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Interlevel information loss in hexagonal discrete global grid systems

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Abstract:

An increase in the speed of obtaining spatial data and the volume of their accumulation requires the development of a theory and technology for data integration, analysis and visualization. Discrete global grid systems (DGGS) which are spatial reference systems that use a hierarchy of equal area tessellations to partition the surface of the spherical Earth into grid cells, seems to be an efficient way to manage big geospatial data. The strict hierarchy of DGGS suggests that it can be a generalization tool. Generalization is associated with a change in the information amount on a cartographic image. The objective of this research is to assess the change in the amount of spatial information when moving between levels in DGGS of different configurations.

The problem is widely considered in the context of choosing the optimal set of resolutions for rasters displaying various geographical phenomena. However, no such studies have been conducted for discrete global grid systems. Only one article, Wang et. al. (2010), uses entropy as a measure of the information constancy when selecting a DGGS hierarchy level for spatial data visualization.

We considered hexagonal grid systems with aperture 3, 4 and 7. To estimate information at each level and difference between levels three indicators were used: entropy, mutual information and Kullback–Leibler divergence. For vector and raster source data we selected the finest suitable levels of each kind of DGGS and then aggregated data to obtain coarser levels. We examined data of different measurement types (nominal, ratio, etc.) and, in case of raster data, different resolutions. Thus, several aggregation operations were used: sum, mean, weighted mean, majority.

The results of the analyses show that (i) the amount of information decreases with decreasing resolution and the rate of decrease greater for DGGS with aperture 7; (ii) for each aperture it is possible to determine the number of levels within which the amount of information will noticeably decrease during the aggregation process and then become approximately constant. The research has yielded extensive quantitative results which will form the basis of the generalization of spatial data on DGGS study.

References

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