The Compilation of a modern Landscape Inventory by the Synopsis of Spatial Layers

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1. Introduction

Under the new Environmental Protection Act for the Austrian province of Vorarlberg, the provincial government is obligated to compile inventories of natural zones and habitats. It was the aim of the pilot project conducted in the *Große Walsertal* to prepare such landscape inventory and, at the same time, develop suitable work strategies by relying on the methods of remote sensing and of the geographical information systems and existing pools of data. One of the reasons why the *Große Walsertal* was chosen as project region was the fact that for the establishment of a biosphere reserve envisaged for that region, a spatial landscape model based on such landscape inventory was required. The present paper describes methodologies allowing landscapes to be classified relatively fast, comprehensively, and at the same time, cost-effectively. In this connection, remote sensing data constitute an essential source of information.

2. Investigated Region

The *Große Walsertal* is undoubtedly one of the most beautiful high Alpine valleys in Austria. It is situated in the province of Vorarlberg, about 70 kilometers south-east of Bregenz, the provincial capital. The mosaic of forests, open land and traditional settlements is the origin of very high animal and plant diversity. The geological patterns force a high diversity of different landscape and vegetation types. The *Große Walsertal* is, along its main axis, a V-shaped valley and, along its slopes, characterized by so-called *gorges* ("Tobel"). The numerous small, deep valleys has given rise to the "Grosses Walsertal" being described as "*a gorge with gorges and mini gorges*". The gorge forests in these *gorges* – each of which is in a largely virgin state - form the characteristic biotopes of this valley.

3. Data and Methods

For the compilation of the landscape inventory, factual spatial data was provided by the authorities of the province of Vorarlberg (geology, biotope mapping, forest map, information derived from digital elevation model, network of waterways, roads, byways and logging trails). The maps of land cover and land use (cultural landscape types) for the research area were offered by the project SINUS, which was set up as an interdisciplinary research project combining remote sensing methods and ecological field-investigations, aiming at the elaboration of spatial indices of sustainable land-use (Wrbka et al. 1999). The project collaborators in the Project SINUS and in the here presented project are almost the same. The applied satellite images were LandSAT 5 compositions out of the 6 canals, except the thermal canal.

The land cover classes were collected through an automated evaluation of satellite images in cooperation with the Institute of Surveying, Remote Sensing And Land Information, University of Agricultural Sciences in Vienna, Austria. In addition to processing LandsatTM5 images, the image material was segmented (basis: centroid-linkage-region-growing algorithm) and classified. As methodical approach for the classification, a combination of knowledge-based and statistical classification was chosen. The determination of land use classes was carried out by a visual interpretation of the satellite images. In this examination, trained collaborators delimited polygons in maps based on the LandsatTM5 images. The homogeneity of land use, landscape structure (Forman & Godron 1986), and the relief features were decisive for the delimitation of a polygon. These three criteria could be derived from the color and the texture of the images.

The entire area of the *Große Walsertal* was subdivided into 3,264 grid cells having a side length of 250x250m. This grid size was determined on the basis of the analysis of individual areas of land cover classes. Using methods of the Geographic Information System (ARC/Info), each grid cell was subsequently examined with regard to its qualitative and quantitative contents, related to the various spatial layers (e.g. land use, land cover, geology, altitudinal zones etc.). Consequently, each grid cell now forms an object for a multivariate analysis, the attributes of these objects resulting from the spatial analysis. The method use for this multivariate analysis was a divisive cluster analysis - conducted by TWINSPAN (Hill 1979). Similar investigative approaches using TWINSPAN were also employed by Bunce et al. (1996) in the ITE Land Classification of Great Britain.

4. Results

Based on the contents of all grid cells, the multivariate analysis created 21 classes, and each of the 3,264 grid cells could be allocated to one of these classes. Each of the 21 classes represented a landscape type of the landscape inventory to be compiled: 2 landscape types of the meadow land and the permanently settled area, 7 landscape types in the area of brooks and gorges, 6 types of Alpine meadow landscape, 6 types of mountainous landscape. The names of landscape types resulted from the features (= attributes) found to be characteristic (e.g.

rich in meadows, rich in forests, on the shady side, etc.). The results of the definition of landscape types were verified at the site in a field inspection based on a representative sample. For this inspection, several grid cells of each landscape types were chosen by random selection. It was demonstrated that only such grid cells having a great proportion of areas facing westwards had in part been allocated to a wrong landscape type. This was due to the fact that in the images, zones facing westwards contain very dark, shady zones that are difficult to interpret.

In addition, each of the landscape types was assigned a "naturality rating" in a personal, subjective appraisal. More specifically, the naturality rating is a 4-step subjective evaluation of landscape types with regard to their naturalness (or intensity of current use – predominantly agricultural – or of the dependence of land use). In a refined, objective procedure, these naturality ratings for the landscape types, at first defined on a purely empirical basis, were computed further into so-called hemeroby values (="cultural influence") per grid cell, which subsequently formed the basis of a zoning proposal for the *Große Walsertal Biosphere Reserve*. In the hemeroby assessment used in this case, the network of roads and trails, the existence of biotopes, and the insular character as regards the naturalness (surrounding cells are rated better or worse) of a grid cell were applied as criteria for improvement or worsening of the resulting hemeroby value.

In the analysis of the landscapes of the *Große Walsertal* and the assessment based thereon, 37% of the area were described as natural, 28% as close-to-natural, 26 as semi-natural, and 9% as largely culture-related. For the development of a zoning proposal for the biosphere park to be established, the areas rated as "natural" were defined as core area, the "close-to-natural" and "semi-natural" areas as buffer zone, and the areas classified as largely culture-related as transition area.

5. Discussion

The present study has shown how studies which, taken alone, provide only a part of the knowledge about a landscape, can be combined into a bigger global perspective in the form of a landscape inventory. This must also be viewed in the light of the fact that the efficient use of existing data by the work strategies presented herein (remote sensing, GIS, and multivariate analysis) helps achieve savings in terms of both financial and human resources.

Literature

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Mapping Landscapes in Transformation gathers experts from different disciplines, active in the fields of historical geography, urban and landscape history, archaeology and heritage conservation. They are specialised in a wide variety of space-time contexts, including regions within Europe, Asia, and the Americas, and periods from antiquity to the 21st century. eISBN: 978-94-6166-283-5. Subjects: Garden & Landscape, Architecture & Architectural History, Sociology.Â 2013) of three re-cartographies of one and the same region, south-west Flanders, which touches upon some contemporary issues that cut across the disciplines of cartography and urbanism. The three re-cartographies re-imagine the territory of south-west Flanders in contemporary terms. The modern form of the word, with its connotations of scenery, appeared in the late sixteenth century when the term landschap was introduced by Dutch painters who used it to refer to paintings of inland natural or rural scenery.Â This is done within a variety of landscape scales, development spatial patterns, and organizational levels of research and policy.[9][10][11]. Landscape is a central concept in landscape ecology. It is, however, defined in quite different ways.Â A cultural landscape, as defined by the World Heritage Committee, is the "cultural properties [that] represent the combined works of nature and of man."[41]. 7. Landscapes: Landscape analysis layers a. Answer: Ecological land units (ELUs) are areas of distinct bioclimates, landforms, lithology, and land cover that form the basic components of terrestrial ecosystem structure. 8. Thought Leader: Richard Saul Wurman: A map is a pattern made understandable a. Answer: Answers will vary.Â c. Answer: Proximity analysis is the most common type of spatial relations. It can be a symmetrical buffer or an asymmetrical drive-time. d. Answer: Spatial patterns deal with the distributions of values (attributes) and the spatial arrangement of the locations. 7. Thought Leader: Linda Beale: The challenge is making complex data understandable a. Answer: Health outcomes are spatial and characterized by human and physical. geographies. Spatial variance is also dependent on the extent of a n investigation. Holding grain constant, a n. increase in extent will incorporate greater spatial heterogeneity, as a greater variety of patch types or landscape elements is included in the area being studied (Fig. 1).Between-grain variance increases with a broadening of scale (extent) (Fig. 2b).Â Short-term studies conducted at broad spatial scales generally have high apparent predictability (pseudopred~ctability) because the natural dynamics of the system are so much longer than the period of study. often, ecologists and resource managers have been most interested in making and testing predictions on relatively short time scales, regardless of the spatial scale of the investigation.