander kombiniert und ermöglichen so die Erkennung der spektralen Signatur. Der Spektralbereich MSS 7 dient im wesentlichen zu einer Diskriminierung zwischen Land, Wasser und Wolken.

Nach diesem Verfahren wurde eine thematische Kartierung von folgenden Objekten durchgeführt: Oberflächenwasser, Wassertiefe, Wasserverschmutzung, Siedlungsgebiete, Verkehrsflächen, Vegetation, Nadel- und Laubwald, Grasland und landwirtschaftliche Nutzflächen. Wenn das räumliche Auflösungsvermögen der ERTS-Aufnahmen ausreicht, können einzelne Typen landwirtschaftlicher Vegetation unterschieden werden.

Eine bessere Unterscheidung landwirtschaftlicher Kulturen erfolgt durch Texturanalyse farbiger Luftbilder.

SUMMARY

ERTS-MSS images from Bavaria are analyzed using a colour scanner for machine processing. It is necessary to make colour compositions of the three b/w pictures from MSS channel 4, 5 and 6 (7). By thisscanning the picture, the radiometric values, i.e. the colour densities, of the three spectral channels are obtained simultaneously for each picture element. The three signals are then correlated in a special analog colour computer and gradation processor. The channel MSS 7 is used for land/water/cloud discrimination.

By this, thematic mapping of the following objects is made: surface water, water depth, water pollution, urban areas, vegetation, conifer and deciduous forest, grassland, agricultural vegetation. If the spatial resolution of the ERTS image is sufficient, different types of agricultural vegetation are discriminated.

Aerial photographs are used for better discrimination of agricultural vegetation by texture analysis.

INTRODUCTION

The images used for processing and analysis are b/w positive transparencies in the size 6 cm x 6 cm, delivered from the NASA. Other material and formats were not available, the use of CCT is not yet possible. The quality of these pictures is not very good, so a preprocessing of the pictures with the colour scanner was made. The pictures are enlarged to the scale 1 : 1 Million, 1 : 400 000 and 1 : 200 000. The colour scanner allows the enlargement up to 20 times with corrections of the density and gradation. The enlargement scale is adjusted slightly for the different MSS channels, so they fit exactly for color compositions.

The enlarged, corrected b/w positive tranparencies are used for further treatment, picture analysis and to compose colour transparencies. For machine processing a scale of 1 : 1 million suffices. The scanning resolution of the machine is 40 lines/mm. This gives a theoretical ground resolution of 25 m . For visual evaluation some parts of the pictures are enlarged to a scale 1 : 100 000.

Aerial photographs are made with a Hasselblad camera on 70 mm colour reversal and ir-colour film. These pictures are mainly used for a discrimination of agricultural vegetation and plant damages by a combination of spectral signature and spatial texture analysis.

OPERATIONS

The procedures carried out for picture processing may be classified in global, local and point operations.

Global operations change the whole picture, like rectification, enlargement, transformation. They are used here only for preprocessing the b/w MSS images.

The local operations are related to the information of the picture element and a small area around it. These are mainly used for pattern and texture analysis. Investigations are made to modify the signal by active electronic filters changing the modulation transfer function and analyzing the spatial frequency spectrum. This method is applied to the classification of agricultural vegetation using aerial photographs, the application on ERTS imagery is planned.

The most applicable operations for ERTS imagery are point operations for spectral signature analysis. There are different methods used for land use and vegetation mapping. The point operations are carried out by the electronic comparison of the three colour density signals in the colour computer or the manipulation of the density signal from one spectral band b/w picture.

It is possible to select different colour tones (hues), given by a fixed ratio of the three signal amplitudes (ratio mapping, clustering). From one channel the quantization of the gray levels or an equidensities display can be made.

Details of these procedures are explained with the following examples for land use classification from an ERTS scene in Bavaria. For further information of the instrument and programming see bibliography. The display of the results is made on colour film, using colour coding of objects. A reproduction in this paper is not possible; colour slides are available from the author.

RESULTS

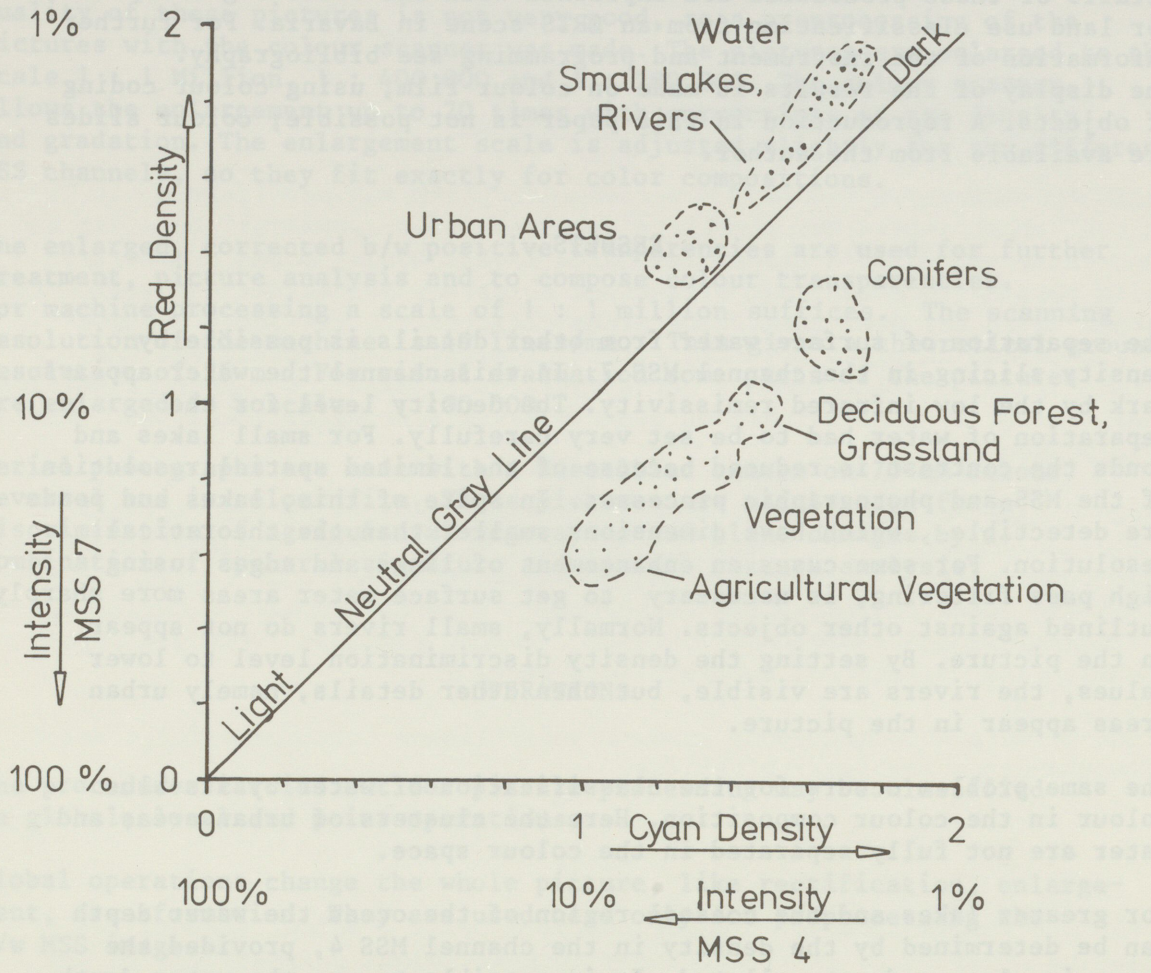
The separation of surface water from other details is possible by density slicing in the channel MSS 7. In this channel the water appears dark by the low infrared remissivity. The density level for the separation of water had to be set very carefully. For small lakes and ponds the contrast is reduced because of the limited spatial resolution of the MSS and photographic processes. In spite of this, lakes and ponds are detectible , which have dimensions smaller than the theoretical resolution. For some cases an enhancement of lines and edges, using high pass filtering, is necessary to get surface water areas more sharply outlined against other objects. Normally, small rivers do not appear in the picture. By setting the density discrimination level to lower values, the rivers are visible, but then other details, namely urban areas appear in the picture.

The same problem occurs for the classification of water by its blue colour in the colour composition. Here the clusters of urban areas and water are not fully separated in the colour space.

For greater lakes and the coastal region of the ocean the water depth can be determined by the density in the channel MSS 4, provided the water is clear and not polluted. It is possible to map the water depth down to 20 m using equidensities display.

For vegetation classification a colour composition similar to the false colour film is used. The vegetation appears in different red colour tones. Normally, in the colour composition the MSS 7 is copied with red, MSS 5 with green and MSS 4 with blue light. A similar result is gained with a two-colour composition, copying MSS 7 in red and MSS 4 in cyan (blue-green). For vegetation analysis these two colour compositions are equal. This shows that MSS 5 (and MSS 6) is of linear dependance from MSS 4 and MSS 7.

Before making an operational analysis of the vegetation with the colour scanner, a cluster diagram was made. For samples of known vegetation objects the three colour densities are measured. Each triple of densities represents a vector in the colour space. For vegetation the colour space



Measured Clusters for Land Use Classification

can be reduced to two dimensions, due to the fact mentioned above. In the cluster diagram (see Fig.) the densities of the channel MSS 4 and MSS 7 are used for co-ordinates. Numerous different objects are measured. The diagram shows that only the cluster for conifer forest is separated from other clusters. The other vegetation shapes a continous cluster with some centers for deciduous forest, grassland and agricultural vegetation.

A verification is made by mapping selected colour tones, corresponding to the clusters in the diagram.

Mapping all red colour tones in the picture, we get a review of the over-all vegetation cover. The ERTS image was taken in October 72, where mostly all fields are harvested, until potatoes, rapes and Indian corn.

Conifer forest is easy to detect and map by the dark violet colour tone. The discrimination of conifer forest is 100 % correct, because the cluster of conifer forest is separated from other objects, only the colours of water are near the cluster.

The colour composition shows various red and violet colour tones, which belong to different kinds of vegetation, like measured in the cluster diagram.

For a classification and mapping the different red colours or hues are transformed into a gray scale, each gray level represents another hue. From this b/w picture the gray levels are quantized by arbitrary steps into several ranges. Each range is displayed in a different colour. The result is a colour coded map of vegetation, areas without vegetation appear clear white. This unsupervised classification is then brought in agreement to types of classification using the cluster diagram and ground truth measurements. The overlapping of different types of vegetation in the colour space, shown in the cluster diagram, does not give an exact determination.

CONCLUSION

The investigations are continued. Additional texture analysis is necessary for agricultural research. A comparison of ERTS images and aerial photographs from underflights is going on. The work is supported from Bavarian ministries and is useful for a general land use planning and management and environmental survey.

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