Geo-Narrative: Extending Geographic Information Systems for Narrative Analysis in Qualitative and Mixed-Method Research*

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This research seeks to contribute to advancing qualitative methodologies at the intersection of qualitative geographic information systems (GIS), narrative analysis, 3D GIS-based time-geographic methods, and computer-aided qualitative data analysis. The approach to GIS-based narrative analysis developed in the study, called "geo-narrative," is based on extending current GIS capabilities for the analysis and interpretation of narrative materials such as oral histories, life histories, and biographies. The three central elements in this approach are (1) narrative analysis as the qualitative approach; (2) 3D GIS-based time-geographic methods as the representational framework; and (3) 3D-VQGIS as the GIS-based computer-aided qualitative data analysis component. A case example based on a study of the lives of the Muslim women in Columbus, Ohio, after 11 September 2001 is used to illustrate the approach. **Key Words: 3D-VQGIS, CAQDAS, geo-narrative, narrative analysis, qualitative GIS.**

这项研究将专注于定性地理信息系统（GIS），叙事分析，三维地理信息系统为基础的时间与地域方法，和电脑辅助的定性数据分析的交汇点以精进定性研究方法。调查范围主要探讨了基于地理信息系统的叙事分析法，简称为"地理叙事。"它的产生是基于扩大现有地理信息系统的能力，以便分析和解释例如口述历史，生活历史和传记等叙事的材料。这个方法的三大核心要素分别是：（1）叙事分析作为定性的方法；（2）三维地理信息系统为基础的时间与地域方法作为代表性的框架；以及（3）三维可视化查询地理信息系统（3D-VQGIS）作为地理信息系统为基础的电脑辅助定性数据分析的组成部分。一项关于穆斯林妇女自2001年9月11日在美国俄亥俄的生活将作为案例来说明此方法。关键词：三维可视化查询地理信息系统（3D-VQGIS），电脑辅助质性资料分析软体（CAQDAS），地里叙述，叙事分析法，定性地理信息系统。

Esta investigación tiene como objetivo contribuir al avance de las metodologías cualitativas que se encuentran en la intersección de los sistemas de información geográfica (GIS, SIG) cualitativa, el análisis narrativo, los métodos tridimensionales, temporales geográficos basados en GIS y los análisis de datos cualitativos auxiliados por computadora. El acercamiento al análisis narrativo basado en GIS desarrollado en el estudio y llamado "geonarrativo" se basa en la ampliación de las capacidades actuales del GIS para el análisis e interpretación de materiales narrativos tales como historias orales, historias de vidas y biografías. Los tres elementos centrales de este acercamiento son (1) el análisis narrativo como el acercamiento cualitativo; (2) métodos tridimensionales, temporales geográficos basados en GIS como el marco figurativo; y (3) VQGIS tridimensionales como el componente de análisis cualitativo de datos auxiliado por computadora y basado en GIS. Para ilustrar este acercamiento, se usa un ejemplo basado en un estudio de la vida de las mujeres musulmanas en Columbus, Ohio, después del 11 de septiembre de 2001. **Palabras clave: VQGIS 3D, CAQDAS, geonarrativo, análisis narrativo, cualitativo GIS.**

Story . . . is the portal through which a person enters the world and by which their experience of the world is interpreted and made personally meaningful.

—Connelly and Clandinin 2006, 479

As geographic information systems (GIS) are understood by many as largely a tool for the storage and analysis of quantitative data, their use in qualitative or mixed-method research has been limited to date. Attempts in recent years to redress this particular understanding of GIS, however, have opened up new possibilities for engaging GIS in qualitative geography (e.g., Mugerauer 2000; Sheppard 2001; Kwan 2002a, 2002b; 2007a, 2007b; Bell and Reed 2004; Kwan and Knigge 2006; Pavlovskaya 2006). Sheppard (2001), for instance, argues that GIS practices are not necessarily quantitative because GIS can incorporate qualitative materials (e.g., photos, videos, and narratives). Kwan (2002a, 2002b, 2007a, 2007b) conceives alternative GIS practices for interpreting and understanding people's lived experiences rather than for conducting quantitative spatial analysis. She asserts that understanding GIS largely as a quantitative method forecloses many opportunities to productively engage GIS in qualitative research. Pavlovskaya (2006) argues that GIS are often not as quantitative as many geographers assume and suggests that there are "openings" in GIS that enable their use in qualitative research. With these arguments supporting the integration and use of GIS in qualitative geography, many geographers have started to conceive the role of GIS in their research differently in recent years (e.g., Pavlovskaya 2002, 2004; Knigge and Cope 2006; Pain et al. 2006; Kwan 2007a, 2008; Brown and Knopp 2008). They have engaged with GIS in a wide variety of exploratory studies or experimentations, and the relationship between GIS and qualitative research is undergoing important changes.

Yet the earliest attempts to use GIS data and methods in qualitative research were made by participatory GIS researchers (e.g., Harris et al. 1995; Jordan 2002; Weiner and Harris 2003). Harris et al. (1995, 197), for example, explored how local knowledge of different participants may be represented in the form of sketch maps and how this knowledge can be "converted into data within a GIS for research and public policy formation" in the context of participatory community planning. The participatory qualitative methodologies developed in these early studies have informed many subsequent studies that seek to incorporate people's local knowledge through a participatory or action research framework (e.g., Rambaldi and Callosa-Tarr 2002; Cinderby and Forrester 2005; Dennis 2006; Pain et al. 2006; Hawthorne, Krygier, and Kwan 2008). These studies tend to involve some mapping exercises through which people's spatial knowledge or perception is "translated" into an explicitly spatial form using existing hardcopy maps. The spatial representations generated in the mapping exercises are then digitized and incorporated into GIS databases. This process is often iterative, involving participants' input, evaluation, and validation at several stages before the final GIS representations or maps are produced. Further, there is also an extensive public participation GIS (PPGIS) literature that examines the process of knowledge production and the power politics embedded in GIS deployments by marginalized or underrepresented social groups (e.g., Elwood 2002; Elwood and Ghose 2004). These PPGIS studies have furnished us with a nuanced understanding of the complex role of GIS in the knowledge production process in the PPGIS context.

Informed by these developments in PPGIS research, there are also important developments in qualitative GIS methodologies in human geography in recent years. In some studies, GIS-based data analysis, mapping, and visualization are deployed to complement or triangulate (i.e., verify results using multiple data sources) the knowledge acquired through the qualitative component of the research. Pavlovskaya (2002, 2004), for instance, uses GIS maps to complement the ethnographic data she collected to illuminate the multiple economies in post-Soviet Moscow at the household level. In Matthews, Detwiler, and Burton (2005), census sociodemographic data are incorporated into a GIS database to provide the context for enriching the interpretation of the ethnographic data collected in the study (see also Skinner, Matthews, and Burton 2005). Cultural and political ecologists have found discrepancies between the "objective"

knowledge provided by GIS data and people's partial knowledge revealed through qualitative methods such as oral histories and participant observation (e.g., Heasley 2003; Jiang 2003; Nightingale 2003). Examination of these discrepancies or contradictions has yielded significant insights into people's spatial knowledge and the meanings they ascribe to particular environmental resources in different social and cultural contexts. In a similar vein, Pain et al. (2006, 2064) use qualitative data of people's fear and experiences of crime to "verify, qualify, and interpret" the results obtained from GIS-based quantitative analysis of police-recorded crime data. The study found that crime hotspots often do not reflect residents' experiences of crime, and satisfaction with street lighting has little relationship with mapped lighting coverage. Combining GIS analyses with qualitative data has enabled researchers to identify issues or raise questions that would not be apparent otherwise in these studies (Skinner, Matthews, and Burton 2005; Knigge and Cope 2006).

In addition to using GIS data and analyses to complement, triangulate, or interpret the knowledge acquired from qualitative data, geographers have envisaged qualitative GIS methodologies that go beyond the static and Cartesian framework of current GIS. Important developments in this direction include multimedia and Internet GIS, which seek to enhance the knowledge production process of qualitative or mixed-method research through incorporating a wide variety of textual and nontextual materials (audios, photos, videos, and narratives) into GIS (e.g., Shiffer 1998, 2002; Al-Kodmany 2000, 2002; Wong and Chua 2001; Bosworth, Donovan, and Couey 2002; Krygier 2002; Lancaster and Bodenhamer 2002; Sieber 2004; Matthews, Detwiler, and Burton 2005; Knigge and Cope 2006). In these applications, geographic features displayed in a GIS (or a Web page) are linked to various types of multimedia files or other Web pages with information pertaining to that feature or location (Shiffer 2002). By making "personal, local, and imaginative narrations, images, and other perceptual-qualitative information" accessible within GIS, multimedia and Internet GIS present "a set of alternative geographies and alternative ways of visualizing those spaces and places inhabited and experienced by diverse groups" (Mugerauer 2000, 318–19).

In much of this literature, the conceptual basis and the analytical approach remain largely implicit. This has started to change with recent contributions such as those included in the special issue on qualitative GIS coedited by Kwan and Knigge (2006). Knigge and Cope (2006, 2021), for instance, describe a research strategy that integrates the analysis of qualitative and quantitative data through grounded theory and visualization—which they aptly called "grounded visualization." The key to this analytical strategy, they argue, lies in a recursive, reflexive, and iterative integration of different processes of data collection and analysis. Drawing on recent work in feminist and critical GIS, they show that grounded theory and visualization can be used together to "construct an integrated analysis strategy that is both iterative and reflexive, both contextual and conceptual" (Knigge and Cope 2006, 2021). Matthews, Detwiler, and Burton (2005), on the other hand, is based on another major qualitative approach: ethnography (Baszanger and Dodier 1997; Tedlock 2000; Silverman 2001). In their multisite study of low-income and welfare recipient families and their children, family and neighborhood ethnographies are integrated in a GIS and made accessible to researchers through a custom interface in ArcGIS. The integration of GIS and ethnography has allowed researchers to visualize and better understand the complexity of the lives of low-income families and the strategies they adopt in negotiating the welfare system. The contextual data in the GIS also play an important data verification function: By mapping the route of an ethnographer's neighborhood walkthrough, instances where he or she is inside or outside the study area can be easily identified (Matthews, Detwiler, and Burton 2005).

Explicit discussion of the qualitative approach adopted and the analytical process (including validation and verification procedures) in these studies goes a long way in addressing the concern for rigor in qualitative research (Baxter and Eyles 1997; Bailey, White, and Pain 1999; Peräkylä 2001; Bradshaw and Stratford 2005). As qualitative materials are incorporated into GIS in these studies through hyperlinks, they are linked to specific geographic features in the GIS database and are accessible for displaying and viewing purposes.[1] For nontextual materials such as photos and voice clips, this

mode of integration poses little problem for the analytical process, but as textual materials such as interview transcripts and field notes are also linked as external files, specific contents of these textual materials (e.g., particular segments of text) cannot be linked to specific geographic features in the GIS database and analyzed within the GIS. As there are no qualitative data analysis capabilities in current GIS, analysis and interpretation of the textual data (e.g., coding, relationship building, and theory building) are performed outside the GIS in these studies using computer-aided qualitative data analysis software (CAQDAS) such as ATLAS.ti and NUD*IST (e.g., Matthews, Detwiler, and Burton 2005; Knigge and Cope 2006). Although an increasing number of geographers are adopting CAQDAS in their research, these programs were developed outside geography and therefore lack capabilities to deal with the geographic or spatial dimension of qualitative data (Crang et al. 1997; Peace and van Hoven 2005). This remains a limitation of recent research on qualitative GIS. It points to the need to explore how qualitative data analysis capabilities can be built within current GIS so that textual materials can be analyzed and interpreted in relation to particular geographic features and spatial context within a GIS.[2]

This article seeks to address this limitation of recent approaches through exploring a more direct approach to incorporating and analyzing qualitative data in GIS: building qualitative data analysis capabilities in GIS. To accomplish this, we conceptualize, design, and implement a 3D geovisualization and qualitative analysis component, called 3D-VQGIS, in ArcGIS, drawing on the design and analytical capabilities of contemporary CAQDAS. The component aims at facilitating the interactive exploration, interpretation, and 3D geovisualization of qualitative data and materials. Further, as recent qualitative GIS research has explored the integration of grounded theory and ethnography with GIS-based analysis, we focus on another broad qualitative approach that has received only limited attention in this literature to date: narrative analysis or narrative inquiry—which studies the stories people told about their lived experiences of events and major turning points in their lives over a certain period of time (Clandinin and Connelly 2000; Chase 2005). As the analytical procedures of

narrative inquiry are quite different from other qualitative approaches, we seek to contribute to the literature through exploring how narratives can be incorporated, analyzed, and interpreted in GIS.

As the chronology of people's experience and the sequence of events are central elements in narrative analysis, GIS-based analysis of narratives needs to address not only the spatial dimension but also the temporal dimension of these materials. To achieve this, we draw on recent advances in 3D GIS-based time-geographic methods to provide the representational framework for integrating narrative analysis with GIS. Based on this framework, this study seeks to contribute to advancing qualitative methodologies in geography at the intersection of qualitative GIS, narrative analysis, 3D GIS-based time-geographic methods, and computer-aided qualitative data analysis. This mode of GIS-based narrative analysis is enabled through extending current GIS capabilities for qualitative data analysis. We call this approach "geo-narrative," which was developed to facilitate the creation and interpretation of contextualized cartographic or visual narratives (Kwan 2002a, 2007a, 2007b, 2008). It is intended to be helpful in the analysis of various types of narrative materials, such as oral histories, life histories, and biographies.

Qualitative Research and Qualitative Analysis

Although qualitative methods have been used widely in geographic research throughout the twentieth century, the last two decades or so witnessed considerable development in qualitative methodologies in human geography (e.g., Aitken 2001; Kobayashi 2001; Smith 2001; Valentine 2002). Qualitative research, as Strauss and Corbin (1998, 10–11) suggest, refers to "any type of research that produces findings not arrived at by statistical procedures or other means of quantification. It refers to research about people's lives, lived experiences, behaviors, emotions, and feelings as well as about organizational functioning, social movements, cultural phenomena, and interactions between nations" that uses intensive methods such as in-depth interviews, focus groups, and participant observation. Qualitative research

emphasizes the importance of meanings and values held by people (Miles and Huberman 1994). It seeks to understand and interpret human experience in its socio-spatial contexts (Dwyer and Limb 2001; Winchester 2005). Qualitative methodologies are concerned with how individuals or social groups view and experience the world. They are means for understanding the motives and power relationships that account for how places, people, and events are constructed and represented (Smith 2000).

Qualitative research is particularly suited for certain kinds of research problems (Strauss and Corbin 1998; Creswell 2007). For instance, qualitative research is useful for illuminating how people's experiences of particular spaces, places, and landscapes across geographic scales are shaped by their emotions, aspirations, and memories (e.g., Bosco 2001; George and Stratford 2005; Davies and Dwyer 2007). It is particularly helpful for understanding the experience of people with problems such as chronic illness or drug addiction, as it seeks to obtain the complex details about phenomena such as feelings and emotions that are difficult to learn about through other methods (Strauss and Corbin 1998; Silverman 2001). Further, qualitative research is useful for recovering the silenced voices of marginalized individuals and social groups whose feelings and thoughts have been ignored by the dominant discourse of powerful groups in society (Nagar 1997; Dunn 2005).[3] For instance, the experiences of women, ethnic minorities, poor people, and children are often omitted in official historical records. The use of a variety of archival sources and qualitative materials can help recover the stories and everyday experiences of these people (e.g., Ulrich 1990; Cope 1998; Sparke 1998; Smith 2000). Qualitative methods can therefore help place "non-dominant" knowledges at the center of geographic research (Dwyer and Limb 2001, 7).

Although there are different qualitative approaches (e.g., grounded theory, ethnography, case study), the qualitative research process tends to share some common characteristics (Miles and Huberman 1994; Creswell 2007). For instance, data are often collected in the natural setting in which participants experience the issue or problem under study (Creswell 2007). The research process is emergent and iterative, meaning that research tasks (e.g., data

collection, analysis, theory building) do not necessarily follow a rigid plan or flow and the research plan is open to modifications as new data are collected and new questions emerge in the research process (e.g., as in grounded theory). Further, issues of positionality, reflexivity, situated knowledge, power relations between the researcher and researched, multiple subjectivities, the varied construction of truth, and the politicized nature of research are central concerns in the qualitative research process (Rose 1997; Dowling 2005; Knigge and Cope 2006). Qualitative research is "a form of inquiry in which researchers make an interpretation of what they see, hear, and understand" and the "researchers' interpretations cannot be separated from their own background, history, context, and prior understandings" (Creswell 2007, 39).

When compared to quantitative approaches, the analytical process in qualitative research (or qualitative analysis) is based on different understandings of how knowledge is created, interpreted, validated, and verified (Strauss 1987; Miles and Huberman 1994; Strauss and Corbin 1998; Denzin and Lincoln 2000, 2005; Silverman 2001, 2005; Creswell 2007). Qualitative analysis involves different but related tasks (or operations) and different approaches may use different sets of analytical procedures. In grounded theory, for instance, the analytical procedures "usually consist of conceptualizing and reducing data, elaborating categories in terms of their properties and dimensions, and relating through a series of prepositional statements" (Strauss and Corbin 1998, 12). The purpose of grounded theory is to "build theories from data about the social world such that theories are 'grounded' in people's everyday experiences and actions. The methods of grounded theory are iterative, reflexive, and inductive" and "they involve multiple stages of collecting data, coding and analyzing them, reflecting on emerging themes, collecting more data targeted to initial theories, and constantly comparing the insights that evolve" (Knigge and Cope 2006, 2024–25).

Further, the analytical process in qualitative research tends to be inductive, iterative, recursive, and dynamic (Miles and Huberman 1994; Gibbs 2002). It usually involves building categories, concepts, themes, and theories by organizing the data into increasingly more

abstract constructs and working back and forth among the concepts, themes, and the database until a comprehensive set of themes is established (Strauss 1987; Strauss and Corbin 1998; Creswell 2007). It may also involve "collaborating with the participants interactively, so that they have a chance to shape the themes or abstractions that emerge from the process" (Creswell 2007, 39). Lastly, various verification and validation strategies are often used to ensure that the accounts produced in this analytical process reflect the experience or views of the participants. These strategies include using multiple and different data sources to provide corroborating evidence (triangulation), having the results or written report reviewed and corrected by the participants (member checking), having the procedures and analysis checked by other researchers (peer review), refining the working hypotheses as the inquiry advances in light of negative or disconfirming evidence (negative case analysis), and clarifying researcher bias from the outset of the study (bias disclosure; Mishler 1990; Miles and Huberman 1994; Bailey, White, and Pain 1999; Creswell and Miller 2000).

Geo-Narrative: GIS-Based Narrative Analysis

Based on this understanding of qualitative research, this study seeks to contribute to advancing qualitative methodologies at the intersection of qualitative GIS, narrative analysis, 3D GIS-based time-geographic methods, and computer-aided qualitative data analysis. The approach to GIS-based narrative analysis developed in the study, called geo-narrative, is based on extending current GIS capabilities for the analysis and interpretation of narrative materials such as oral histories, life histories, and biographies. The three central elements in this approach are (1) narrative analysis as the qualitative approach; (2) 3D GIS-based time-geographic methods as the representational framework; and (3) 3D-VQGIS as the GIS-based computer-aided qualitative data analysis component.

Narrative Analysis

Narrative analysis or inquiry is "the study of experience as story" (Connelly and Clandinin 2006, 479). People "shape their daily lives by stories of who they and others are and as they interpret their past in terms of these stories" (Connelly and Clandinin 2006, 375). Narrative analysis studies the stories people told about their lived experiences of events and major turning points in their lives over a certain period of time (Denzin 1989; Riessman 1993, 2007; Connelly and Clandinin 1990; Polkinghorne 1995; Clandinin and Connelly 2000; Chase 2005; George and Stratford 2005; Riessman and Quinney 2005; Clandinin 2006; Creswell 2007; Pinnegar and Daynes 2007). These stories can take a variety of forms. They may consist of personal reflections of events and their causes and effects (oral history), portray a person's entire life (life history), or describe an individual's personal experience found in a single or multiple episodes (personal experience story; Plummer 1983; Denzin 1989). They may be written by the researcher and record the experience of another person's life (biography) or they may be written and recorded by the individuals who are the subject of the study (autobiography; Denzin 1989; Moss 2001; Creswell 2007).

As a research method, the focus of narrative analysis is not only on people's experiences as stories but also on illuminating the social, cultural, and institutional contexts within which those experiences "were constituted, shaped, expressed, and enacted" (Clandinin and Rosiek 2007, 42). Narrative inquiry is useful for "discovering and preserving the experiences of ordinary people," and is particularly valuable for "studying hidden histories and geographies, the place-based lives and memories of disadvantaged people, minority groups, and others whose views have been ignored or whose lives pass quickly, producing few, if any written records" (George and Stratford 2005, 107). It provides "a means to step back to the mix of past times and places *as these are mediated* through the words and memories of another person" in the past or the present (George and Stratford 2005, 108). Narrative research is best for "capturing the detailed stories or life experiences of a single life or the lives of a small number of individuals" (Creswell 2007, 55). Narrative is "a distinct form of discourse" and "retrospective meaning making"; it is "the shaping or ordering of past experience" and "a way of organizing events and objects into a meaningful whole, and of connecting and seeing the consequences

of actions and events over time" (Chase 2005, 656).

The purpose and analytical process of narrative inquiry differ from other qualitative approaches. Narratives such as oral histories are accounts of events or series of events chronologically connected (Czarniawska 2004). The chronology of narratives and the emphasis on sequence distinguish narrative inquiry from other qualitative approaches (Cortazzi 1993). The focus of narrative analysis is therefore on "restorying" people's individual experiences through reorganizing and interpreting those experiences in relation to their particular social, cultural, and political contexts (Creswell 2007, 56). It often proceeds through analyzing the key elements of people's stories (e.g., time, place, plot, and scene), ordering the meaning of people's experiences chronologically, and rewriting those stories in terms of some analytical framework (Ollerenshaw and Creswell 2002; Creswell 2007).

Different analytical frameworks have been used to analyze narratives. For instance, narratives may be analyzed in terms of the five elements of plot structure: characters, setting, problem, actions, and resolution (Yussen and Ozcan 1997). Further, themes that arise from the story may be analyzed to provide a detailed discussion of the meaning of the story, and the analysis may provide a description of both the story and the themes that emerge from it (Huber and Whelan 1999; Creswell 2007). Narratives may also be analyzed using sociolinguistics and discourse analysis, which focus more on how and why experience and events are storied than the contents of what people say (Riessman 1993; Labov and Waletzky 1997; Chase 2005; Riessman and Quinney 2005). For geographic research, however, the three-dimensional narrative inquiry space proposed by Clandinin and Connelly (2000) seems most relevant. In this approach, narratives are analyzed in terms of three main elements: action and interaction (personal and social), time (past, present, and future), and space (physical places or the storyteller's places). As Clandinin and Connelly (2000, 50) suggest, stories "have temporal dimensions and address temporal matters; they focus on the personal and the social in a balance appropriate to the inquiry; and they occur in specific places or sequences of places." The GIS-based qualitative data analy-

sis component developed in this study is intended to deal with various elements of narratives: chronology (epiphanies, events), the three narrative dimensions (action and interaction, time, space), as well as themes.

Time-Geographic Visual Narratives

As the chronology of people's experience and the sequence of events are central elements in narrative analysis, we use time geography as the representational framework for our approach of GIS-based narrative analysis. Time geography conceives the unfolding of a person's life or daily activities as a continuous life path in three-dimensional space (where location is represented by the horizontal dimensions and time is represented by the vertical dimension; Hägerstrand 1970; Parkes and Thrift 1975; Lenntorp 1976). Its integration of the temporal and spatial dimensions into a single framework allows the researcher to examine the complex interaction among space, time, and people's experience (e.g., how a person's feeling may change as he or she visits different places at different times). The time-geographic framework, which explicitly incorporates the spatial and temporal dimensions of people's experience and events, is therefore particularly suitable for exploring "the intersection of the geographical and the biographical" and the "overlapping domains of self and place, positionality and identity, spatiality and subjectivity" (Daniels and Nash 2004, 450).[4] It also closely corresponds to the three-dimensional narrative inquiry space (interaction, time, space) proposed by Clandinin and Connelly (2000, 20)—who suggest that "narrative inquiry is a way of understanding experience . . . over time, in a place or series of places, and in social interaction with milieus."

As the time-geographic representation of a person's life path explicitly portrays the temporal progression of events, it has been a helpful device for creating visual narratives that tell stories about people's experience or unfolding events over space and time. Gregory (1994), for instance, combines the daily path of a dockworker in late nineteenth-century Stockholm with photos and word pictures to tell the story about what life was like in that particular context. Laws (1997) uses the space–time path of a woman's life course to show the changes

in her residential location and spatial mobility from childhood to retirement. The life course space–time diagram she constructed is a helpful visual device for telling biographical stories. Alibrandi, Thompson, and Hagevik (2000) use a similar representation with GIS to represent an individual's biographical narrative in the form of a series of historical life maps. In these cases, spatial stories are presented not as an objective account but as interpreted visual narratives of experience and events based on a person's life path in space and time.

Recent studies have also explored the use of 3D GIS methods for representing and visualizing people's life paths based on the time-geographic framework (e.g., Kwan 1999, 2000, 2002a, 2007b, 2008; Kwan and Lee 2004; Ren and Kwan 2007). These studies show that, when comprehensive geographic data are incorporated to provide the interpretive context, 3D GIS-based time-geographic methods offer a helpful means for visualizing the spatio-temporal data pertaining to people's life paths and lived experience. For instance, Kwan's (2002a) visualization of the daily space–time paths of a sample of individuals in Portland, Oregon, reveals a highly racialized urban space, where the homes and workplaces of African American women are found to be concentrated in a small area of the entire metropolitan region, and their activities' locations are much more spatially restricted when compared to all other gender and ethnic groups. As these time-geographic methods are helpful means for representing the chronology of people's experiences and sequence of events in relation to the relevant geographic context, they provide a useful representational framework for undertaking GIS-based narrative analysis. As Kwan (2002b, 272) argues, when "visual representations of individual daily space–time paths are presented together with an interpretative textual narrative that incorporates other information collected from personal interviews, rich and scale-sensitive spatial stories" about what a person goes through in a particular day can be told.

The method of GIS-based narrative analysis we develop in this study therefore draws on the time-geographic framework. Using life path as the representational tool, people's narratives about their experience and events can be chronologica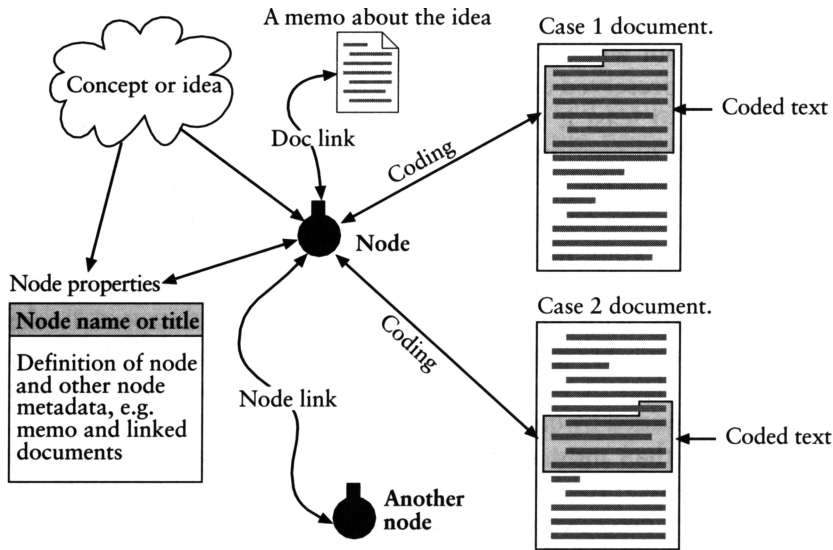lly organized, visualized, and interpreted. Further, by linking specific segments of a person's life path to a wide variety of textual or nontextual materials—such as memos, photos, video and voice clips, subject's handwriting, hand-drawn maps and other sketches—3D GIS time-geographic methods can be augmented to provide a multimedia environment for the interactive interpretation and visual analysis of narrative materials. As Kwan (2002b, 273) suggests, GIS can be used in a manner in which "visual images (albeit generated and composed with digital technology), words, and numbers are used together to compose contextualized cartographic narratives." In the context of "bringing the visual to narrative inquiry," Bach (2007, 281) argues that "[s]eeing is a way of being in relation with people, nature, and self" and composing visual narratives is an important way to "construct knowledge" in qualitative inquiry. Creating visual narratives "is an intentional, reflective, active human process in which researchers . . . explore and make meaning of experience both visually and narratively."

Computer-Aided Qualitative Data Analysis

The third element of our approach to GIS-based narrative analysis is a computer-aided qualitative data analysis component (called 3D-VQGIS) we developed for the analysis of textual data within GIS. It is based on the design and functionalities of NVivo, which is a commonly used CAQDAS program. CAQDAS packages are developed to handle unstructured qualitative data and have specific capabilities for analyzing textual materials—which include text storage and retrieval, word searching, coding, memoing, graphic mapping, hierarchical tree building, concept building, and reflexive report writing (Ryan and Bernard 2000; Weitzman 2000; Gibbs 2002; van Hoven 2003; Peace and van Hoven 2005; Seale 2005). NVivo has considerable capabilities for coding qualitative data, identifying relationships between concepts, and building models based on grounded theory. Its central element is the "project," which holds and organizes all the relevant qualitative data items such as interview transcripts, memos, and field notes for a particular study (Bazeley and Richards 2000; Gibbs 2002).

NVivo uses three systems for managing qualitative data: documents, nodes, and attributes
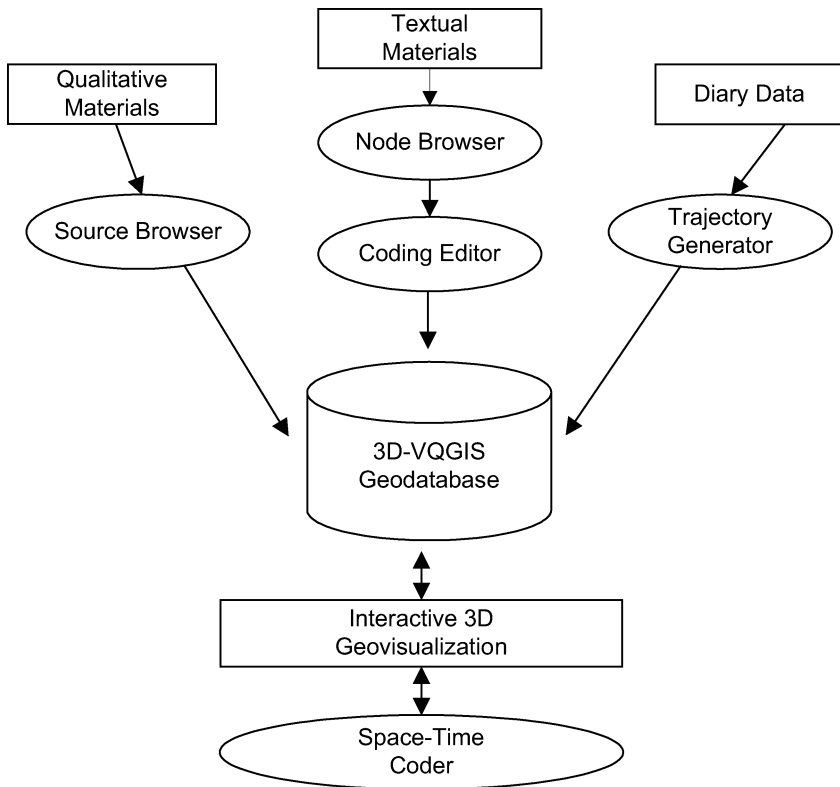
Figure 1 *Relationships among a node, coded text, and documents in NVivo (Source: Gibbs 2002. Used by permission of Graham R. Gibbs).*

(QSR 2002). Documents like interview transcripts in NVivo are plain or rich text files, which can include embedded links to photos, audio clips, spreadsheets, databases, Web pages, or other data items stored outside the program. Any part of a document can be coded at any number of nodes, which are containers of categories and codes (Figure 1). Nodes can represent any categories, including concepts, people, abstract ideas, places, and any other things that are important to the project. They can be stored as free nodes or organized hierarchically in trees or linked networks. Both documents and nodes can have attributes with values that represent any of their properties that can be used in searches. NVivo can be used to perform a variety of qualitative data analysis tasks: (1) linking—documents can be linked to other documents or nodes in the project, and nodes can be linked to other nodes or documents; (2) coding—assigning interpretive tags to text (or other material) based on categories or themes that are relevant to the research; (3) shaping—building trees to link nodes or using sets to group nodes and documents; (4) searching—looking for the occurrences of specific words or phrases, or finding particular combinations of coded text; and (5) modeling—building visual models by drawing, diagramming, or representing ideas and relationships visually (Gibbs 2002; QSR 2002).

As NVivo is a sophisticated CAQDAS program, we do not intend to duplicate all its functionalities in 3D-VQGIS. Our developmental effort in this study focuses on providing some basic qualitative data handling and analysis capabilities within current GIS, including two types of coding functions: conventional qualitative coding and space–time coding (which is described in the next section). In developing 3D-VQGIS, we use an object-oriented design that utilizes and extends the object models of ArcGIS. The core of the system consists of two main components: (1) a database component (called 3D-VQGIS Geodatabase) stores and organizes the data, and (2) a data analysis component with a collection of custom-built functionalities (e.g., Coding Editor; Figure 2).

The database component incorporates the relevant geographic data and multimedia materials. It provides the interpretive context for undertaking GIS-based narrative analysis. It utilizes ArcObjects (the development platform for ArcGIS) to construct custom feature or document objects for storing and managing the data. It was implemented as a geodatabase

Figure 2 *Architecture of 3D-VQGIS.*

in ArcGIS. Several types of objects and geographic features are modeled in the 3D-VQGIS Geodatabase. First, subject's location in space–time is represented in the form of 3D life paths and modeled with the segment, edge, and junction feature classes. Second, geographic objects in the urban environment (e.g., buildings and rivers) are handled as distinctive feature classes with specific properties. For instance, buildings are defined with attributes like function or use (e.g., commercial or residential), height, number of stories, and street address; and land parcels are defined with attributes like land use (e.g., shopping malls or schools). Finally, qualitative materials collected in the study are modeled as document objects. These materials include interview transcripts, voice clips, photos, maps, and handwritten sketches or diagrams.

Custom functionalities for the analysis of qualitative data in 3D-VQGIS were created using Visual Basic for Applications (VBA)

and originally developed dynamic-link libraries (DLLs). This data analysis component of 3D-VQGIS has four main modules (Figure 2): (1) Trajectory Generator, which reads subject's space–time data and generates 3D life paths in ArcScene; (2) Source Browser, which is designed for incorporating, browsing, and managing different types of qualitative materials in the Geodatabase; (3) Node Browser and Coding Editor, which are used to code, edit, and analyze text-based materials incorporated in the Geodatabase; and (4) Space-Time Coder, which is used to link qualitative materials to specific geographic features or segments of a subject's life path. These four qualitative data analysis modules were added to ArcScene as customized components and can be invoked through the function buttons added to the toolbar of ArcScene.

In the next section, we present a case example to demonstrate geo-narrative as an

approach to GIS-based narrative analysis. It draws on Kwan's study on the impact of anti-Muslim hate crimes on the lives of the Muslim women in Columbus, Ohio, after the attacks on the World Trade Center and the Pentagon on 11 September 2001 (hereinafter 9/11).[5] The purpose of presenting this example is mainly to illustrate the approach and the functionalities of 3D-VQGIS. It is not intended to be a systematic report of the research results or an in-depth discussion of the complex methodological or substantive issues involved.

Case Example: Lives of Muslim Women After 9/11

After 9/11 the Muslim population in the United States experienced a dramatic increase in hostility and hate crimes against them. These crimes included various acts of physical violence or direct threats of specific acts of violence. They ranged from simple assault and battery, to rape, arson, aggravated assault, and at least six murders (Council on American-Islamic Relations 2002, 2003). Kwan conducted a study that sought to understand the impact of these crimes or knowledge about these crimes on the lives of the Muslim women in Columbus, Ohio—mainly in terms of how these crimes affect their daily activities and travel, access to and use of public spaces, as well as perception of the urban environment (especially their perception of safety and potential risk in the urban environment before and after 9/11).

The project focused on Muslim women because they are especially vulnerable to anti-Muslim hate crimes and discrimination as many of them can be easily identified in public places based on their distinctive religious attire (Mustafa 1993; Moore 1998; Shakeri 1998; Kaya 2007).[6] Women of the Islamic faith who practice such religious attire wear the Muslim headscarf (*hijab*) in public spaces and in the presence of men outside the family (Shakeri 1998; Nimer 2001). Further, Muslim women are particularly vulnerable because their traditional gender role in the family renders it necessary for them to undertake many out-of-home activities in their normal daily lives (e.g., chauffeuring children to and from schools). As many of these household responsibilities impose rather restrictive space–time constraints

on their daily lives, the need to undertake them can make the lives of these women particularly stressful in the post–9/11 period. To avoid the risk of being harassed or attacked after 9/11, some Muslim women might change their religious attire, and some others might modify their normal daily activities and trips. They may change the places they normally visit (e.g., shopping malls) or the time they visit these places. Through the project, Kwan sought to examine the short-term and long-term impact of Muslim women's fear of being attacked on their daily activities and trips, and the strategies they adopted to cope with the threat of anti-Muslim hate crimes in their daily lives. As reports on anti-Muslim hate crimes and their impact were largely absent in mainstream media after 9/11, the project also sought to expose the silences and omissions of these media as well as to recover the personal emotional geographies of individual Muslim women.

Data Collection

Data for the project were collected from a sample of thirty-seven Muslim women in Columbus in 2002 in two phases.[7] First, an activity diary survey was conducted to record each participant's activities and trips in a designated survey day. Each activity diary recorded data for all activities that the participant undertook in the survey day, including their starting and ending time, travel mode, street addresses, and purposes (e.g., household responsibilities, recreational or social purposes, etc.). Oral histories were then collected through in-depth interviews from each participant shortly after the activity diary survey. They are the participants' stories about what kind of changes 9/11-induced hate crimes might have brought to their daily activities and trips, and to their perception of safety and risk in the urban environment. These oral histories were recorded with digital recorders with the permission of the participants and transcribed for subsequent analysis. In addition, participants sketched on a map of the study area to indicate the locations they frequent in their daily lives and the areas they consider unsafe before and after 9/11. The photos and voice clips used to illustrate the functionalities of 3D-VQGIS in this article, however, were produced with the kind help and permission of a key informant of the project.

Table 1 *Activity diary data of a participant (trips between activities are omitted)*

Activity	Activity description	Activity location	Starting time	Ending time
1	Stayed at home	Home	0:00 a.m.	8:07 a.m.
2	Dropped child off at school	School	8:16 a.m.	8:20 a.m.
3	Stayed at home	Home	8:27 a.m.	9:00 a.m.
4	Had a religious class	Mosque	9:13 a.m.	11:42 a.m.
5	Shopped at a grocery store	Grocery store	11:45 a.m.	12:09 p.m.
6	Shopped at a department store	Department store	12:12 p.m.	12:30 p.m.
7	Shopped at a supermarket	Supermarket	12:54 p.m.	1:55 p.m.
8	Stayed at home	Home	2:07 p.m.	2:40 p.m.
9	Picked up child at school	School	2:51 p.m.	3:12 p.m.
10	Picked up another child at school	School	3:15 p.m.	3:16 p.m.
11	Stay at home	Home	3:34 p.m.	0:00 a.m.

Because of the sensitive nature of the research topic, no qualitative material of this kind was collected from other participants.

Generation of 3D Life Paths

Because our approach to GIS-based narrative analysis, as described in the last section, is based on the time-geographic framework and focuses on the unfolding of people's life paths in relation to their experience, their activities, and the places they visit, the first analytical step is the generation of participants' life paths using their activity diary data. Table 1 shows the diary data of a Muslim woman who participated in the study. On the survey day, her first out-of-home activity was dropping off a child at school. She then returned home and went to a mosque before making three shopping stops at various stores. After these shopping trips, she returned home and then picked up her two children at their schools and stayed at home for the rest of the day. Using these activity diary data, the Trajectory Generator of 3D-VQGIS created the participant's 3D life path in ArcScene as shown in Figure 3.

Incorporation of Qualitative Materials

After participants' life paths were created, qualitative materials such as field notes, memos, photos, and voice clips from participants' oral histories were incorporated in the Geodatabase using the Source Browser of 3D-VQGIS. As shown in Figure 4, a list of the materials incorporated is presented in the right pane, and these materials can be previewed directly in the left pane by selecting the source. They can also be viewed or listened to using ap-propriate Windows programs (e.g., Windows Media Player) by double-clicking an item on the list. These materials were later linked to specific segments of the participants' life paths or geographic features in the study area through space–time coding. Further, attribute data of these geographic features (e.g., buildings, land parcels, street networks) were also incorporated to provide the geographic context for analyzing and visualizing participants' oral histories.

Three-Dimensional Narrative Analysis

With the participants' life paths created and relevant qualitative materials incorporated into the Geodatabase, the participants' oral histories were then analyzed using the two coding functions of 3D-VQGIS: qualitative coding and space–time coding. Qualitative coding is similar to conventional coding in CAQDAS. It is "the assigning of interpretive tags to text (or other material) based on categories or themes that are relevant to the research" and its purpose is to evaluate and organize data to understand meanings in the text (Cope 2003, 445). To facilitate the analysis and coding of participants' oral histories, a node hierarchy based on the three-dimensional narrative inquiry space proposed by Clandinin and Connelly (2000) was constructed in 3D-VQGIS (Figure 5). Three of its four top-level nodes correspond to the three narrative dimensions they outline: action, spatial reference, and temporal reference. An additional top-level node, feelings and emotions, was added to facilitate the analysis of participants' experience and feelings (fear, safety).[8] These nodes (as high-level abstractions or themes) and their
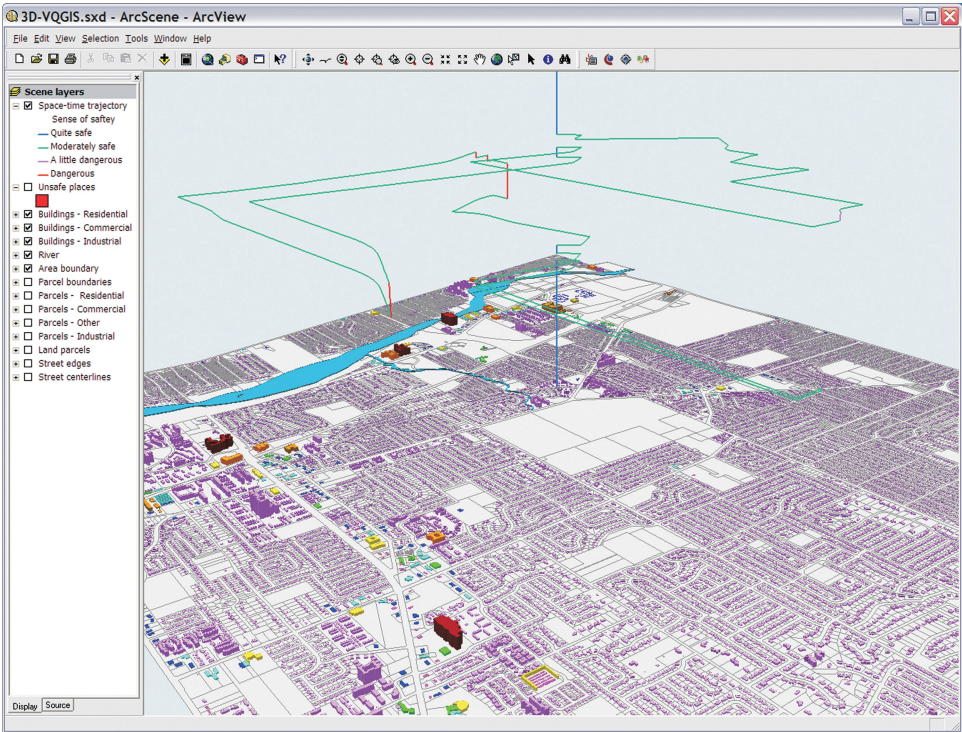
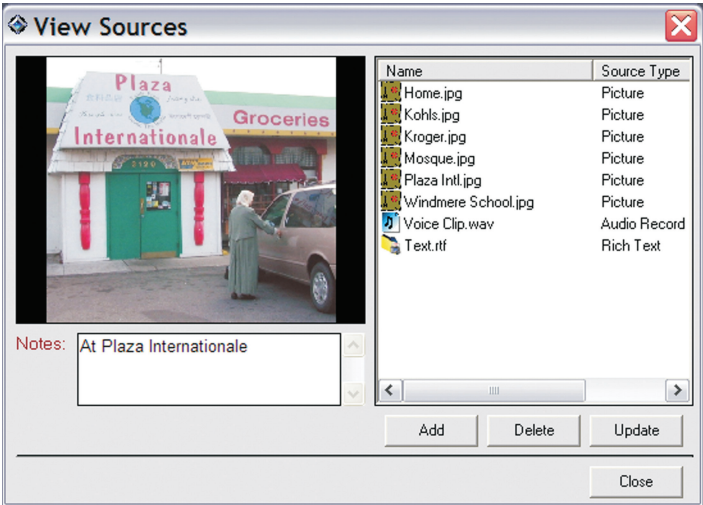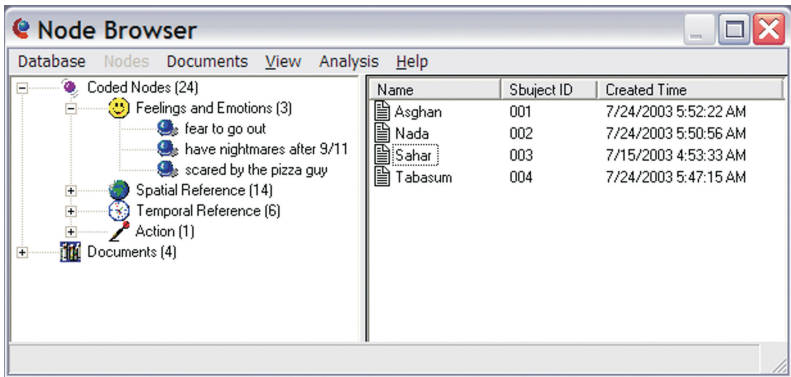**Figure 3** *Life path of the selected participant.*

Figure 4 *The Source Browser of 3D-VQGIS.*
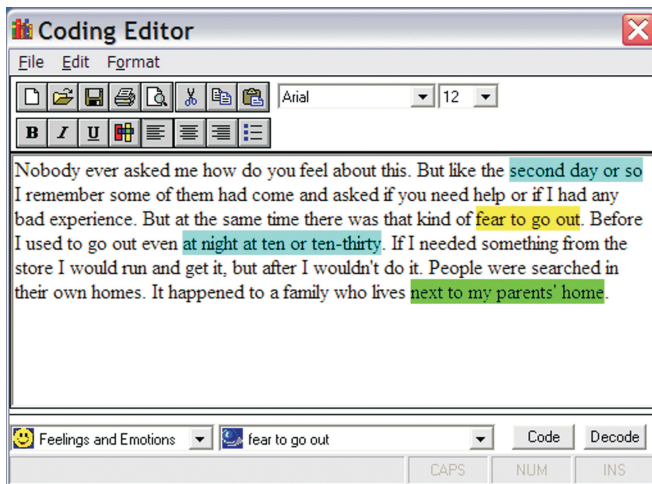
Figure 5   *The Node Browser of 3D-VQGIS.*

contents were created and organized using the Node Browser of 3D-VQGIS.

With this node structure established, qualitative coding was then performed with the Coding Editor of 3D-VQGIS. An example is shown in Figure 6, in which a passage from a participant's oral history was coded at one feeling node ("fear to go out"), one spatial reference node ("next to my parents' home"), and two temporal reference nodes ("second day or so" and "at night at ten or ten-thirty"). These in vivo codes (codes based on the exact words of the participant) were then used to explore the relationships among the participant's feelings

and the locations and times of what they have heard or experienced after 9/11.

Composing Time-Geographic Visual Narratives

As elaborated in the last section, life paths created with 3D GIS time-geographic methods can be a helpful device for chronologically organizing, visualizing, and interpreting participants' narratives about their experience. This was accomplished using the space–time coding function provided by the Space-Time Coder of 3D-VQGIS, which links passages of

Figure 6   *The Coding Editor of 3D-VQGIS.*

text, nontextual materials, or attribute values (e.g., subjective level of fear) to pertinent segments of participants' life paths or the relevant geographic features in the Geodatabase. Using space–time coding, particular buildings, street segments, or shops were coded (using an attribute value and visualized in color) to create subjective representations of the urban environment and portray participants' personal landscapes of fear. Further, a comment like "I don't feel comfortable shopping in this supermarket in the morning" can be linked to the supermarket in the Geodatabase. In addition, a photo showing the supermarket can be attached to the point or segment of the participant's life path that represents her visit to the supermarket on the survey day.

As the participants of the study often commented on how they experienced different levels of fear as they ventured outside of their home after 9/11, their life paths were interactively coded by attribute values that reflect the changes in their sense of safety or danger in relation to specific locations, times, or geographic features in the study area. Figure 3 shows the experience of a key informant of the project. Her color-coded life path shows what she recalled about her sense of safety after 9/11. She felt that all shopping activities were dangerous (in red) and there was no place that she really felt very safe (hence, no segment of her space–time path is coded "very safe"). Only when she was at home or traveling inside her minivan did she consider herself "quite safe" (in blue) or "moderately safe" (in green). Through this process of space–time coding, participants' time-geographic visual narratives were composed and interactively visualized in ArcScene.

Analysis and Interpretation

The geo-narrative procedures just described created a multimedia environment for the interactive interpretation, analysis, visualization, and "restorying" of the participants' oral histories. Based on the three-dimensional narrative space approach and the composed time-geographic visual narratives of the subjects, Kwan found that space and time played a significant role in shaping the participants' post–9/11 experience. In the first few days after 9/11, most participants experienced some form of verbal or physical harassment (e.g., being

spit at, insulted, cursed obnoxiously, or having a gun pointed at them), and they encountered these violent acts mostly in public spaces such as bus stops, department stores, and shopping malls. As some of the participants recalled, these encounters triggered an intense sense of insecurity when they ventured outside of their homes in the first few days after 9/11, and this sense of fear led many of them to restrict their out-of-home activities for several days to four weeks.[9] Further, several locations or places in Columbus identified by the participants to be associated with high levels of fear or discomfort after 9/11 emerged in their visual narratives. The most prominent among them was the Port Columbus International Airport, to which many participants were apprehensive about going due to their knowledge or perception about Muslims being profiled or targeted by law enforcement agents. For some participants, their apprehension affected their out-of-town travel considerably for several months after 9/11 (one participant said that her family only traveled to destinations that could be reached by driving in the first few months after 9/11).

Further, the geo-narrative procedures enabled Kwan to identify certain temporal patterns in the chronology of the participant's experience and events. For instance, the sense of fear or insecurity for most participants was most intense in a short period of time after 9/11, and this sense of fear or insecurity declined over time, more rapidly for some participants than others. Important turning points in the lives of the participants were also identified by in vivo codes such as "before" and "after" (as in "after 9/11" and "before coming to the United States"). These turning points often signified important changes in participants' everyday experiences as Muslim women. Kwan also recognized that the participants' experiences could be interpreted in multiple and overlapping temporal scales: daily activities and trips, a few months (before and after 9/11), and a longer period involving migration to Columbus or to the United States.[10]

Verification and Validation

In providing this account of the participants' experiences, Kwan recognizes that her narrative is actually her interpretation of the participants' representations of their own experiences.

As Riessman (1993, 22) emphasizes, "Narratives are interpretive and, in turn, require interpretation. They do not 'speak for themselves,' or 'provide direct access to other times, places, or cultures.'" When people talk about their lives, they may "forget a lot, exaggerate, become confused, and get things wrong. Yet they are revealing *truths*. These truths don't reveal the past 'as it actually was,' aspiring to a standard of objectivity. They give us instead the truths of our experience" (Personal Narratives Group 1989, 261). The truths of personal narratives are "neither open to proof nor self-evident" and we "come to understand them only through interpretation, paying careful attention to the contexts that shape their creation and to the world views that inform them" (Personal Narratives Group 1989, 261). Further, as Denzin (1989, 26) highlights, "When a writer writes a biography, he or she writes him- or herself into the life of the subject written about. When the reader reads a biographical text, that text is read through the life of the reader. Hence, writers and readers conspire to create the lives they write and read about."[11]

Bearing in mind these considerations about the knowledge production process in narrative analysis, Kwan attempted to validate her interpretations of participants' oral histories through some common validation strategies in qualitative research (e.g., member checking and triangulation). She adopted a reflexive, iterative, and recursive analytical process in the project. For instance, she was initially not sure why a stretch of East Broad Street in Columbus emerged repeatedly as an area associated with high levels of fear in the participants' visual narratives. She then checked with one of the participants through subsequent in-depth interviews and learned about the incident in which the Islamic Foundation of Central Ohio (which is located on East Broad Street) was vandalized: Holes were drilled through the floors and ceilings of the multistory structure to allow water to run through the entire building, incurring US$100,000 in damages. In addition, Kwan also drew from a wide variety of sources to contextualize her analysis and interpretation of the data (e.g., electronic newsletters from the Council on American-Islamic Relations, observation in local shopping malls, shops, and grocery stores). In fact, geo-narrative and 3D-VQGIS were developed iteratively and gradually over time. The original analytical plan was informed more by grounded theory than narrative analysis and was thus largely based on the analysis of themes. After conducting some theme-based analysis with the data and gradually realizing the limitations of grounded theory methods and current GIS for analyzing narrative materials, Kwan then started to conceive adopting and developing an approach and analytical tools for handling narrative data. Further, the development of 3D-VQGIS also involved several rounds of iteration between analysis of the narrative materials and its design and implementation in ArcGIS.

Conclusion

Geo-narrative is a GIS-based approach to narrative analysis. It is based on extending current GIS capabilities for the analysis and interpretation of narrative materials such as oral histories, life histories, and biographies. The three central elements in this approach are (1) narrative analysis as the qualitative approach, (2) 3D GIS-based time-geographic methods as the representational framework, and (3) 3D-VQGIS as the GIS-based computer-aided qualitative data analysis component. Using a case example, the approach was shown in this article to be helpful for handling the chronology of people's experiences and the sequence of events. It integrates a wide variety of geographic data and narrative materials in GIS and provides a geographic context that facilitates interpretation and understanding of the lived experiences of the research participants. It allows for the creation and interactive geovisualization of their subjective environment. With this analytical approach, the user can step back to read the linked text passages or memos, listen to voice clips, and view photos. These materials together provide a rich and vivid account of a participant's experience. Through pondering the meanings of the coded materials, assessing the relationships among nodes and codes, identifying important themes and patterns, reorganizing the node structure, and recoding materials as needed, this approach provides a flexible environment for the recursive and interactive analysis of narratives within GIS.

The development, implementation, and use of the qualitative data analysis component (3D-VQGIS) in the study indicates that qualitative data analysis capabilities can be established

within existing GIS using the development environment and modeling languages they support. Several difficulties, however, remain for future research to address. The most significant challenge perhaps is how to deal with the imprecise spatial and temporal references that research participants often used. For example, how can GIS be used to code phrases like "near my mom's home," "around where I live," "east side of the city," "in the morning" or "in the evening," as they do not refer to any specific or clear-cut objects in the GIS database? Recent studies on geospatial ontology, qualitative georeferencing, and geosemantics has made important progress in resolving this kind of problem (e.g., Renz 2002; Sieber 2004; Agarwal 2005; Arpinar et al. 2005; Yao and Jiang 2005; Schuurman and Leszczynski 2006; Yao and Thill 2006, 2007). These studies attempt to bridge the ontological and semantic gaps between the ambiguities of natural language and the computational logic of current GIS through methods such as natural–language based spatial query, mathematical representations of imprecise linguistic variables, fuzzy set or neuro-fuzzy modeling, and new methods of visualization. Much research, however, is still needed to inform the future development of qualitative GIS.

Further, as the qualitative data analysis component of geo-narrative, 3D-VQGIS has only some basic qualitative data analysis functionalities such as coding. It lacks the comprehensive capabilities (e.g., searching and model building) of sophisticated CAQDAS packages. Much research is still needed to extend the capabilities of existing GIS to provide better support for qualitative and mixed-method research in geography. In addition, 3D-VQGIS was specifically developed for dealing with qualitative data that involves the temporal dimension. For the analysis of nonnarrative materials or for research that does not involve the chronology or sequence of events, other approaches (such as grounded visualization or geo-ethnography) may be more appropriate. ■

Notes

[1] See Zeiler (2001) and Environmental Systems Research Institute, Inc. (1996) for how external files or Web pages can be linked to geographic features in a GIS using the hyperlink feature.

[2] We constructed qualitative data analysis capabilities within current GIS instead of building GIS functionalities in current CAQDAS programs because GIS software offers a much more powerful development environment than existing CAQDAS programs. ArcGIS, for example, offers a comprehensive object library (ArcObjects) and many application development interfaces (e.g., Visual Basic and Visual C++). Further, although we developed a computer-aided qualitative data analysis component in this study, we are aware of the concerns of using computer programs in qualitative research and the limitations of CAQDAS programs (e.g., Hinchliffe et al. 1997).

[3] Whether and to what extent qualitative methods can help recover the voices or experiences of marginalized individuals has been subject to considerable debate. Feminist and postcolonial critiques have seriously challenged the notion that the experience of the subaltern can be represented or accessed and that a researcher can "speak for" the subjects (e.g., Spivak 1988). These critiques and the crisis of representation they ushered in have led researchers to adopt more reflexive and nonrepresentational research practices that might help mitigate the problem (yet, see Del Casino and Hanna's [2006] cogent argument about why geographers should not disengage themselves entirely from visual representations).

[4] Some geographers have raised concerns about the epistemological limitations in using time-geographic representations such as the life path in the study of people's everyday experience (e.g., Rose 1993). Gregory (1994), however, suggests that these representations do not necessarily presume particular epistemologies. Laws (1997) also indicates the possibility of using the time-geographic perspective for understanding women's spatiality based on feminist theories of identities and corporeality. More recently, Kwan (2002a, 2007a) provides a feminist poststructuralist retheorization of time-geographic life paths based on the work of Grosz (1990, 1994), Foucault (1977), Young (1989), and Parks (2001). With these reinterpretations, time-geographic life paths can be fruitfully deployed for understanding people's lived experience in geographic research based on a variety of epistemologies.

[5] There is now an extensive literature on the various meanings and implications of the attacks on the World Trade Center and the Pentagon on 11 September 2001. For helpful discussions see Chomsky (2001), Safi (2001), Branston (2002), Council on American-Islamic Relations (2002), Karim (2002), McChesney (2002), Bennis (2003), and Hyndman (2005).

[6] No data or estimates are available regarding the proportion of Muslim women who wear the

Islamic religious attire, the exact form of which differs depending on the country of origin of a particular style. According to a survey of 60,000 Muslim Americans conducted by the Pew Research Center (2007), 72 percent of the respondents said religion plays a "very important role" in their life. Together with the data on the respondents' religious practices—which include daily prayer, mosque attendance, giving to charity, reading the Koran daily, fasting during Ramadan, and taking a pilgrimage to Mecca—it may be estimated that about 50 percent to 70 percent of Muslim women adhere to the Islamic religious attire (that is, wear a loose-fitting outer garment and the Muslim headscarf in public spaces and in the presence of men outside the family). Further, Kwan recognizes the diversity of experience and religious practices among Muslim Americans (e.g., M. A. M. Khan 1998; S. Khan 2000; Nimer 2001; Falah and Nagel 2005; Kaya 2005, 2007; Hopkins, Kwan, and Aitchison 2007; Kwan 2008). She does not intend to use *hijab* as a binary subject indicator but foregrounds the importance of a visible difference that often makes Muslim women more vulnerable to discrimination and harassment in their daily lives. Such a material difference not only can be life-threatening to Muslim women, but also is a critical element in the process of their identity formation and their subjectivities (Mustafa 1993; Moore 1998; Shakeri 1998; Council on American-Islamic Relations 2002, 2003; Kaya 2004; Kramer 2004; Aitchison, Hopkins, and Kwan 2007).

[7] This sample was generated using purposeful sampling (see Bradshaw and Stratford [2005] for a helpful discussion on various sampling strategies in qualitative research). It involves a hybrid strategy that has elements of both variation sampling and criterion sampling, and seeks to create a diverse group of participants (e.g., in terms of their race, occupational status, immigrant status, country of origin, and length of stay in the United States).

[8] As Pain (2006, 1), suggests, "fear is not simply reactive, but is situated in complex individual and collective emotional topographies and everyday experiences. We should expect fear-provoking events and discourse to be interpreted, resisted and subverted by people in different ways." By using a node hierarchy that is based on the three-dimensional narrative inquiry space proposed by Clandinin and Connelly (2000), Kwan does not intend to suppose that participants' feelings of fear or safety are solely mechanically or ecologically determined. The node structure merely provides a useful point of departure for exploring the complexities of the emotional geographies of the participants and the complex ways in which the microgeographies of fear are constituted in space and time.

[9] The home was not an entirely safe place for some participants, one of whom received death threats via telephone calls to her home. She recalled that there was an arson case in which a member of a Muslim family was hospitalized for serious injuries.

[10] If weekly or monthly diary data were collected, participants' life paths could be constructed, coded, and visualized with an extended temporal scale. For example, a participant's weekly life path can be represented as one continuous path over time, using one week as the temporal scale. Alternatively, it can be represented by seven separate daily paths using twenty-four hours as the temporal scale. This latter method will reveal the patterns of day-to-day repetitions and variations in the participant's activities and trips during the week.

[11] Recent psychoanalytic theory and methods have also questioned the possibility of reading personal narratives for unconscious process, thus highlighting another limitation of narrative analysis (see the helpful discussion in Thomas 2007).

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