

MODIFIABLE TEMPORAL UNIT PROBLEM

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In spatial thinking (thus, in solving many geographic tasks), time is a fundamental element. This has been broadly acknowledged and demonstrated in geographic information science literature for decades (Hägerstrand 1970; Thrift 1977, Pequet 1988; Miller and Bridwell 2009). For example, when studying human activities in physical space, or when assessing the environmental impact of geographic processes, temporal aspect is critically important (Meentemeyer 1989; Kraak 2000; Ott & Swiaczny 2001). But how do people decide whether a temporal resolution is appropriate or not to perform the spatio-temporal analysis of a geographic process? This is essentially a question of scale in temporal dimension. In this position paper we treat this question at a conceptual level, drawing a parallel with the well known Modifiable Areal Unit Problem (MAUP), and introducing the term *Modifiable Temporal Unit Problem* (MTUP).

In spatio-temporal analysis of geographic processes, temporal granularity can introduce critical issues (Meentemeyer 1989; Gibson et al. 2000; Hornsby and Egenhofer 2002). These issues are similar to those related to the MAUP (Openshaw and Taylor 1979). The MAUP is a well studied, yet formally unresolved problem (Reynolds 1998; Shawna and Bram 2007). It can introduce strong bias to the interpretation of the statistical hypotheses; even produce false positives or negatives. The analyst has to be aware the MAUP. Considering that time is a part of any geographic process, the analyst must also be aware of problems that relates to the temporal scale. Therefore, we suggest categorizing the problems of temporal scale under the common denominator of MTUP. The MTUP, in our view, consists of three aspects: duration (how long), temporal resolution (how often) and the point in time (when).

A growing number of studies deal with temporal data to analyse the spatio-temporal variability, the temporal extent and the periodicity of geographic processes. Meentemeyer (1989) suggests that every type of activity/process has its own temporal and spatial resolution range. Additionally, Harrower (2000) demonstrates that, when visualizing temporal data, some behavior can only be seen in a certain resolution of time. Therefore, selecting the appropriate level of detail for a task is essential to study the right phenomena (Hornsby and Egenhofer 2002). Thus, we argue that the MTUP is of critical importance as the identified phenomena in a spatio-temporal analysis depend on the temporal resolution.

Currently, the decisions on the choice of a temporal scale for a task often depend on the data availability alone, or on "trial and error" approaches, rather a grounded theory. There are many different ways but no standard 'container' to deal with temporal unit problems. We currently study the MTUP with a self-developed tool called TIMELINE (Kuhn et al. 2011); by creating animations based on existing webcams, with controlled temporal input. On-going research within this project is to visualize the impact of MTUP on the spatio-temporal analyses of geographic processes, and to establish a formalised method to choose an appropriate time unit for analysing a phenomenon. In the workshop we would like to present and discuss our approach with our peers to refine our thinking.

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