MODELING OF IMPERVIOUS SURFACE IN GEMRANY USING LANDSAT IMAGES AND TOPOGRAPHIC VECTOR DATA

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ABSTRACT

The constant loss of land resources due to growing settlements and transport infrastructure is a widespread phenomenon in most developed and emerging countries. The expansion of urban agglomerations is closely associated with a significant increase of impervious surface (IS). Surface sealing involves the irreversible loss of essential soil functions, prevents precipitation from infiltrating the ground and entails the use of incoming solar radiation for heating rather than evaporation – a phenomenon that leads to the emergence of urban heat islands. Moreover, the maintenance of the established infrastructure increases the pressure on the communal budgets. Hence, the monitoring of IS is increasingly recognized as an important step in terms of assessing the sustainability of urban development.

However, in Europe, robust, applicable and cost-effective methods for the quantification and assessment of IS on a national scale are still rare. Thus, we researched into the characterization of IS based on a combined analysis of Landsat images and vector data on the road network and railway system using Support Vector Machines (SVM) and GIS functionalities. The method was applied to the entire territory of Germany - comprising a mosaic of 32 Landsat scenes that covered an area of approximately 360.000 km^2. The analysis targeted the provision of data on the percent impervious surface (PIS) for the total of residential, industrial and transport areas in the year 2000 whereby the information was referenced to the administrative units of communities. The methodological approach is implemented as a stand-alone application – the so-called Impervious Surface Analyst (iSurf-A). The functionality of this tool includes three consecutive steps: 1) the modeling of IS for built-up areas (PIS_B) based on Landsat data using SVM regression, 2) the combination of PIS_B with vector data providing additional information on small-scale infrastructure such as roads and railways (PIS_T) and 3) the spatial aggregation of the combined product PIS_{BT} to the administrative units of communities.

The accuracy of the modeling was accessed on the basis of high resolution maps on the impervious surface provided for the German cities Leipzig, Ludwigshafen, Osnabrück and Passau. Compared to the reference data sets the applied model showed a mean absolute error of 19.4 %, a mean error of -2.3 % and a mean standard

deviation of 17.3 %. In near future the validation will be extended by reference data of further cities such Berlin or Osnabrück. Regarding the PIS for the total of residential, industrial and transport areas in Germany our research provided a value of 43.0 % for the year 2000. On the level of the German federal states the values range from 39.3 % to 47.1 %.

The results of this study document that the proposed approach is qualified for an area-wide mapping of the PIS. Inaccuracies emerge due to confusions with certain bare soils whose spectral signature barely differs from these of impervious materials such as concrete, bricks or stones. Further errors originate from shadowing effects or dense tree coverage hiding impervious surfaces located underneath. The advantage of the proposed approach lies in the ability of a fast, area-wide and at the same time spatially detailed and accurate mapping of IS – requirements that can not be met with a reporting based on official statistics. It is even possible to describe the structure and distribution of impervious surfaces within villages or towns. Moreover, the information on IS can be addressed to arbitrary spatial or administrative units. The approach also facilitates the mapping and assessment of IS by constant and objective rules - a key issue in view of regional or national surveys. Finally, the design of the developed approach also enables the use of very high resolution data such as Ikonos and QuickBird imagery or aerial photographs instead of Landsat images. Thus, the level of detail can be further increased in order to meet the high demands of municipalities with respect to the spatial resolution of according analyses.

2. REFERENCES

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