

Modifiable Areal Unit Problem

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The Modifiable Areal Unit Problem (MAUP) is present in spatial data and is defined as “a problem resulting from the imposition of artificial units of spatial reporting on continuous geographical phenomenon resulting in the generation of artificial spatial patterns (Heywood, 1998).” Geographic data is often aggregated in order to present the results of a study in a more useful context, and spatial objects such as census tracts boundaries are examples of the type of aggregating zones used to show results of some spatial phenomena.

MAUP consists of two components: one is the **scale problem**, which is the variation in numerical results that occurs due to the numbers of zones used in an analysis; the other is the **aggregation problem** or **zonation effect**, which refers to which zoning scheme used at a given level of aggregation (or the variation in numerical results arising from the grouping of small areas into larger units). The scale problem is the tendency for different statistical results to be obtained from the same set of data when the data is grouped at different levels of spatial resolution. Many have found this effect including Armheim (1995) who found differences in numerical results between mortality rates by municipality and health areas. Given that many policy decisions are made on the basis of statistical associations obtained from the analysis of spatial data more attention needs to be paid to the MAUP.

To solve MAUP, two difficulties need to be overcome: one is the development of an adequate statistical framework and clearly formulated models for treating these problems. The other is the lack of a practical method which can be offered to researchers for using areal data to draw meaningful inferences about individual/household-level relationship (Wrigley, 1995). A few generic and practical solutions exist and researchers have only begun to unpack the effect of MAUP on analysis. Weighing areal units by population, as well as complex statistical procedures are currently being explored to address MAUP. A straightforward way to deal with this problem is to analyze it at multiple scales or zones. Even in the absence of a solution, recognition of the effect of scale and zone is imperative when using spatial data.

Roger Bivand's (1998) review reports on recent contributions to the literature by Fotheringham and Wong (1991), Amrhein (1995), Fisher and Langford (1995), Amrhein and Reynolds (1996), and Morphet (1997). Openshaw (1996) summarizes many of the technologies now available for choosing zoning systems to optimize results. Bivand (1998) suggests that the most interesting work has resulted from collaboration between social statisticians experienced in complex survey design and geographers, including Holt, Steel, Tranmer, and Wrigley (1996) and Holt, Steel, and Tranmer (1996), and Wrigley (1995). Focusing closely on the scale and zoning effects, these authors conclude that the use of well chosen grouping variables to adjust the area-level results may yield reliable estimates of underlying individual-level relationships, thus providing at least a partial solution to the MAUP with respect to the “ecological fallacy”, the drawing of individual-level inferences based on area-level analyses.

An assessment of developing and implementing a geocomputational pattern-seeking paradigm within GIS has done by Openshaw and Albanides (1999). They anticipate that the proliferation of digital spatial databases, coupled with the ever-wider use of GIS, will allow users to create their own customized zonal representations of spatial distributions. Their approach to calculating zonal averages is inductive, and uses the computational power of GIS to identify the full range and diversity of outcomes that zone design can generate through repeated scaling and aggregation experiments (Longley et al., 2001).

Reference and Further Readings

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Other websites about MAUP include:

- Jerry Ratcliffe (now of Temple) <http://www.jratcliffe.net/research/maup.htm>
- Lisa Oliver (University of British Columbia)
http://www.geog.ubc.ca/courses/geog516/notes/MAUP_lecture.htm