Geographical information systems:
an effective planning and decision-making platform
for community health coalitions in Australia

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Abstract
The development of locally-based healthcare initiatives, such as community health coalitions that focus on capacity building programs and multi-faceted responses to long-term health problems, have become an increasingly important part of the public health landscape. As a result of their complexity and the level of investment, it has become necessary to develop innovative ways to help manage these new healthcare approaches. Geographical Information Systems (GIS) have been suggested as one of the innovative approaches that will allow community health coalitions to better manage and plan their activities. The focus of this paper is to provide a commentary on the use of GIS as a tool for community coalitions and discuss some of the potential benefits and issues surrounding the development of these tools.

Keywords (MeSH):
Community Healthcare; Community Health Planning; Community Health Networks; Geographical Information Systems; Clinical Decision Support Systems

The need for new tools and techniques
The development of locally-based healthcare initiatives has become an increasingly important part of the public health landscape. These developments, which capitalise on collectives, partnerships, consortia or cooperatives, are substantially different from traditional health practices (Ansari, Phillips & Hammick 2001; Barnard & Hu 2005). Collaborative planning and management methods are seen as an important way of progressing health agendas and addressing chronic problems in society. Although there is no consensus about the definition of health coalitions (Glendinning 2002), these initiatives generally involve formal alliances of organisations, groups and agencies that have joined forces to plan strategies that can address a common goal, namely increasing health or reducing the risk of chronic disease. As researchers in this area have noted (Ansari, Phillips & Hammick 2001), health coalitions tend to have ambitious goals and tackle long-standing systemic social problems. They require sustained investment and usually evolve over long periods of time. They often include a number of complex activities that may be dependent on each other or have a synergistic effect and represent a ‘system’ of actions rather than one clearly defined intervention. These actions may not be standardised, changing in response to sub-contexts within the community over time.

From health bureaucrats and health practitioners to community workers, there is increasing concern about how to achieve sustainable health outcomes within the context of this collaborative settings-focused landscape. The challenge is heightened by the fact that community-based health partnerships typically have diverse membership from across multiple sectors that historically have not intersected and therefore necessitate a different approach to planning and the adoption of tools that facilitate localised conclusions.

The localised focus of these initiatives has necessitated some form of ‘small area’ community planning process that can accommodate and facilitate place-specific knowledge (Bullen, Moon & Jones 1996). Further, these initiatives are based on a multitude of cross-sectoral data sources that are rarely understood as a coherent whole. The fractured nature of these data raises questions about how to integrate the information used by these collectives. This combined need...
to develop sound community-level planning and to overcome the fracturing of knowledge bases provides an incentive for the uptake of new and novel data analysis and presentation approaches. One platform that can address both concerns is Geographical Information Systems (GIS), particularly when used to underpin the development of an online decision support system (DSS).

**GIS as a platform for health planning**

GIS has been defined by the National Centre for Geographic Information and Analysis (NCGIA – USA, 1990) as ‘a system of hardware, software and procedures designed to support the capture, management, manipulation, analysis, modelling and display of spatially referenced data for solving complex planning and management problems’. More simply, GIS can be understood as a tool that places data in the particular spatial context within which intervention and illness is occurring. It allows vastly different datasets (health and non-health) to be collated using location as the common feature. Individual-level data (e.g. client outcomes) can be combined with district- or region-level data to gain a more precise understanding of the factors that affect health. GIS allows an understanding of disease or risk factor ‘hot spots’ that can be mapped and compared against the spatial patterns of other community features, such as infrastructure and services. Thus, GIS mapping provides a deeper level of explanation and enables relationships to emerge that would not otherwise be apparent. Most importantly, GIS allows users to conduct interactive queries, ‘what if’ scenarios, forecasting and future projections that facilitate planning. Beyond simple data management, however, GIS provides the capabilities for presenting data in a form that is readily understandable for most audiences and, when combined with sophisticated online technologies, can allow wide engagement and efficient dissemination of information across many stakeholders.

In recent years, GIS has been used extensively to study public health issues, including disease mapping, epidemiological inquiries, health services analyses and planning, environmental health analyses, exposure/risk modelling, disease diffusion and clustering studies, health disparities research, and investigations of many other public health issues (Barnard & Hu 2005). The wide ranging utility of GIS is apparent in published epidemiological research using spatial data analysis in areas such as communicable diseases (Law et al. 2004), cardiovascular disease (Jarrett et al. 2005), alcohol and drug use (Hanson & Wieczorek 2002) and chronic respiratory diseases (Dominici et al. 2006).

For public health planning and other areas of health policy, the importance of GIS as a planning tool lies in its ability to identify the intricate links between location and health outcomes. The spatial patterning and mapping of health outcomes and processes has been a long standing preserve of the medical geographer and can be traced back to Snow’s iconic study of cholera in London. The advent of GIS and related technologies has provided contemporary medical geographers and spatial epidemiologists with a range of new tools with which to identify and understand health issues from new perspectives. For those working in the policy field of public health, GIS and its related technologies can inform processes such as health needs assessments, planning and implementation, and monitoring and evaluation.

Advances in spatial analytical techniques have further increased the utility of GIS technologies and have expanded the functionalities that have become available within easy-to-use packages. For this reason, GIS is being touted as a sophisticated addition to the health researcher and policy-makers toolbox (O’Dwyer & Burton 1998). The ability to handle geographic data and their attributes makes GIS a useful tool to answer questions such as: What services or resources exist at or near a particular location? What geographic areas meet particular criteria? What spatial patterns exist in particular diseases? What spatial associations exist between infrastructure and health outcomes?

Goodman and Wennberg (1999) described three interrelated functions of GIS: data management, data visualisation and data analysis. In public health usage, all three are desirable qualities. These three functions are supported by the multi-layered database structure. A base layer containing the administrative boundaries of a specific area can be supplemented by additional layers populated with information about health outcomes, resources or qualities. By adding layers from other sectors (e.g. transport networks or socioeconomic status), GIS enables planners and practitioners to understand and visualise the distribution of disease states, health issues and health outcomes (see Figure 1).

The output from sophisticated statistical analyses (e.g. calculated indices to represent combinations of factors) can also be added as additional layers, to support the identification of links between health outcomes and proximity to hazards (e.g. pollutants) or health care assets (e.g. health practitioners) or as a means of identifying hot-spots within particular communities that require attention.
GIS as an online interactive planning system

GIS allows the simple visualisation of pre-loaded maps representing particular areas of interest. These simple static GIS platforms are widely established in the public health domain (see Buckeridge et al. 2002). However, GIS can be combined with online applications to facilitate a range of dynamic functionalities (e.g. interactive end-user engagement, personalised maps), allowing a deeper level of explanation and enabling relationships to emerge than would otherwise be apparent. Most importantly, an interactive GIS system would allow users to conduct their own queries and to model various scenarios for future projections and planning.

A truly dynamic and interactive GIS-based decision support system would allow the end-users to access data and run sophisticated analyses such as spatially weighted regression or other spatially based routines. However, as a planning tool for public health, this type of fully interactive approach would be of less use due to the high level of statistical and technical knowledge required. Once placed in a user-friendly online environment, even complex spatial analyses based on multiple layers contained within the GIS can be viewed by practitioners and policy makers simply by choosing from drop-down menus made available through a purpose-designed website. Unlike the static representations of GIS, dynamic applications in an online environment are less easily identified in the health literature.

In Australia, the Social Health Atlas online (www.publichealth.gov.au) is an example that allows the user to map specific health outcomes and associated socio-economic status for administratively defined boundaries. Although in Australia there appears to be a lack of examples illustrating the use of these online tools in the context of health coalitions, international examples do provide an illustration. The Population Health Surveillance Unit of the Vancouver Island Health Authority in Canada has developed a platform whereby GIS is used for local data integration, visualisation and analysis for health planning (Barnard & Hu 2005). Internet interactive cancer mortality maps have been developed by the National Cancer Institute in the United States of America (http://www3.cancer.gov/atlasplus). These maps allow users to customise output in terms of type of cancer, age, gender, race and geographic scale. These examples demonstrate the potential utility of a web-based interactive platform for the GIS-based decision support system.

GIS in the context of health coalitions

Although GIS and the online display of mapping output has been a significant part of medical geography and spatial epidemiology for some time, its use in health coalitions or community partnerships has been limited to date. However, there is no doubt that GIS and its use in an online environment as a decision support platform, is a potentially powerful resource for health coalitions.

Despite the volume of data that currently exists within the health system, the use of this information for the purpose of health planning has been hindered by the absence of suitable and accessible methods and frameworks for data collation and interpretation. Indeed, a recent public review of the state health system in Australia (Queensland Health 2005) concluded that there are ‘many information systems that provide a wealth of data, yet little information that assists districts in service planning and performance evaluation’ (p. 389). It is well recognised that health coalitions, because of the broad membership of such organisations, are confronted with even larger amounts of data at the community level. Thus, it is not surprising that the outcomes produced by health coalitions are dependent on the extent to which they have access to shared, reliable information and...
expertise that can facilitate meaningful decision making and planning (Foster-Fishman et al. 2001). Other researchers (e.g. Roussos & Fawcett 2000) have confirmed that the use of monitoring and feedback systems was associated with improved partnership functioning. Specifically, coalitions with access to technology reported greater satisfaction than those without access, but their ability to use information effectively to underpin their decisions remained hindered by the absence of suitable and accessible methods for interpreting their data.

For health coalitions based around a geographically defined community or health district, the ability to understand how health outcomes are distributed and the association between these patterns and patterns of access and socioeconomic characteristics, are important to localised planning, informing and educating. Joerin and Nembrini (2005) argued that GIS can be used for raising a community’s level of awareness about local problems and for building support for participatory decision making. Because GIS provides a visual display of statistical data, it can make data more readily understandable and meaningful for all members of a coalition, thus facilitating equal participation in decision-making.

The true essence of community health coalitions is that community members are full partners in the planning process (Lasker, Weiss & Miller 2001), based on the assumption that no one person or organisation is capable of resolving the multiple health concerns and challenging issues that abound in contemporary society. When combined with the mandate for health coalitions to actively engage with the wider community in planning and decision making (Ansari et al. 2001), new tools and techniques are required. Applying GIS within a health coalition setting has the potential to facilitate effective problem identification, problem solving and shared evidence-based decision making.

As with any tool, its potential usefulness depends on the quality of the output and the level of complexity or expertise required for its use. The potential for a fully matured GIS online system to be developed within a health coalition setting is a significant possibility. However, it is also important to realise that a range of issues must be addressed prior to successful implementation. For instance, data confidentiality can be an issue in providing widespread access to public health data (Bell et al. 2006; Caley 2004) and remains one of the most significant challenges in the area of health mapping (Cromley & McLaugherty 2002). In cases where data is coded and provided at the level of street address, online interactive use of GIS increases the possibility that individual privacy may be breached.

Although methods exist to ensure confidentiality (e.g. mapping aggregate level outcomes at a broad spatial scale such as statistical local areas, suburbs or postal codes, secure access and user control systems), some will still be concerned about this issue.

However, increasing levels of confidentiality can result in decreased usability. As the level of spatial aggregation increases to ensure confidentiality, there is likely to be a commensurate decrease in the usability and specificity of the maps and analysis that can be produced. That is, the spatial scale at which data are presented will impact on the possible interpretation of that data. Data presented at a small scale level, such as a street or local community, will be much more meaningful to those working in a local health coalition than data presented at a larger regional level, such as a health district. The point at which confidentiality is preserved but data usability and interpretability is maximised is an important issue that needs to be addressed by health coalitions entertaining the adoption of a GIS platform within an online system.

In addition to these challenges, there will remain a question regarding the extent to which resources and expertise are available to update and maintain the GIS system. Although partnerships between researchers and local health coalitions have resulted in the development of many GIS systems (e.g. Buckeridge et al. 2002), the ability to maintain, improve and update these systems in the long term is likely to be restricted. These tasks can be time and resource intensive, necessitating structures and processes to enable the integration of these systems into existing public health infrastructure.

Finally, a significant challenge to online GIS systems is the extent to which stakeholders will actually use the tools both initially and in a sustained way. Past examples have shown that by ensuring the inclusion of members of the health coalition in the process of developing the GIS system and online platform, any potential angst associated with understanding and using the system can be reduced (Buckeridge et al. 2002). The study conducted by Buckeridge et al. clearly demonstrated the utility of a GIS surveillance system to support decision making when it was developed in collaboration with the end users. In this study, university and community members collaboratively designed the GIS system to provide visual access to routinely collected health data. The community then engaged in training and participated in the process of analysing data and applying the conclusions to decision-making. Thus, by providing sufficient exposure and training in GIS to members of the health coalition and ensuring the establishment of a GIS project team with at least one member.
who is well versed in the technological aspects of GIS, potential problems can be reduced.

Our own experience within the Logan Beaudesert Health Coalition has highlighted the importance of early adopters and champions who will engage other members of the coalition in the application of the GIS to local decisions. During this project, we have documented the process of designing, developing, implementing and evaluating an online GIS-based decision support system for use by a local coalition that included members from Queensland Health, local councils, the non-profit sector, general practice divisions and the university. The purpose of the coalition is to examine and promote new ways of managing chronic disease in a specific socioeconomically disadvantaged area. The coalition managed resources to fund the development of local responses, but had little data on which to base any decisions.

The importance of this coalition and its processes for decision making will be highlighted in coming years as Australia moves through its latest round of national health reform (National Health and Hospitals Network 2010). The shift towards widespread reliance on local area primary healthcare organisations and hospital networks will increase the need for reliable and user-friendly planning tools, such as that provided by the GIS within an online decision support system. Indeed, the importance of adopting a ‘community health surveillance system’, or a network that constantly gathers, integrates, and analyses data on health indicators, occurrences, and transmissions of disease in a particular population has already been highlighted in other countries (Davenhall 2002).

Conclusion
Is GIS an effective planning and decision making platform for community health coalitions in Australia? It is currently the only type of platform that can meet the demand for spatial knowledge and analysis as might be required by localised settings-focused interventions (Cromley & McLafferty 2002). There is no doubt that rapid technological and scientific developments, such as GIS, have the potential to alter the nature of public health planning dramatically. It is not surprising, then, that some health researchers have been calling for comprehensive GIS-based systems within national health sectors internationally (Boulos 2004). Despite this potential of GIS to provide a health surveillance and decision making system, this technology is not readily available to health planners and is dependent on complex statistical modelling techniques that are beyond the scope of the sector (Phillips et al. 2000). However, as the scope of online capability has expanded, so too has the potential for the use of GIS technology across many policy fields. For health coalitions whose policy focus is on the local community, the use of a well-structured and user-friendly GIS-based online decision support system should be seen as an important part of the policy toolbox. With appropriate interfaces that facilitate the use and interpretation of GIS outputs, such a system can provide significant advances to evidence-based policy development.

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