

**Context and Uncertainty in Geography and GIScience:  
Advances in Theory, Methods, and Practice**

[Forum on “Context and Uncertainty in Geography and GIScience: Advances in Theory,  
Methods, and Practice” – Guest editorial]

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**Abstract**

This article introduces the background and contents of this forum, which includes six articles based on presentations in the opening and closing plenary sessions of the featured theme on “Context and Uncertainty in Geography and GIScience” at the 2017 AAG annual meeting in Boston. The purpose of the featured theme was to explore and deepen our understanding of the spatiotemporal uncertainties in the contextual influences on human behavior, practice, and experience. All articles in this forum focus on specific themes concerning context and uncertainty in geographic and GIScience research. They provide a helpful discussion of the complexity and challenges of specific issues through different theoretical and methodological perspectives.

**Key Words:** environmental influence, geographic context, neighborhood effect, uncertainty, GIScience.

## **Context and Uncertainty in Geography and GIScience: Advances in Theory, Methods, and Practice**

Much of geographic and social science research is concerned with the influence of contextual or environmental factors on human behavior, practice, and experience. Widely understood as the neighborhood effect in urban and health research, contextual influences on people's behavior and experience have often been analyzed using arbitrary and static enumeration units (e.g., census tracts or post-code areas), which may deviate significantly from the true causally relevant geographic contexts and ignore the role of past contexts on current behavior or experience.

The spatial dimension of this problem has been recognized and articulated as the uncertain geographic context problem (UGCoP): the problem that findings about the effects of area-based attributes (e.g., neighborhood walkability or social deprivation) may be affected by how contextual units are geographically delineated and the extent to which these areal units deviate from the true causally relevant geographic context at a given moment (Kwan 2012). It is a significant methodological problem because it means that analytical results can be different for different delineations of contextual units (e.g., census tracts, circular buffers, network-based buffers, or perceived neighborhoods) even if everything else is the same.

There is also a temporal dimension to the problem of contextual influence: the effects of contexts from earlier times may manifest at later moments (e.g., of a day or the life course)

when connectivity over time becomes more important or relevant than connectivity over space (e.g., spatial proximity). Such relational effects have been described in many different ways (e.g., historical dependence, spill-over or life-course effects), but they remain poorly understood and their evaluation presents major methodological challenges. For instance, it is difficult to identify which, when, where, for whom, and how past contexts matter. Spatially uncertain contextual effects are thus also mediated and often amplified by temporal uncertainties.

To explore and deepen our understanding of spatiotemporal uncertainties like these, the featured theme on “Context and Uncertainty in Geography and GIScience” at the 2017 AAG annual meeting in Boston was convened. The featured theme had about 30 sessions, featuring geographers and GIScientists with relevant research expertise in the analysis of contextual effects on human behavior, practice, and experience. The papers were solicited from all geographic subfields and perspectives, and the topics include: (1) more accurate representation and assessment of the space-time configurations of environmental risk factors, individual daily mobility, and their interactions (e.g., capturing situational contingencies and real-time contexts with ecological momentary assessment; reconstructing the daily paths and activity spaces of individuals of different social groups using means like GPS, mixed methods, and qualitative GIS; and collecting and using high resolution space-time data of environmental influences and individual mobility); (2) examination of the differences between the UGCoP and the modifiable areal unit problem (MAUP); (3) exploration of means for mitigating the UGCoP; (4) conceptualizations of temporally extended and spatiotemporally uncertain contextual effects;

(5) realistic representations of such effects using quantitative and mixed methods approaches; and (6) empirical examination of temporally extended as well as spatiotemporally uncertain contextual effects.

In light of the tremendous interest the featured theme generated, we invited the six speakers of the theme's opening and closing plenary sessions to contribute to this Forum on "Context and Uncertainty in Geography and GIScience: Advances in Theory, Method, and Practice." The first article by Goodchild argues that many contextual factors may explain a phenomenon, but the distances over which such factors have influence are largely unknown. As a result, the geographic extent of the phenomenon's context is uncertain, and there are many possible definitions of geographic context. Further, suitable data available for defining context are often limited because some useful variables may be limited due to data confidentiality or the need to protect individual privacy. As the recent increase in the amount of geospatial data suggests that characterizing context should be easier than before, these new data sources bring new forms of uncertainty. Goodchild discusses GIS techniques that are useful for operationalizing new conceptualizations of geographic context and avoiding the problems of using reporting zones to define context.

Drawing upon recent studies, the article by Kwan argues that neighborhood effects may not be as robust or reliable as often assumed and researchers need to be attentive to their limitations. It explores the complexities of contextual influences and the challenges in accurately representing and measuring individual exposures to those influences. It discusses the

idiosyncratic and multidimensional nature of contextual effects, the temporal complexities of contextual influences, the frame dependence of exposure measures, selective mobility bias, and publication bias in neighborhood effects research. The article concludes with some suggestions about how contextual uncertainties may be mitigated in future research (e.g., through collecting and using high-resolution space-time data, and moving toward frame-independent exposure measures whose results are not affected by how data are organized with respect to space and time).

Pearce argues that much geographic research on the relationships between health and place has focused largely on spatiotemporal mobility over short time periods (e.g., day, week), and that there is little work to date that examines the extent to which people are exposed to different types of environments and places over their full life span. Drawing upon recent studies, he explores whether the influences of place are cumulative or if there are critical periods during the life course that are particularly important for health. Using the life course of place framework (Pearce 2015) and the longitudinal data his team have collected recently, Pearce discusses the challenges in integrating longitudinal environmental data with longitudinal health and demographic information. He suggests that the approach offers ample opportunities for researchers to develop better understandings of the complex relationships between health and place and how place-based processes operate to affect health through people's life.

Griffith explores research frontiers regarding uncertainty and context in geography and GIScience with a specific focus on spatial autocorrelation, spatial sampling, and georeferenced

public health data. The article provides an overview of three sessions of the featured theme that focused on these three areas. Griffith discusses the five major sources of uncertainty of particular relevance in geography and GIScience: calculation, measurement, specification, sampling, and stochastic. He concludes that much of uncertainty in spatial and space-time data is still unknown, and it is important to better understand uncertainty associated with geocoded public health data.

In his contribution, Schwanen concentrates on uncertainties in contextual effects on everyday mobility that are not necessarily mitigated by better data or analysis techniques. Using cycling as an example, he reflects on the ‘unknown unknowns’ that emerge when causality is understood only as regularity in conjunction with one or more dependent variables and contextual and other independent variables. He proposes that mobilizing multiple understandings of causality in research can shed light on forms of uncertainty that are otherwise difficult to identify and thus offer novel, more dynamic insights into how contexts affect behavior, practice, and experience.

To address the increasing complexity of and uncertainties in spatial big data (SBD), Zhang et al. propose advanced SBD analytics for extracting knowledge from SBD with stage-by-stage uncertainty handling to enhance the reliability of the knowledge generated. Their article explores challenges in several areas in uncertainty-based SBD analytics: place-based heuristics and analytics, biases and semantic information inferences of cellphone tracking data, quality assessment of user-generated images and texts, and uncertainties in deep learning and other

black-box analytics for spatial big data. The uncertainty-based SBD analytics Zhang et al. propose seek to understand and mitigate the uncertainties in spatial big data and their propagation in each stage of the geographic knowledge extraction process.

All articles in this Forum focus on specific themes concerning context and uncertainty in geographic and GIScience research. They provide a helpful discussion of the complexity and challenges of specific issues through different theoretical and methodological perspectives. We hope they will be useful for understanding and addressing particular concerns of geographic context and uncertainty in future research.

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