Journal of Mixed Methods Research

http://mmr.sagepub.com

The online version of this article can be found at:
http://mmr.sagepub.com/cgi/content/abstract/3/4/349

Published by:

$SAGE

http://www.sagepublications.com

Additional services and information for *Journal of Mixed Methods Research* can be found at:

Email Alerts: http://mmr.sagepub.com/cgi/alerts

Subscriptions: http://mmr.sagepub.com/subscriptions

Reprints: http://www.sagepub.com/journalsReprints.nav

Permissions: http://www.sagepub.com/journalsPermissions.nav

Citations http://mmr.sagepub.com/cgi/content/refs/3/4/349

CAQDAS-GIS Convergence

Toward a New Integrated Mixed Method Research Practice?

Nigel Fielding
University of Surrey, Guildford, UK
César A. Cisneros-Puebla
UAM Iztapalapa, Mexico City, Mexico

Abstract The article explores qualitative geography and qualitative social science as sites of mixed methods research practice. The authors argue that there is an emergent convergence of methodologies and analytical purposes between qualitative geography and qualitative social science. The authors show how methodological and analytical convergence has been enabled by technological convergence between geographical information systems (GIS) and qualitative software (CAQDAS). The argument is illustrated by examples of convergent geo-referenced mixed methods studies, including a main example from research on reproductive health in Paraguay.

Keywords: *geo-referencing mixed methods, data integration, qualitative software, GIS*

Convergent Methodologies and Convergent Technologies

This article aims to profile the convergent interests of qualitative geography (QG) and qualitative social science (QSS) as an emergent, innovative, and inclusive form of mixed methods research (MMR). We argue that, insofar as a threefold typology captures the range of mixed methods research designs (QUAN-qual, QUAL-quan, "pure mixed"; Johnson, Burke, Onwuegbuzie, & Turner, 2007), spatially oriented qualitative social science and qualitatively oriented geography are particularly likely to produce "pure mixed" forms of MMR. We further argue that a major impetus toward this affinity for "pure mixed" MMR is the technologies that support QG and QSS.

Social science is seeing an increasing convergence of techniques around digital technologies offering new resources for methodological integration. The emergence of "CAQDAS" (see glossary) in the 1980s provided new computational resources for qualitative and mixed methods research, including basic quantification features encouraging quantitative/qualitative data integration and support for digital audio, image, and video files. During these developments, a parallel interest in qualitative methodologies was developing in

geography. Qualitative geography (Doel, 2001; Pavlovskaya, 2006; Sheppard, 2005) has an associated technical practice of qualitative GIS (see glossary) and sympathies with critical GIS (Kwan, 2007; Pickles, 1995; Schuurman, 2000; Sullivan, 2006).

QSS and QG have wider methodological affinities. QG is often oriented to feminist research, action research, and participatory research (Elwood, 2006; Elwood et al., 2007). Similarly, qualitative methods are increasingly used in "citizen research." Examples include information "mash ups" of Internet-derived, geo-referenced data to identify crime "hotspots," decide where to buy a house, or to choose a school. QG and QSS both have affinities for Mertens's (2003) advocacy of MMR for social transformation.

Convergence between the methodologies associated with QSS and QG is matched by the convergence of CAQDAS and GIS technologies. In this article, we explore that ground as a new site of MMR ("new" because, in a recent review, 15 of 19 leading definitions of MMR specified that what is mixed is quantitative and qualitative data; none specifically referred to spatial data; see Johnson et al., 2007, p. 118). We will explore (a) the kinds of analytic work that are in frame for geo-referenced MMR and (b) the affordances of the relevant technologies. But first, we anchor these developments on the substrate of mixed methodology conceptualizations, a substrate that is firm in places, shifting in others.

Mixing Geographical and Social Science Methods: Conceptual Foundations

Reflecting disciplinary variations and differing motivations for mixing methods, we are concerned with the pathways by which geo-referenced QSS and QG have found their way to mixed methods, an enabler of which is technological convergence. Greene (2008, pp. 8-10) posits four generic domains framing any social science methodology: (a) philosophical stances, (b) inquiry logics, (c) guidelines for practice, and (d) sociopolitical commitments. Epistemology is central to Domain 1. In Greene, Caracelli, and Graham's (1989) assessment, "mixing paradigms is problematic for designs with triangulation or complementary purposes, acceptable but still problematic for designs with a development or expansion intent, and actively encouraged for designs with an initiation intent" (Green et al., 1989, p. 271); mixing methods to "initiate" new conceptualizations involves addressing disjunctions between findings from different data sources (Rossman & Wilson, 1985). MMR involving QG and geo-referenced QSS is motivated largely by "development" or "initiation," on the evidence of examples discussed below.

Morse (1991) distinguishes between "simultaneous" and "sequential" mixing, the former featuring limited interaction between data sources and the latter being where results from one method are necessary to position the next. Spatially oriented MMR is characterized by the sequential type, reflecting the practices involved in work with GIS, which involves constant comparison of different representations of geo-referenced data. QSS and QG are also amenable to the idea that "paradigms may shift during a sequential design in which one starts from a postpositivist perspective (quantitative) and then moves to a constructivist (qualitative) worldview" (Creswell, 2009, p. 102; see also Creswell & Plano Clark, 2007). Several spatially oriented MMR exemplars testify to initially underpinning GIS representation with a postpositivist epistemology before exploring different perspectives, competing interests, and alternative representations under constructivist precepts.

These positions suggest that, in QG and geo-referenced QSS, epistemology remains important but paradigmatic incompatibility is not a crippling obstacle. The willingness of QG and QSS to learn from each other reflects the Deweyian pragmatism with which Greene (2008) underwrites mixed methods (see also Johnson et al., 2007, p. 113). Indeed, this willingness is noted in Greene's own remarks on qualitative geography (Greene, 2008, pp. 18-19). Greene's (2008, p. 16) vision of mixed methodologists incorporating "such quantitative forms as graphs, tables and figures; and such qualitative forms as stories, poems and performances; and even such spatial forms as maps and networks" is apt and timely.

As we will see, QG evolved out of disenchantment with the epistemological position of mainstream geography, as evidenced by GIS—the kinds of tools it offers, the things it represents, and the interests it serves. Similarly, QSS remains somewhat of an outsider practice, given the skepticism about its legitimacy amongst those who see Randomized Control designs as the "gold standard." QG and QSS have found themselves sharing an "interpretive community" (Greene, 2008, p. 16), perhaps as much by their outsider status as by needing to converge to solve research problems.

This article also addresses Greene's Domain 2—methodology. Regarding Greene's (2008) "broad inquiry designs," we profile the research design logic of our principal example and subsidiary examples. We flag a critical issue in QG/QSS here in light of Greene's assessment that analytic integration has largely been elaborated in *practice*. A prime issue with which QG/QSS is presently grappling is how exactly to integrate the analytic routines and features in GIS and CAQDAS software. One aspect is Lee and Greene's (2007) "integrated data display," described by Greene (2008, p. 15) as "presenting data from multiple sources in one display, thereby enabling cross-method comparisons and analyses." Such working practices are receptive to Johnson et al's. (2007, pp. 127-128) principled choice of convergent and divergent design elements ("designing studies . . . in a way that results in overall . . . .design viability and usefulness"; ibid., p. 128). The methods of spatial analysis greatly expand the choice of design elements for combination with qualitative and quantitative components. Also, "time" is a major geographical variable. Geographers are interested in change in space over time (e.g., ethnic/class cycles in urban population growth). This draws QG to longitudinal designs, and is an opening to Fetter, Yoshioka, Greenberg, Gorenflo, and Yeo's (2007) insight that MMR can be *both* sequential and concurrent.

Regarding Domain 3, our exemplars profile practical issues in convergence and data interrelation. Bazeley's (2003) strategies for mixing data sets are significant in the present engagement between QG and QSS, and her contribution on data file exchanges is strongly practically oriented. Bazeley (2004) notes that "initiation . . . requires an integration of methods, in contrast to the simpler component designs typically used for corroboration or expansion" (p. 144). Bazeley (2004) observes that fully integrated designs are uncommon "perhaps because the technology for managing integrated analyses is still in development." Technological facilitation is an important theme in QG and QSS. Both qualitative software developers and super-users have pursued data integration. MAXQDA and its predecessor winMAX implemented developer Kuckartz's (1995) "case-oriented quantification," an approach to typification retaining attention to individual cases. Bazeley pioneered techniques for converting qualitative coding into quantitative variables for

predictive regression modeling and correspondence analysis. The integration poles here were quantitative and qualitative. The integration poles in the present article are spatial and qualitative.

As to Greene's (2008) Domain 4, we find that QG and QSS share quite prominent affinities. Both are oriented to the interests served by research. In both, there is debate about the role of technology. Both are oriented to research with and for communities, and regularly pursue underdog and subaltern interests that are opposed to those of big government and elites.

Convergent Methodologies

"Qualitative geography" (as a recognized subdiscipline of geography) originates in the critique of GIS as masking alternative versions of social reality, a theme with antecedents in early debates about GIS (Marble, 1990). The critique emphasizes that knowledge is socially constructed even in apparently factual representations of space and place, such as maps (Knigge & Cope, 2006, p. 2022). Here, GIS is not a neutral tool for use according to whatever script users bring to the task. To qualitative geographers, mainstream GIS imposes a "God's eye view" (Haraway, 1996) neglecting the socioeconomic organization of people in geographical space from the perspective of minorities and the underprivileged. Feminist geographers also argue that geography should allow for multiple perspectives, context, and subjectivity (Kwan, 2002a). "Critical GIS Science" has emphasized the effects of power on technologies, epistemologies, and methodologies (Schuurman, 2006).

Those such as Knigge and Cope (2006) not only critique mainstream GIS but advocate a convergence of quantitative and qualitative methods in GIS representations to iteratively build an understanding of how social space is constructed and perceived. Their "grounded visualization" involves a convergence of visualization based on *quantitative* GIS and grounded theory based on *qualitative* fieldwork to reveal "both 'context' and 'content' in a spatial dimension" (Skinner, Matthews, & Burton, 2005, p. 230). In geography, "visualization" employs several representation methods: geographic visualization, information visualization (nonnumeric data sets), and scientific visualization (large multivariate data sets). Thus, as well as integrating social science methods, geographical visualization is a mixing practice between geographical methods themselves.

Turning to QSS, the qualitative methodologies founded on fieldwork and text analysis were long practiced using technologies no more sophisticated than pen and paper. The first computer applications to text came more than 40 years ago. They supported basic quantitative content analysis. Henceforth, technological development has accelerated. Qualitative software has expanded from data management systems with few affordances beyond those of an "electronic filing cabinet" to a comprehensive suite of programs supporting complex Boolean retrievals, hypothesis testing, case-based reasoning, conceptual mapping, and data integration, including "conversion" of qualitative data into quantitative data (Bazeley, 2006). Also, virtually any data type can be accommodated: text, audio, still images, digital video, Web downloads, spreadsheets, and statistical software output.

The convergence of interests between QG and QSS promises several benefits. First, these developments have emerged in relation to new research technologies and thus draw

on technology's impetus toward systematic, formal, and transparent analytic practices. Second, they move toward integrated MMR practice with an explicit embrace of quantitative input. Third, they offer to widen research participation outside the traditional research community, with benefits to the public understanding of science. From geography, social science can gain better sensitivity to scale, place, context, and flows. From social science, geography can gain better practices for documenting processes and cultural variation, systematic code-based data management, and formal analytic strategies.

Convergent Technologies

In parallel with the emergence of QG and increasing computational support for QSS, tools to support their convergence around an MMR "pure mix" of quantitative, qualitative, and spatial data have grown in sophistication. CAQDAS developers have worked with users to provide wanted features, and trainers, and initiatives such as the CAQDAS Networking Project (http://caqdas.soc.surrey.ac.uk/) have promoted a growing technical capacity. Several CAQDAS packages have lately incorporated geo-referencing. Although early research suggested CAQDAS was mostly used for data management (Fielding & Lee, 1998), analytic features are lately of much-increased importance. For instance, a recent survey of MAXQDA users found that the second, third, and fourth most-used features were data integration tools, ranking behind only the memo-writing feature (survey details will be posted on www.maxqda.com).

Regarding GIS, since the introduction of programs such as ArcGIS and ArcInfo (www.gis.com) in the early 1980s, GIS has offered platforms for numerous ways of representing geographic data. GIS's common association with maps is only one of three ways of understanding a GIS. The "database view" considers the GIS as a structured geographic database or information system. In the "map view," the GIS is a set of intelligent maps and other resources capturing features on the earth's surface and relationships between them. Maps stimulate questions that the GIS handles by supporting queries, analytic procedures, and information editing. In the "model view," new data sets are derived from GIS data sets in "geo-processing functions" that take information from it, perform analytic functions, and write results into new derived data sets. We further discuss technological convergence below, after profiling other stimuli to convergence.

Methods for What?

Trends in the wider methodological arena have promoted MMR around QG and QSS. The Internet has spurred instrumentally motivated "citizen research," and CAQDAS has supported research by people in occupations other than social science (Fielding & Lee, 2002). Qualitative methods are particularly accessible to nonspecialists, and the Internet-based "information mash-up" joins a long practice of action research, community life history studies, and other approaches involving researchers and participants coproducing research. Technology has stimulated citizen research such as Carmichael's (2002) work with Rwanda genocide survivors, the archival organization Qualidata's experience with classroom-based projects (see www.qualidata.essex.ac.uk), and the facilitation of the Ibero-American participatory research tradition by video technology.

Community-oriented QG draws on multiple methods "where visual images, words and numbers are used together to compose contextualized cartographic narratives" (Kwan, 2002b, p. 273). This can enrich and validate findings, as in Nightingale's (2003) study of "community forests" in Nepal turned over by the government to village user groups to manage. Aerial photographic data suggested one account of changes in forest cover but was challenged by data from villager interviews. The photos produced an image of land cover change that was "flat, remote and static" (Nightingale, 2003, p. 81), whereas the interview data were affected by subjectivity issues, including how well respondents knew Nightingale. "It was only by analyzing the incompatibilities between the photos (that showed minor change) and the oral histories (that insisted resources are much more accessible) that I was able to appreciate . . . the partiality of both methodologies" (Nightingale, 2003, p. 85).

For Nightingale (2003), juxtaposing the data sources revealed what the respective methods could and could not capture and enabled an analysis truer to the community's lived experience. "Placed in conjunction . . . the resulting data sets revealed far more about the political and social struggles around claiming forest land and ecological improvement than either one did in isolation" (ibid., p. 82). By mapping boundaries of different land cover types in a time series of aerial photos and then layering the maps on top of each other, Nightingale calculated percentage change in the area of each cover type. This was compared with villager interviews about whether the forest was more productive under government or village management.

> The photos show that the areas that have improved the most are those closest to the villages but that overall forest cover has changed very little. This information, when compared to the [interviews] that emphasize overall improvements, suggests that the accessible areas are [valued most by the] . . . villagers . . . They can see tangible signs of improvement in the areas that are most accessible, and to them this is a dramatic change. (Nightingale, 2003, p. 85)

Given policy makers' tendency to take remote sensing data (e.g., aerial photography, Google Earth images) as unambiguous and authoritative, it is important that the interviews challenged the photos and that combining the data sources rendered a new analysis. That is because government policy is to reannex forests if vesting their management in communities is shown to have reduced forest area. Thus, QG is a promising methodology to those who champion community interests (Harris, Weiner, Warner, & Levin, 1995). Knigge and Cope's (2006) work on "community gardens" in a deprived area of Buffalo, New York further illustrates this. A Web-based multimedia environment was used. Its centerpiece was a map showing community resources and facilities, surrounded by boxes detailing themed quantitative, qualitative, and spatial data, including ethnic composition charts, land parcel attributes, specific location maps, photos of neighborhoods, textual descriptions of features, and text and audio of resident interviews.

At a community meeting about redevelopment, residents who identified with the area but whose properties were not on the planners' maps successfully used the multimedia resource to get planners to redraw their maps. As well as interviews, one of the authors of Knigge and Cope (2006), namely, Knigge, bicycled around the area to see how the built

environment signalled the associations people felt with it. This led to her discovering "community gardens" spontaneously created by residents, an important indicator of community integration, and raised questions about the area's economy that Knigge and Cope (2006) pursued using quantitative information such as labor market statistics that was then added to the original map resources. Cadastral (see glossary) parcel-level data were explored via a GIS to visualize land use, count vacant land parcels, and relate this to house values.

There are two big messages from Knigge and Cope's (2006) study. First, MMR was needed because both main methods had constraints that led to a partial picture.

> Knigge . . . realized that by solely looking at published quantitative data she may have missed the existence of community gardens, and a wholly ethnographic study might have missed potential correlations and clusters that were best analyzed through GIS. (Knigge & Cope, 2006, p. 2034)

Second, such work can be important to communities. In this case, Buffalo had an aggressive demolition policy on run-down housing stock. This opened space for the community gardens but they were invisible to conventional planning tools. Recognizing that residents valued their community gardens introduced a new factor into the planning debate, whereas before Knigge's study the planners did not even know the gardens existed because they had no quantitative or geographical record. Sullivan (2006) claims the stimulation of such online community-based projects by Google Earth constitutes a "GIS 2."

Current Computational Affordances

Recognizing the uses of MMR designs in spatially oriented research, we turn to the affordances of CAQDAS and GIS, highlighting benefits from their articulation.

CAQDAS Programs

There are three basic types of qualitative software: *text retriever*, *code-and-retrieve*, and *theory-building* software (Kelle, 1996; Weitzman & Miles, 1995). *Text retrievers* recover specified keywords, other character strings, combinations of these, and patterns such as alpha-numerical sequences, from selected or all files. Analytic memos can be linked to retrievals. Text retrievers such as Metamorph, WordCruncher, ZyINDEX, and Sonar Professional specialize in retrieving data from numerous documents and can cope quickly with enormous data volumes.

Code-and-retrieve packages support attaching codes to segments of data, and retrieving segments by code, combinations of codes, or by how codes relate to one another. Retrieval can combine conceptual codes and features such as sociodemographic variables, for example, where two characteristics apply but not a third (e.g., data from MALE respondents with LOW PAY who are NOT alienated).

Whereas such packages focus analytically on relationships between codes and data, *theory-building software* emphasizes relationships between codes. It helps users develop analytic typologies and data representations other than those derived directly from data, such as by hypothesis testing. It can visually represent connections between codes, showing code labels as nodes in graphic displays that users can link to other nodes by specified relationships such as "causes" or "is a kind of." Retrievals can be based on properties of the relational links between nodes.

Theory builders such as Atlas.ti and NVivo and high-end code-and-retrievers such as MAXQDA best suit mixed methods designs involving geographical data. Also important to work with geographical data, which often involves considerable "exploration" before the final analysis, is support for verification (e.g., of code assignment) and complex analytic retrievals. Verifying coding or performing analytic retrievals may require comparing code assignments in different subsets of data. The Boolean operators AND, OR, XOR, and NOT, and Proximity operators such as NEAR and CO-OCCUR, are usually provided.

Qualitative software supports data integration, providing ports to export data to SPSS and import quantitative data tables, and tools to count "hits" from specified retrievals. CAQDAS can systematically match responses to sociodemographics, rating scales, or survey responses. Beyond sorting by categorical or scaled criteria, Bazeley (2006) suggests two types of data integration: "combination," for example, using categorical or continuous variables both for statistical analysis and to compare coded qualitative data and "conversion," such as converting qualitative codes to variables. Where coding records the presence/absence of the code in each case or as a frequency, a case-by-variable matrix can be derived. Techniques such as cluster analysis, correspondence analysis, and multidimensional scaling are then possible. CAQDAS thus offers geographers facilities to integrate quantitative and qualitative data.

Qualitative software's ability to go back to source at a "click," to support "audit trail" review of interpretations, is a crucial affordance in data integration (Bazeley, 2004). It is also critical in spatial analysis. Work with GIS often involves researchers moving between representations, exploring data at different levels of granularity or expressed in different forms. QG's requirement to oscillate between different representations would seem to make mixing of methods intrinsic to the discipline. Moreover, the "coding on" activity that is critical where qualitative data are converted for statistical manipulation, and that requires repeated scrutiny of sources, has a parallel in geo-referenced qualitative data, where constant checks are necessary on data such as interviews because the geo-reference may be to the interview location, locations of events discussed in the interview, and so on.

Regarding geo-referencing, Atlas.ti Version 6 treats locations as a "quotation." Google Earth ("GE") is opened as a KML file and Atlas.ti creates a new "primary document" (data source). Each GE data source can be used with any number of documents, each having different subsets of locations. Users select a location and hit the quotation button. The quotation is assigned a map reference in coordinates, and a quotation information template opens in the GE view. Files such as dynamic population growth charts can be linked to GE primary documents, so charts can be run while examining relevant GE images. Google Maps ("GM") can also be opened from Atlas.ti but only offer aerial views and coordinates, without GE's view-from-different-angles facility. Atlas.ti will also operate KMZ files created in Google Earth Professional, letting users run movies "flying" around an area.

Atlas.ti aspires to be a complete workspace, capturing external applications such as spreadsheets so these are operable within the worked project's "hermeneutic unit" (HU). Atlas.ti's approach to incorporating GE and GM reflects this. It provides tools to operate GE and GM and allows users to annotate GE/GM images, code and retrieve them, and link them to other objects in the HU for inclusion in Atlas.ti's "network view," a conceptual mapping feature for visualizing relationships between the HU's components. Along with hyperlinking to Web files, and the ability to import image and video files, NVivo offers geo-oriented researchers similar facilities. It imports GE files as "internal images" that can be selectively coded, annotated and hot-linked to other data.

These packages share an approach of providing users with as many tools as possible within one package. This may suit geo-oriented qualitative social scientists more than qualitative geographers. Their expertise in GIS may make MAXQDA's approach preferable. Although MAXQDA offers a tool to operate with geo-links to KML or KMZ files, users can also create a hyperlink to ArcGIS in the margin of its main screen. This provides map images (not the aerial photographs of GE, which can be quite old). Rather than re-create GIS tools, MAXQDA provides a gateway to them. However, for users wanting such functionality, an add-on MAXmaps module is available (see below).

GIS Programs

GIS offers an MMR-friendly environment by handling data collected on multiple spatial scales, numerical data, and hot links to audio, video, image, and text files. Matthews, Detwiler, and Burton (2005) developed a multiple format data set concerning families on welfare, combining NUD*IST qualitative software files, spreadsheets (Excel, DBF), audio recordings, and photos. The data represented location-based activities and was tied to police district boundaries, political boundaries, and tax, property, and land-parcel data. A graphical user interface (GUI) was written in Visual Basic for ArcGIS, enabling users to explore contextual geospatial data and attributes in relation to family locations and neighborhood boundaries. Family local contexts were analyzed in terms of community services, crime risks, and spatial and temporal constraints (Matthews et al., 2005, p. 81). Welfare mothers' residential moves were time-mapped and then related to topics they discussed in interviews. There were also data validation applications. Geo-coded field notes were used to map fieldworkers' paths through neighborhoods. Hot-linking this to locations within the GIS revealed that field data were sometimes recorded outside the sample area, explaining anomalous field notes about surprising "middle class" features of the study area.

Following Kwan and Lee's (2004) demonstration of how GIS can convey an understanding of people's daily "life-paths," Kwan and Ding (2008) developed a "Geo-Narrative" approach, comprising narrative inquiry, 3D GIS-based time-geography methods, and a Visual Basic for Applications component supplementing NVivo with ArcGIS. They used interviews, activity diaries, and participants' sketch maps to identify frequently visited, and avoided, places of 37 Muslim women before and after 9/11. Event sequences were analyzed using time-geographic methods to link memos, photos, sketch maps, video, and voice clips to ArcGIS. Their "3D Visual Qualitative GIS" component was added to ArcScene.

GIS programs enable exploratory data analysis with "zoom and pan" to put physical features in context, "focusing and brushing" to highlight subcategories of numerical data (e.g., high-poverty census tracts), dynamic visualizations, and multiple images to represent change over time, and linking of maps to charts, graphs, field notes, photos, or audio. Additional features include interactive legends, user-controlled animation, virtual environments, real-time 3D modeling, semi-immersive environments, and 3D flybys (Knigge & Cope, 2006, p. 2027).

More imaginative still are techniques little-explored in MMR, such as "information visualization," the representation of nongeographic data as if it were spatialized. Text such as political speeches can be represented as map-like visualizations (3D topographies, tree maps, neural networks) to aid interpretation. Information visualization is a direct intersection of CAQDAS and GIS, because features such as Atlas.ti's "Network View" employ a spatial metaphor and visualization techniques to explore data and graphically represent analytical relationships. Both grounded theory and geographical visualization use visual techniques such as relational networks and scatter plots.

Jung (2009) has developed a spatially oriented MMR application called Computer-Aided Qualitative GIS ("CAQ-GIS") that stores qualitative data directly in GIS data structures. Previous approaches required transformation of qualitative data. For instance, Pavlovskaya's (2002) study of Moscow's post–Soviet economy used census data to profile the official economy, and interview data to profile the informal economy. Data from both sources informed GIS maps. But Pavlovskaya quantified the interview data so it could be visualized alongside the census data (as per Bazeley's (2006) "conversion" techniques), inevitably losing some of its richness. Matthews et al.'s (2005) hot links/hyperlinks approach requires researchers to "create" connections even more basically, by looking from one data format to another.

Jung's (2009) approach avoids the need to quantify qualitative data and opens the door to using GIS in concert with qualitative analytic techniques, rather than only to visualize qualitative data at the final representational stage (Jung, 2009). GIS uses either a vector model or a raster model. Jung's implementation combines the raster model's (see glossary) grid structure and the vector model's relational tables. An "Imagined Grid" feature enables qualitative data to be saved in a GIS database, but only one item per grid cell. To overcome this constraint, a "hybrid relational database" is used. Relational database structures allow users to build one-to-many relationships, so a single record in one table can be associated with multiple records in another. Multiple qualitative data attributes can then be associated with a single grid cell. This hybrid structure allows a field to be created containing codes that are assigned to data in Atlas.ti. Kwan and Ding (2008) report a related approach.

Jung's (2009) CAQ-GIS provide a layer displaying an image or text (or a text within an image, such as a field diary on a table) with enough resolution that one can look "through" the qualitative layer to the fieldwork location map. Users could explore the image—zooming and panning around the room—and "open" the diary to read the field notes. Three-dimensional visualization is also possible so users could explore the room from several perspectives or examine its surroundings.

Presently, the converging needs of the QG and QSS research community have not led to new computer architectures specifically supporting spatially oriented MMR. However,

CAQDAS programs capture GE images and GM maps for manipulation similar to other qualitative data, and Visual Basic applications create additional ''layers'' in the hierarchical structure of the GIS to ''hold'' qualitative data. Given the affordances of GIS it seems questionable to reinvent them within CAQDAS. The most fruitful convergence may be to provide CAQDAS-type tools for managing and analyzing qualitative data that can reside in the GIS. For its part, CAQDAS could most usefully enable research mixing spatial and qualitative information by providing features that accurately geo-reference qualitative data, so that coordinates are attached, ready for export to GIS programs. Issues here are methodological as well as technical. For instance, should the qualitative data be geo-referenced to places where interviews occurred, places mentioned in interviews, or both?

Reproductive Health in Ibero-America: Bringing GIS and CAQDAS Together

To illustrate the use of MMR combining GIS with CAQDAS, we take Andes & Cisneros study of young peoples' sexual health in Paraguay, a collaboration with the Centro Paraguayo de Estudios de Población (CEPEP), specifically the Espacio Joven Project in Asunción, the capital. CEPEP is a major provider of reproductive health services in Paraguay and conducts national surveys on sexual and reproductive health. This nongovernmental organization maintains four health clinics across the country. In addition to providing youth-friendly clinical services, the Espacio Joven Project sought to improve adolescent sexual and reproductive health in Asunción, San Lorenzo, and Encarnación with an emphasis on preventing unplanned pregnancies and sexually transmitted infections. Answering questions such as ''why aren't adolescents seeking clinical services?'' and ''how do we reach out to them?'' was vital to the Espacio Joven project's viability.

The research objectives were to (a) build an understanding of factors influencing use or nonuse of condoms, contraceptives, and clinical services; (b) identify places in the community where youth spend time and understand how those places are associated with high-risk behaviors and/or protective activities; and (c) develop an understanding of adolescent relationships and how they relate to sexual activity/abstinence. Here we concentrate on the second objective, based on fieldwork in six neighborhoods in Asunción. Andes & Cisneros (2009) report findings concerning the social geography of adolescent life in Asunción, risk and protective factors as described by youth participants, the nature of adolescent romantic and sexual relationships, and youth perceptions of family planning methods and services. Andes & Cisneros (2009) discuss how central issues for the needs assessment in Asunción were identified and prioritized, the methodological approach to collecting data on adolescent behaviors in the Asunción clinic's catchment area, and findings on associations between behaviors and places where they occurred.

Methodological Approach

Using maps to reveal the mapmaker's perspective can be a powerful research tool, as in Amsden and Van Wynsberghe's (2005) use of community mapping in participatory action research with youth in evaluating Canadian health services. This was one approach

informing the Espacio Joven Project research design. Another was ''PLACE'' (Weir, Morroni, Coetzee, Spencer, & Boerma, 2002), which has been used in South Africa as a rapid assessment technique to target interventions by identifying high-risk venues for HIV transmission. PLACE asks informants to name places in the community where people go to meet new sexual partners, and locations where condoms are available. These are then visited and characterized, and individuals frequenting a sample of the sites are interviewed about their sexual risk behaviors.

The Paraguayan research combined spatial data with data from small group discussions, based on the premise that youths spend time in particular places that can be characterized in terms of the risk and protective behaviors youths engage in when they are there. However, unlike PLACE, an interim mapping was prepared before contacting participants rather than only mapping sites mentioned by them. Subsequently, group discussion participants were asked about places that youth frequented or avoided, who they typically saw in various locations, and the activities conducted when they were there. The preliminary mapping by CEPEP staff included GPS points for churches, schools, neighborhood associations, social service organizations, cooperatives, sports clubs, restaurants, malls, bars, discos, plazas, clinics, medical offices, pharmacies, and other shops where contraceptives/condoms could be purchased. Some 500 nonresidential sites were identified and mapped using ArcView software. The resulting digital maps of each neighborhood were used as visual aids in the small group discussions (Andes & Cisneros, 2009, p. 37).

The group discussions were conducted in March and April 2006 by a moderator and a note-taker and typically lasted 60 to 90 minutes. They were digitally audio-recorded with participants' consent to ensure the accuracy of the field notes prepared by the moderator and note-taker (ibid., p. 38). The group discussions began with questions such as ''How do youth meet romantic partners?,'' ''Are youth having romantic relationships with peers (schoolmates, coworkers, and friends) or people outside these social networks?,'' and ''Where do romantic partners spend time together early in a relationship?,'' which related to the objective to understand adolescent relationships and how they relate to abstinence/sexual activity. They were then invited to examine the map and locate on it the places in their accounts. Researchers sought to establish rapport before addressing the more sensitive issues like risk/protective factors at community level, extracurricular activities, parental supervision, substance use, and peer risk behavior. The group discussions then addressed questions such as: ''Where do youth get information about protection against pregnancy, STI and HIV?'', ''Where do youth prefer to obtain contraceptives/condoms?,'' ''What are the most prevalent barriers/facilitators to contraceptive/condom use (cost, location, confidentiality, and quality of care)?,'' ''What might help youth overcome barriers?,'' ''Are youth aware of the services offered by CEPEP's Espacio Joven project?,'' ''How are they perceived?,'' and ''How might CEPEP encourage adolescents to access services?'' Thus, the question guide was based on the questions and domains in Table 1. The group discussions first focused on Objective 3, followed by questions from Objective 2. and then Objective 1. Each group discussion produced rich audio and textual data and collectively sketched maps.

The guide presented a suggested phrasing for open-ended questions for each part of the needs assessment, followed by a list of domains that moderators should follow up if participants did not volunteer them. A total of 24 single-sex group discussions were held with 8 to

Table 1
Objectives, Questions, and Domains

Objectives	Questions	Domains
Objective 1: Build understanding of factors influencing youth's use/nonuse of condoms, contraceptives, and clinical services	Question 1a: Where do youth get information about protection against pregnancy, STI and HIV?	HIV/sex education, parent/child communication, peer sexual activity/contraceptive use, partner communication/ agreement on contraception/ condom use
	Question 1b: Where do youth prefer to obtain contraceptives/ condoms? Do they know where and when they are available in their community?	Availability of contraceptives/ condoms by time and place, pharmacy versus clinic access
	Question 1c: What are the most prevalent barriers/facilitators to contraceptive/condom use (cost, location, confidentiality, and quality of care)? What might help youth overcome barriers?	Barriers and facilitators to contraceptive/condom use
	Question 1d: Are youth aware of the services offered by CEPEP's Espacio Joven project? How are they perceived? How might CEPEP encourage adolescents to access services?	Awareness of services, perception and promotion of services, pharmacy versus clinic access
Objective 2: Identify places in community where youth spend time and understand how those places are associated with high-risk behaviors and/or protective activities	Question 2a: How do youth perceive risk factors in their neighborhoods? Do these perceptions influence where youth spend time?	Community-level risk/protective factors (crime/violence, unemployment, stress, adult monitoring)
	Question 2b: Where do youth spend time (home, school, work)? How do youth spend their time when they are not at home, in school or at work? Who do they usually see there (peers, partners, parents, teachers, other adults)?	Relationship to school/home/ work, extracurricular activities, religiosity, parental supervision, monitoring by other adults in community
	Question 2c: Where do youth engage in high-risk behaviors? Who do they usually see there (e.g., peers, romantic partners, nonsupervisory adults)?	Substance use, delinquency, problem or risk-taking behaviors, parental supervision, monitoring by other adults, peer risk behavior
Objective 3: Develop understanding of adolescent relationships and how they relate to abstinence and sexual activity	Question 3a: How do youth meet romantic partners? Are youth having romantic relationships with peers (schoolmates, coworkers, and friends) or people outside these social networks?	Relationship types, partner characteristics, older male partners
	Question 3b: Where do romantic partners spend time together early in a relationship (before physical intimacy)? Does it depend on how "serious" it is?	Relationship quality, relationship types, parental supervision, monitoring by other adults in community

Note: CEPEP = Centro Paraguayo de Estudios de Población.
Source: Andes & Cisneros (2009, p. 35).

Table 2
Distribution of Small Group Discussions in Target Neighborhoods

Neighborhood	Total Population	No. of Male Groups	No. of Female Groups
Ciudad Nueva	8,584	1	1
Pinoza	6,621	1	1
Silvio Pettirossi	11,380	2	2
Vista Alegre	12,611	2	2
San Vicente	15,412	3	3
Obrero	19,823	3	3
Total	74,431	12	12

Source: Andes & Cisneros (2009, p. 37).

10 participants aged 15 to 19 years in each. Participants in 20 of the 24 discussion groups were recruited through local *colegios* and held in a private location. More groups were held in more populous neighborhoods. Equal numbers of male and female groups were conducted in each neighborhood (see Table 2).

Community Mapping

At the beginning of the group discussions, participants gathered around a large map of their neighborhood to describe their communities, marking areas they discussed on the map. The maps were produced with ArcView GIS software, but were printed without the GPS points collected prior to the discussions so that adolescents themselves could draw features on the map while narrating how they experienced those places. The group discussions began by asking where youth felt safe or unsafe, how and where youth usually met potential romantic partners, where they spent time together, and if those places differed depending on relationship seriousness. These spaces were identified on the map when they were within the neighborhood, or noted for later identification. Participants were then asked to describe where youth in their neighborhoods engaged in activities related to the risk and protective factors targeted by the research; how they perceived the community level of intervention in activities related to such factors, and finally the domains of use or nonuse of condoms, contraceptives, and clinical services. A collectively sketched map was the final product of each group discussion, as in Figure 1.

The 24 maps produced by the small group discussions are a data source and analytical tool (Ruvane & Dobbs, 2008) offering new insights into the participants' understanding of geographical and social space. Because the group discussions were intended to generate information on particular sites and behaviors associated with them, a verbatim transcript was not deemed necessary, but moderators could refer to the recording while writing field notes after each group discussion. Salient portions were transcribed and embedded within the moderator's field notes, which otherwise summarized the content of the discussion and the moderator's observations. Note-takers also wrote field notes for each discussion, summarizing the flow of the discussion and adding observations. Moderators and note-takers then exchanged field notes, discussed any apparent discrepancies, and edited their own field notes based on that discussion (ibid., p. 38).

Figure 1
Community mapping

Data Analysis

Both sets of field notes were entered into MAXqda2 software. A first round of coding using one set of field notes generated a codebook consisting of 33 codes organized under six general themes: methods, individual, partner, peers, family, and community. Discussion condensed the codebook to 17 thematic codes. These were reorganized and redefined during subsequent rounds of coding, but the essential framework remained through to the finalized codebook (ibid., p. 39).

For each subsequent round of coding, six field notes or approximately 25% of the data, were selected and coded by two researchers. To check intercoder agreement, the team adopted the convention of selecting an entire paragraph and applying relevant codes. Coding tables for each coder and text were exported from MAXqda2 to an Excel file in order to compare the coding for each paragraph. The two coders for each text then re-inspected the original data for every discrepancy and discussed their reasons for applying or not applying a particular code. Following each round of coding and reconciliation, problems with code definitions were discussed and appropriate changes made to the codebook. Intercoder agreement was no longer checked after round 4; however, all texts were coded

by two independent coders who then compared their coding and resolved any differences by consensus. Table 3 lists codes and code definitions in the final codebook.

The next phase of the analysis involved a focused rereading of the more than 2,400 coded passages in field notes and memos. Code and retrieve analysis used MAXqda2, the only qualitative software with full documentation in Spanish at the time. MAXqda2 handles large volumes of textual data and includes advanced data searching and reporting functions. There were four main analytic themes: methods, relationship types, risk and protective factors, and adolescent spaces (see Andes & Cisneros 2009). Using MAXMaps add-on module, the sketch maps were integrated in several layers to the MAXqda2 analysis as an object in jpg format. Coded segments, codes, and memos were linked to each map in a conceptual diagram to visualize connections between verbal and spatial data. Analyzing geo-referenced spaces and textual data using links to GE functions was the best means available prior to the release of Geo-links in MAXQDA 2007. Subsequently, hyperlinks to geo-referenced data in ArcGIS were used to reexamine the data with MAXQDA 2007, as in Figure 2.

This image enables comparison of the heterogeneous distribution of places where young people spend free time with locations of contraceptive availability. The source link to the ArcGIS mxd file is anchored to specific textual data in MAXQDA's text browser. Although this ArcGIS map was built using GPS points from the preliminary work by CEPEP staff, it was entirely validated by the group discussion data.

Different data layers in ArcGIS also provide a platform to integrate the youth's sketch maps into a sophisticated tool to represent the feelings they have about unsafe places, as in Figure 3.

In this layer, rich data on perceptions is depicted as lines and polygons representing the unsafe places the adolescents described and drew. Memos, codes, and coded segments were the source for the geo-referenced images. One important finding from GIS and CAQDAS-enabled MMR was a gendered perception of place.

Such procedures have potential applications in many fields involving linking space, place, and inequality. They can more robustly link outcome-based spatially defined inequalities with process-based investigation of their origins. In mixed methods terms, this is both a classic quantitative/qualitative "complementary" application, and an exercise for "initiation" purposes, because the resulting fuller picture destabilizes reified conceptualizations, such as those accounting for nonuse of contraception on the basis of ignorance, fecklessness, or deviance.

Conclusion

Teddlie and Tashakkori (2003, pp. 38-39) rightly emphasize the importance of inference (validity) in MMR. Amongst the associated challenges for mixed methodologists is the need to agree standards for evaluating inference quality (capturing both "design quality" and "interpretive vigor"). Teddlie and Tashakkori (2003) identify four dimensions of inferential quality: "consistency within the design of the study, consistency of multiple conclusions with each other, consistency of interpretations across people, and distinctiveness of the interpretations from other plausible ones" (p. 40). As new MMR practices, QG

Table 3
Codebook with Definitions

Code	Definition
Methods	Methods of protection for pregnancy or STI/HIV including medical (pills, IUDs, injections, sterilization, condoms, diaphragms, spermicides) and traditional (withdrawal, calendar, ''yuyos"—traditional herbs). Includes access to methods, barriers/facilitators to use, perceptions of providers
CEPEP	Familiarity with services at CEPEP's *Espacio Joven*, perceptions of availability and quality of services
Intimacy	References to intimacy and sexual relations even if stopping short of intercourse (petting, kissing, etc.). Also sexual reputation (e.g., ''easy girls")
Gender	Distinctions in practice by gender, perceptions of differences between males/females
Places	Any mention of places: in general (types of places youth frequent) or specified (named and localizable by participants)
Safety	Perceptions of safety and danger in space, references to police or security guards, community-level risk factors related to unemployment, community stress, violence, crime, delinquency, drugs, and so on
Dangerous people	Perceptions of danger related to presence of attackers, robbers, delinquents, ''*peajeros*," drunks, ''*gente del bajo*," and so on. Also references to individuals armed with guns or knives
Darkness	References to darkness, lighting, night, and ''silent" spaces in community
Protective factors	Protective factors in general. Includes factors not listed specifically in codebook
Supervision	Supervision/monitoring by parents or guardians. Strategies youths use to avoid parental supervision
Religiosity	Belonging to a religious community, attending activities at church
Sports	Participation in sports activities (organized or not). Excludes references to sports events if youth in question is not participating
Extracurricular activities	Participation in organized activities: art, culture, dance, languages, (sports), and so on
Sex education/ information	Sources of information on sexual and reproductive health. Includes sex education in school or other groups (*charlas*), and from media, personal communication or other sources
Parent/child communication	Parent/child communication about romantic relationships, sex, HIV/STIs and/or contraception
Adult monitoring	References to teachers, coaches, youth group leaders, priests/pastors, or other adults in supervisory position. May also include parents of friends or other adults in community
Future aspirations	Aspirations related to education, professional or technical careers, attachment to school or other organizations that can support those aspirations
Risk factors	Risk factors in general. Includes factors not listed specifically in codebook
Violence, crime	References to violence, crime, or delinquency
Alcohol, drugs	Reference to using alcohol or drugs, drug dealing, or community presence of addicts/alcoholics. Definition of drugs includes sniffing glue or using other substances such as a drug
Partner	References to a romantic or sexual partner, boy/girlfriend, fiancée, friend, *amigovio*, and so on
Communication	Partner communication regarding sexual activity, the use of condoms and contraception, and desire to have/avoid pregnancy
Type/quality	References to types of relationships, formal, serious, casual, etc. References to quality of relationship: duration, communication, respect, negotiation and decision making, etc.
Free time	References to how youth spend free time (when not in school or at work). Includes pastimes and diversions away from home, as well as at home or friend's home

Note: CEPEP = Centro Paraguayo de Estudios de Población.
Source: Andes & Cisneros (2009, p. 40).

Figure 2
ArxGIS 9 map for places where youth spend free time and density of contraceptive ability
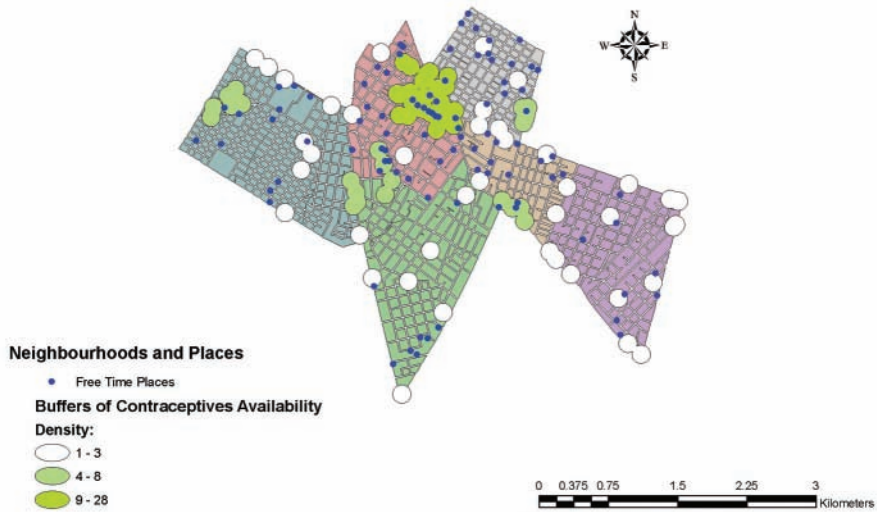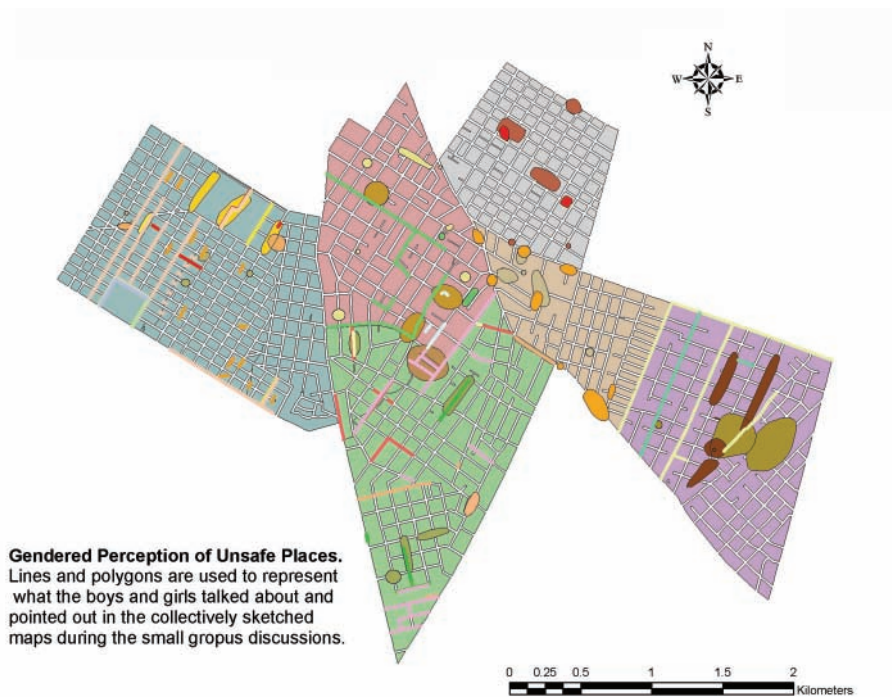

Neighbourhoods and Places
- Free Time Places

Buffers of Contraceptives Availability
Density:
- 1 - 3
- 4 - 8
- 9 - 28

0   0.375 0.75   1.5   2.25   3
Kilometers

Figure 3
ArxGIS 9 map for perception of unsafe places by young men and women

Gendered Perception of Unsafe Places.
Lines and polygons are used to represent
what the boys and girls talked about and
pointed out in the collectively sketched
maps during the small gropus discussions.

0   0.25 0.5   1   1.5   2
Kilometers

and spatially oriented QSS need understandings of inferential quality that negotiate the distinctive forms of data they use. Published examples currently pursue a ''fuller picture'' rather than triangulation-for-convergence approach, but there are signs of triangulation-type reasoning, as in Nightingale's (2003) realization that individually, neither her aerial photos nor villager interviews revealed whether community management had reduced or increased tree cover. Moving beyond a naively objectivist view of artifacts such as maps is a start but it remains unclear what qualitative geographers will replace it with or how qualitative social scientists will incorporate relativism and perspectivalism into their analysis of spatial data. The ''audit trail'' capacities of qualitative software may be important here. Pursuing agreed inferential standards for geo-referenced MMR, a community of scholars can exploit such capacities to make inferential reasoning transparent and reviewable.

We have discussed common threads in contemporary qualitative geography and qualitative social science, highlighting in each the moves toward data integration. A key commonality is the drive to understand what Knigge and Cope (2006) call the ''small and large scale.'' We have noted how GIS and CAQDAS can extend analysis, but they can also perform validation, as in Matthews et al.'s (2005) tandem use of GIS and CAQDAS to identify where fieldworkers had inadvertently strayed outside the sample area. Validation can also involve using spatial data to test participants' testimony. Spatial analysis tools provided by GIS are essential to verify the congruence between different kinds of data, but the convergence of GIS and CAQDAS can extend their reach.

GIS as a ''social actor'' (Pickles, 2006) opens our methodological imagination to new MMR frontiers in integrating new kinds of data, including contextual geospatial data and qualitative data in 3D visualization or in time–space coordinates. Egenhofer and Mark's (1995) vision of exploring ''naïve geography'' to create models of commonsense geographical knowledge using GIS is advanced by the contribution CAQDAS can make in grounding the mapmaker's representations in the experiences of the people who inhabit the territory. A ''Spatially Integrated Social Science'' (Goodchild, Anselin, Appelbaum, & Harthorn, 2000) can gain from these convergent methodologies and technologies, but creative insights from empirical research bridging the gaps between spatial and qualitative data analysis will always be welcome (Cope & Elwood, 2009; DeLyser, Aitken, Crang, Herbert, & McDowell, 2009). These are not only important trends in mixed methods research practice but can help to make social science closer to communities and people.

Glossary

Boolean: The algebra of set theory
Cadastral: Land ownership map
CAQDAS: Computer-Assisted Qualitative Data AnalysiS
GIS: Geographic Information System
Raster: Data displayed as discrete picture elements (pixels)
Vector: A geometric element, stored as a point with x, y coordinates

References

Amsden, J., & VanWynsberghe, R. (2005). Community mapping as a research tool with youth. *Action Research*, *3*, 357-381.

Andes, K. L. & Cisneros-Puebla, C. (2009). *Salud Sexual y Reproductiva en Adolescentes en Asuncion, Paraguay: Una Evaluacion Cualitativa de Necesidades.* Asuncion, Paraguay, South America: Centro Paraguayo de Estudios de Poblacion (CEPEP).

Bazeley, P. (2003) Computerized data analysis for mixed methods research. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods for the social and behavioral sciences* (pp. 385-422). Thousand Oaks, CA: SAGE.

Bazeley, P. (2004). Issues in mixing qualitative and quantitative approaches to research. In R. Buber, J. Gadner, & L. Richards (Eds.), *Applying qualitative methods to marketing management research* (pp. 141-156). Basingstoke, UK: Palgrave.

Bazeley, P. (2006). The contribution of computer software to integrating qualitative and quantitative data and analysis. *Research in the Schools*, *13*, 63-73.

Carmichael, P. (2002, May). Extensible mark-up language and qualitative data analysis. *Forum: Qualitative Sozialforschung*, *3*(2). Retrieved July 27, 2009, from http://www.qualitative-research.net/fqs-texte/2-02carmichael-e.htm

Cope, M., & Elwood, S. (2009). *Qualitative GIS: A mixed methods approach*. Thousand Oaks, CA: SAGE.

Creswell, J. (2009). Mapping the field of mixed methods research. *Journal of Mixed Methods Research*, *3*, 95-108.

Creswell, J., & Plano-Clark, V. L. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, CA: SAGE.

DeLyser, D., Aitken, S., Crang, M., Herbert, S., & McDowell, L (2009). *Handbook of qualitative research in human geography*, Thousand Oaks, CA: SAGE.

Doel, M. (2001). Qualified quantitative geography. *Environment and Planning D*, *19*, 555-572.

Egenhofer, M., & Mark, D. (1995). Naïve geography. In A. Frank & W. Kuhn (Eds.), *Lecture notes in computer science* (Vol. 988, pp. 1-15). Berlin, Germany: Springer-Verlag.

Elwood, S. (2006). Participatory GIS and community planning. In S. Balram & S. Dragicevic (Eds.), *Collaborative geographic information systems* (pp. 66-84). Hershey, PA: Idea Group.

Elwood, S., Feliciano, R., Gems, K., Gulasingam, N., Howard, W., Mackin, R., et al. (2007). Participatory GIS: The Humboldt/West Humboldt park community GIS project. In S. Kindon, R. Pain, & M. Kesby (Eds.), *Participatory action research approaches and methods* (pp. 170-178). New York: Routledge.

Fetters, M., Yoshioka, T., Greenberg, G., Gorenflo, D., & Yeo, S. (2007). Advanced consent in Japanese during prenatal care. *Journal of Mixed Methods Research*, *1*, 333-365

Fielding, N. G., & Lee, R. M. (1998). *Computer analysis and qualitative research*. London: SAGE.

Fielding, N. G., & Lee, R. M. (2002). New patterns in the adoption and use of qualitative software. *Field Methods*, *14*, 197-216.

Goodchild, M., Anselin, L., Appelbaum, R., & Harthorn, B. (2000). Toward spatially integrated social science. *International Regional Science Review*, *23*, 139-159.

Greene, J., Caracelli, V., & Graham, W. (1989). Toward a conceptual framework for mixed-method evaluation designs. *Educational Evaluation and Policy Analysis*, *11*, 255-274.

Greene, J. (2008). Is Mixed Methods Social Inquiry a Distinctive Methodology? *Journal of Mixed Methods Research*, 2, 1, 7-22.

Haraway, D. (1996). Situated knowledges: The science question in feminism and the privilege of partial knowledge. In J. Agnew, D. N. Livingstone, & A. Rodgers (Eds.), *Human geography: An essential anthology* (pp. 108-128). Malden, MA: Blackwell.

Harris, T. M., Weiner, D., Warner, T., & Levin, R. (1995). Pursuing social goals through participatory GIS. In J. Pickles (Ed.), *Ground truth* (pp. 196-222). New York: Guilford Press.

Johnson, R. B., Onwuegbuzie, A., & Turner, L. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research*, *1*, 112-133.

Jung, K.-I. (2009). Computer-aided qualitative GIS: A software-level integration of qualitative research and GIS. In M. Cope & S. Elwood (Ed.), *Qualitative GIS: A mixed methods approach*. (pp.115-135) Thousand Oaks, CA: SAGE

Kelle, U. (1996). *Computer-aided qualitative data analysis.* Thousand Oaks, CA: SAGE.

Knigge, L., & Cope, M. (2006). Grounded visualization: Integrating the analysis of qualitative and quantitative data through grounded theory and visualization. *Environment and Planning A*, *38*, 2021-2037.

Kuckartz, U. (1995). Case-oriented quantification. In U. Kelle (Ed.), *Computer-aided qualitative data analysis* (pp. 158-176). Thousand Oaks, CA: SAGE.

Kwan, M.-P. (2002a). Feminist visualization: Re-envisioning GIS as a method in feminist geographic research. *Annals of the Association of American Geographers*, *92*, 645-661.

Kwan, M.-P. (2002b). Is GIS for women? Reflections on the critical discourse in the 1990s. *Gender, Place and Culture*, *9*, 271-279.

Kwan, M.-P. (2007). Critical GIS. In K. Kemp (Ed.), *Encyclopedia of geographic information science* (pp. 56-57). Thousand Oaks, CA: SAGE.

Kwan, M.-P., & Ding, G. (2008). Geo-narrative: Extending GIS for narrative analysis in qualitative and mixed method research. *The Professional Geographer*, *60*(4), 1-30.

Kwan, M.-P., & Lee, J. (2004). Geovisualisation of human activity patterns using 3D GIS. In M. Goodchild & D. Janelle (Eds.), *Spatially integrated social science* (pp. 48-66). NewYork: Oxford University Press.

Lee, Y.-J., & Greene, J. (2007). The predictive validity of an ESL placement test. *Journal of Mixed Methods Research*, *1*, 366-389.

Marble, D. (1990). The potential methodological impact of geographic information systems on the social sciences. In K. Allen, S. Green, & E. Zubrow (Eds.), *Interpreting space: GIS and archaelogy* (pp. 9-21). London: Taylor & Francis.

Matthews, S., Detwiler, J., & Burton, L. (2005). Geo-ethnography: Coupling geographic information analysis techniques with ethnographic methods in urban research. *Cartographica*, *40*(4), 75-90.

Mertens, D. (2003). Mixed models and the politics of human research. In A. Tashakkori, & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (pp. 135-166). Thousand Oaks, CA: SAGE.

Morse, J. (1991). Approaches to qualitative-quantitative methodological triangulation. *Nursing Research*, *40*, 120-123.

Nightingale, A. (2003). A feminist in the forest: Situated knowledges and mixing methods in natural resource management. *ACME: An International E-Journal for Critical Geographies*, *2*, 77-90.

Pavlovskaya, M. E. (2002). Mapping urban change and changing GIS. *Gender, Place and Culture: A Journal of Feminist Geography*, *9*, 281-289.

Pavlovskaya, M. E. (2006). Theorizing with GIS: A tool for critical geographies? *Environment and Planning A*, *38*, 2003-2020.

Pickles, J. (1995). *Ground truth: The social implications of geographical information systems*. New York: Guilford.

Pickles, J. (2006). Commentary: Ground truth 1995-2005. *Transactions in GIS*, *10*, 763-772.

Rossman, G., & Wilson, B. (1985). Numbers and words: Combining quantitative and qualitative methods in a single large-scale evaluation study. *Evaluation Review*, *9*, 627-643.

Ruvane, M., & Dobbs, R. (2008) Genealogy, historical geography, and GIS: Parcel mapping, information synergies, and collaborative opportunities. In D. J. Timothy & J. K. Guelke (Eds.), *Geography and genealogy* (pp. 43-61). Aldershot, UK: Ashgate.

Schuurman, N. (2000). Trouble in the heartland: GIS and its critics in the 1990s. *Progress in Human Geography*, *24*, 569-590.

Schuurman, N. (2006). Formalization matters: Critical GIS and ontology research. *Annals of the Association of American Geographers*, *96*(4), 726-739.

Sheppard, E. (2005). Knowledge production through critical GIS. *Cartographica*, *40*(4), 5-21.

Skinner, D., Matthews, S. A. & Burton, L. M. (2005). Combining ethnography and GIS technology to examine constructions of developmental opportunities in contexts of poverty and disability. In T. S. Weisner (Ed.), *Discovering successful pathways in children's development: Mixed methods in the study of childhood and family life* (pp. 223-239). Chicago: University of Chicago Press.

Sullivan, D. (2006). Geographical information science: critical GIS. *Progress in Human Geography*, *30*, 783-791.

Teddlie, C., & Tashakkori, A. (2003). Major issues and controversies in the use of mixed methods in the social and behavioral sciences. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research*. (pp. 3-50). Thousand Oaks, CA: SAGE.

Weitzman, E. & Miles, M. (1995). Computer Programs for Qualitative Data Analysis. Thousand Oaks, CA: SAGE.

Weir, S. S., Morroni, C., Coetzee, N., Spencer, J., & Boerma, J. T. (2002). A pilot study of a rapid assessment method to identify places for AIDS prevention in Cape Town, South Africa. *Sexually Transmitted Infections*, *78*(Suppl. I), i106-i113.

Nigel Fielding is Professor of Sociology and an Associate Dean at the University of Surrey. Since 1994 he has co-directed CAQDAS Networking Project, a training and capacity-building project for qualitative software. His research interests are in new technologies for social research, qualitative research methods, and criminal justice, in which fields he has authored or edited widely, including The SAGE Handbook of Online Research Methods (2008).

César A. Cisneros-Puebla is Professor in the Department of Sociology at Universidad Autonoma Metropolitana-Iztapalapa, Mexico. Since 2002 he is the editor of FQS: Forum of Qualitative Social Research Spanish version. His research interests are in qualitative software, qualitative research methods and the convergence of GIS-CAQDAS.