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Spatio-Temporal Dynamic of Woody Vegetation Assessment Using Oblique Landscape Photographs

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Abstract : Ground-level landscape photos can be used as a source of objective data on woody vegetation and vegetation dynamics. We proposed a method for processing, analyzing, and presenting ground photographs, which has the following advantages: 1) researcher has to form holistic representation of the study area in form of a set of interlapping ground-level landscape photographs; 2) it is necessary to define or obtain characteristics of the landscape, objects, and phenomena present on the photographs; 3) it is necessary to create new or supplement existing textual descriptions and annotations for the ground-level landscape photographs; 4) single or multiple ground-level landscape photographs can be used to develop specialized geoinformation layers, schematic maps or thematic maps; 5) it is necessary to determine quantitative data that describes both images as a whole, and displayed objects and phenomena, using algorithms for automated image analysis. It is suggested to match each photo with a polygonal geoinformation layer, which is a sector consisting of areas corresponding with parts of the landscape visible in the photos. Calculation of visibility areas is performed in a geoinformation system within a sector using a digital model of a study area relief and visibility analysis functions. Superposition of the visibility sectors corresponding with various camera viewpoints allows matching landscape photos with each other to create a complete and wholesome representation of the space in question. It is suggested to user-defined data or phenomenons on the images with the following superposition over the visibility sector in the form of map symbols. The technology of geoinformation layers' spatial superposition over the visibility sector creates opportunities for image geotagging using quantitative data obtained from raster or vector layers within the sector with the ability to generate annotations in natural language. The proposed method has proven itself well for relatively open and clearly visible areas with well-defined relief, for example, in mountainous areas in the treeline ecotone. When the polygonal layers of visibility sectors for a large number of different points of photography are topologically superimposed, a layer of visibility of sections of the entire study area is formed, which is displayed in the photographs. Also, as a result of this overlapping of sectors, areas that did not appear in the photo will be assessed as gaps. According to the results of this procedure, it becomes possible to obtain information about the photos that display a specific area and from which points of photography it is visible. This information may be obtained either as a query on the map or as a query for the attribute table of the layer. The method was tested using repeated photos taken from forty camera viewpoints located on Ray-Iz mountain massif (Polar Urals, Russia) from 1960 until 2023. It has been successfully used in combination with other ground-based and remote sensing methods of studying the climate-driven dynamics of woody vegetation in the Polar Urals. Acknowledgment: This research was collaboratively funded by the Russian Ministry for Science and Education project No. FEUG-2023-0002 (image representation) and Russian Science Foundation project No. 24-24-00235 (automated textual description).

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