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Adjustment of geometric level of detail charactristics based on landuse/landcover distribution

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Abstract:

Generalization models are guided by numerical parameters that define the resulting detail of a map. However, detail is still a weakly formalized and elaborated concept. Previous investigations try to assess the geometric side of detail through assessment of conceptual schema, geometric resolution, precision and granularity. Such characteristics as feature type, vertex density, object size, shortest edge length and others can be utilized in complex characterization of detail. However, average geometric characteristics and density of spatial features can differ significantly for topographic maps of the same scale which cover the areas with different landscape complexity. As a consequence, economically developed, especially urban landscapes, which are often more complex than natural, can be mistakenly judged as having higher level of detail (LoD) than homogeneous natural landscapes represented in the same database. The same bias can be observed for mountainous regions in comparison to planes.

In this work in progress we investigate the possibility to adjust the characteristics of LoD in a way that removes the influence of landscape complexity and makes the comparison of LoDs more robust. We extracted 200x200 km fragments of 1:200k, 1:500k and 1:1M digital topographic maps which cover 9 different areas around the cities of Groznyy, Moscow, Petrozavodsk, Rostov-on-Don, Salekhard, Sharia, Surgut, Ufa, and Voronezh in Russia. Calculated detail characteristics included relative mesures such as feature density, vertex density, intersection density, and absolute measures, such as mean width of a bend, mean height of a bend and average feature area.

Currently performed investigation included the subset of topographic data which characterizes the socio-economic infarstructure. Therefore, we extracted the settlement boundaries, settlement block structure, roads and railways, engineering networks and administrative boundaries. All features were combined into one set, and the mean values of characteristics described above were calculated for each map fragment. Both relative and absolute characteristics of detail showed a a significant variance inside one LoD, hence performing a Student test did not allow to differentiate LoDs based on mean values of these characteristics.

Since the extracted fragments differ significantly in their economic development and urbanization, we investigated the influence of this factor on resulting detail characteristics. For this we utilized the independent Copernicus Global Land Cover (CGLC) raster data with 100 m spatial resolution. The fractions and urban and crop areas (all other 20 types are natural) for each map fragment were calculated based on CGLC data. Then regression analysis between these fractions and the relative (density) characteristics of map detail was performed. Results indicated the statistically significant ($p < 0.05$) dependence between the logarithm of urban/crop fractions and relative detail characteristics. Obtained regressions showed different slope for different LoDs, therefore to compensate for this effect, we normalized each characteristic on the mean value for each LoD. This allowed us to obtain a general model of dependency:

$$d_i = \alpha_i + \beta_i \log(u + 1) + \gamma_i \log(c + 1),$$

where d_i is the value of normalized relative characteristic of detail, u is urban fraction, and c is crops fraction. This model predicts how much higher or lower is the relative characteristic of detail for the current map fragment in relation to the mean value of the same characteristic for all map fragments of the same LoD. Using this model we obtained the expected values of normalized relative characteristics for each map fragment, and divided the true value on the modelled value. This transformation reduced substanttially the variance of relarive characteristics of detail for each map LoD and allowed

statistically significant differentiation of the different LoDs using the Student test. Thus, the influence of economic development on resulting detail estimations was reduced, which resulted in a more robust approach.

We plan to extend this approach on natural layers of topographic maps, and to add landscape complexity measures as a predictors of normalized geometric detail masures. Extended results as well as those described in the current abstract will be presented at the workshop.

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