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Chapter 1

Introduction

Introduction

Despite being a recognised part of the planner's toolbox for more than three decades, geographic information systems (GIS) can still possess a kind of mystique: excitement about their capabilities, mixed with the sort of fear and admiration of the skilled user that might be found as one regards a neurosurgeon. This mystique is not deserved. It should not be this way.

Although the sometimes overblown claims of tech professionals and software companies might lead us to think otherwise, GIS users – unlike, say, neurosurgeons – do not actually save lives in their day-to-day work. Yet, as has been known for some time, cartographers wield a sort of power that has very often been used for ill rather than good, and the safest and fairest conclusion might be, in the words of Mark Monmonier, that maps lie.

But a good part of the reason why GIS commands hushed admiration and respect is because of its potential to transform the communication of complex ideas about society, about cities and the impacts of policies, about the unevenness that pervades every aspect of life on Earth. GIS was at the forefront of the 'big data' revolution, for example, given that the vast majority – and an increasing amount – of information is also information specifically about places somewhere on the planet. From football clubs to Twitter conversations, government spending to the spread of diseases, these can be mapped, and not just as part of a trivial, academic exercise in analytical one-upmanship, but because by mapping it we can genuinely see patterns, tell stories and infer things in a way that we sometimes cannot by poring over tables and spreadsheets and charts. That is the heart of what might be called spatial analysis, and it is these possibilities that are uniquely unlocked by a computational approach to dealing with geographical information.

Map-making is an inescapable part of planning practice, even if it is no longer its central activity. Planning is fundamentally about land; and yet it is also about contestation and the mediation of opposing viewpoints and sets of values. A good planner sees not only the map but also the process and has the skills of diplomacy and dialogue to understand not only 'how to get there' but also where it is that we want, or need, to get to. In that sense, planning is a communicative art, with information – both tacit and technical – flowing both from planner to stakeholders and vice versa. Maps are a great communication tool, but they are not the only tool, just as technical evidence is not the only raw material the planner must deal with.

2 *GIS for Planning and the Built Environment*

This is a book about using GIS in the planning of the built environment. It is first and foremost a practical volume: it is designed to inspire but also to lead readers through the possibilities of using GIS and spatial analysis within the broad realm of spatial planning practice. But it is not a technical guide, even if we do provide some useful practical guidance in Chapter 6. It is not the intention to provide a narrow, technocentric view of the world. Rather, it starts from the premise that planners are dealing with so-called ‘wicked problems’, in the environment, in society, in the economy. Planners are part of the solution, but they are not the solution alone; they need to talk with others, use others’ information and – most critically – implement processes of consultation and plan-making that involve communities and lead to better places and better outcomes for people.

Working with data and information about places is central to this, and that is where GIS comes in. The central purpose of the book is to allow those with an interest in planning the built environment – be they professional planners themselves, residents, students, civil servants, elected community representatives, businesses or academics – some way of understanding the art of the possible with regards to the application of GIS and spatial analysis to the problems they face, and putting it into practice. The democratisation of data and – with the advent of open source software – the technologies themselves, means that for the first time in that 40-plus-year history, GIS can truly be a tool for everyone and not just for those with power.

Who is this book aimed at?

All the above leads to the question, who should be reading this book? In short, anyone with an interest in applying GIS methods to planning problems. It will also be useful to anyone using GIS in a built environment context more generally. The book assumes a basic understanding of information technology but does not require specialist knowledge of data analysis, GIS or spatial analysis. More important is the imagination to understand spatial problems and the way that analysis of information could help yield insights into them. This means that planners and students of planning are not the only groups that will find this book useful. Indeed, the city councillor wishing to write a neighbourhood plan and who wants to know how to get information on housing and map it, or the business wanting to understand how to improve its analysis of its local customer base, will find much within this book to interest them.

We now live in the very privileged position that, in Europe and North America as indeed throughout much of the world, the move is inexorably towards the opening up of access to data. This includes the vastly expensive digital mapping resources that taxpayers have traditionally funded but have until recently had no way of freely accessing. A good example of this is in Great Britain, where Ordnance Survey (the national mapping agency) have made vast

archives of spatial data available. Spurred on in part by technological advances in data management and delivery, but also by shifts in expectations around governance and transparency, the default position regarding access to these vast data resources is increasingly to make them openly accessible, albeit with some restrictions.

At the same time, private global corporations have funded incredible new geospatial data resources, whether it be Google Maps, Bing Maps, satellite imagery and addressing resources, or the geotagging of just about every object on the Internet. Even geospatial data from several Space Shuttle missions is now freely available on the Internet courtesy of NASA. Incredibly useful as these resources are, they are not *always* open, and some remain proprietary and ‘read only’. Thus, even more exciting is the maturity of the open source, distributed and ‘crowdfunded’ approach to major data generation challenges, such as that of mapping the world as the fantastic OpenStreetMap project has done.

This open approach now extends into the production of the very tools and techniques we can use. The free availability for several years of useful but somewhat cumbersome and specialist toolkits like GRASS has now yielded fruit in projects like QGIS, which bring together open source toolkits and user-written modules and present them in a user-friendly and freely available cross-platform environment. It is only the beginning when we see several city governments across the globe building their corporate GIS capabilities around QGIS, in so doing doubtless causing sleepless nights for account managers throughout the GIS software industry.

The consequence of this new world is that we are at a point where the readership for a book like this ought not to be confined to professional planners and students but to those from all walks of life who want to, or need to, engage with the full apparatus of place-making machinery, agonistically or peaceably, and who need evidence to make their case. We do not aim to provide a comprehensive account of the world of GIS; that is too big a task, and is not the aim here anyway. Instead, we focus on what we believe is most important for students of planning and the built environment, though we do not assume a high level of prior knowledge.

That said, a working knowledge of how planning systems work or what planning is (in any national context) will help the reader. By this, we mean the ways in which the production and reproduction of the built environment are achieved, the key social, economic and environmental resources that go into this endeavour, and the ways that it is regulated and governed. The specifics and the principles vary from place to place, of course, but throughout the world such systems are united by their focus on spatial relations, or the spatial contexts for and implications of other key societal relations, such as power relations. This is not intended to be a theory-heavy text, but we do start from the point of view – mentioned above – that planning is a process with communication at its heart. Consequently, we are keen to emphasise in this book the communicative power of GIS, alongside its analytical capabilities, and this is covered in more depth in Chapter 5, on geovisualisation.

Aims and objectives

Hopefully, the reader who has got this far sees themselves in one of the roles pictured above. They understand the problems, and are thirsty for ways of designing the analytical tools that help them get further insight. This book aims to equip those readers with the knowledge, skills and experience to understand how spatial analysis can help them to understand spatial planning problems. The focus throughout will be on commonly available tools. The book aims to fill the gap between very theoretical, abstract treatments of GIS (e.g. from the organisational or information management perspective) and those that are heavy with the arcane methodological and technical material that characterises some of the more specialised texts. This book is no more a ‘how-to’ guide as it is a ‘why’ guide: why would we use GIS in a particular given circumstance; to understand a particular given problem? Then how might we do it?

The book arose from a recognition that there were very few – if any – contemporary texts that really took as their starting point the kind of socioeconomic problems that planners face. Many of the textbooks are multidisciplinary in nature, but this means that some of the techniques are described in a way that is very difficult to translate them to the language of the built environment. In our work, we routinely use spatial analysis techniques and software tools that were designed by physical geographers wishing to model environmental processes to, instead, get some insight into social phenomena. Seen at the scale of the city, for example, house prices have ‘gradients’ and ‘surfaces’, just as sand dunes do, and it is sometime helpful to think of social and economic issues using different lenses when trying to understand the bigger picture.

So this book is a little bit translational in nature: hopefully, the reader will find that techniques that were developed with some other purpose in mind translate with a little imagination to the problems inherent in the built environment and its planning.

It is hoped that readers of this book will:

- Obtain the knowledge, skill and experience to understand how the spatial analysis of data about the ‘real world’ can be used to understand planning problems;
- Be able to apply a broad range of spatial analytic and visualisation techniques using industry standard GIS software packages; and
- Understand how maps and data can be used effectively as evidence for planning-related issues.

Structure of the book

In pursuit of the above aims and objectives, the book adopts a structure that begins by looking at why GIS is particularly useful for planning and the built environment. It then moves on to consider in more detail what is special about GIS, in the sense that it is a spatial database of our world. Owing to its centrality

to GIS, we then look at data as ‘the currency of GIS’ before going on to look at the communicative power of it through geovisualisation. This is followed by a more practical chapter on mapping the built environment before we take two key analytical approaches – spatial analysis and network analysis – and provide more detail and examples of why they are so important. The final chapter attempts to bring all this together and reflects on key messages.

There are several important points of departure from the wisdoms or perspectives that might be propounded by other GIS texts, and it would be advisable for the reader to at least familiarise themselves with these. Rather than develop a thematic structure that is driven by data or methods, we adopt three key themes that are related to what we see as the principal advantages of using GIS. These themes, which are woven into the fabric of the text throughout the book, are:

- *Improved understanding* of spatial phenomena;
- *Efficient management* of planning processes; and
- *Enhanced communication* of ideas between stakeholders.

Chapter 2 sets the scene by tackling the question, ‘why GIS for planning and the built environment?’. We seek to move beyond the rather simple idea that planners use GIS because planners use maps. Rather, we want to get to the idea that planners need to use GIS because it helps answer questions and it helps communicate ideas. In this chapter, we begin by reflecting on GIS’s origins as a technical, scientific subject and its relationship with planning, where it has often been seen as a tool of the ‘specialist’ rather than the generalist. We challenge this view here and argue that the world – and GIS – has moved on and it is time for planning to re-assess GIS and re-engage with it. Yes, planning is a complex discipline but it also needs good mapping and spatial analysis and we can learn much from looking at GIS afresh and put maps firmly back in planning. We look at GIS from four different perspectives here: as a tool for description, as a discipline in itself (as in geographical information science or GIScience), as a tool for engagement and public communication, and as a way of learning in relation to GIS for education. We also urge caution in relation to the use of GIS, by referring to Maslow’s so-called ‘law of the instrument’: ‘I suppose it is tempting, if the only tool you have is a hammer, to treat everything as if it were a nail.’ Ultimately, we argue for the importance of GIS in planning and the built environment and suggest that it is too important to be left to the specialists.

Chapters 3 and 4 put in place the essential concepts that we think are important to comprehend when using GIS to tackle planning issues. The first is the idea that, actually, GIS is not really about map-making at all: it is about an explicitly spatial approach to managing *data*. We contend in Chapter 3 that GIS is best understood not from the starting point of the map (and seeking to explain its development as the digital equivalent of cartography) but from the starting point of the data (seeing its development as a digital spatial database). GIS is a spatial database of our world. It does all the things that ‘traditional’

databases do: organise collections of data so that questions can be efficiently posed of those collections of data, while bringing to the database paradigm the killer weapon: *geography*. Being able to answer questions related to geography, such as ‘*where* do things happen?’ or ‘*what is near* me?’, extends the scope of the idea of a database hugely. But, of course, databases and the computing platforms on which they sit have their own special languages. GIS is built on those, too. This is why GIS can too often seem like a computing technology, aimed squarely at a closed group of techies, than something of use for multidisciplinary generalists like planners, designers, politicians or activists. This chapter introduces some of the basic database concepts and terminologies and attempts to show how these apply within GIS software by using some real-world metaphors. The chapter also discusses how the efficacy of any spatial model of the world built up from data relies on some fundamental concepts such as accuracy, precision, scale and generalisation.

Having proposed the fundamental idea of GIS as a spatial database as more useful to planners than the idea of GIS as cartography, we next look at the raw material itself: data. **Chapter 4** discusses data as the ‘currency of GIS’ and seeks to understand its true value within the context of the need for planners to move beyond superficial ideas about ‘knowledge’ towards a more informationally rich understanding of ‘wisdom’. In other words, data helps us answer questions. But handled well it also helps us to identify new questions. In an era of ‘big data’ and massive, freely available spatial datasets, it is more urgent than ever to have a clear, systematic approach towards identifying and answering questions and the role of data in that. We are not interested in, nor would we support, the idea of just throwing data at a problem to see what sticks. Chapter 4 also provides a wealth of practical tips on how to use datasets within GIS, and how to understand the myriad different file formats that are used to store mapping data, tabular data and the other raw data resources used within GIS.

Chapter 5 extends the idea of the map into the realm of *geovisualisation*, which places a particular emphasis on the communicative power of maps and spatial data and the role of these in planning discourse. This chapter explains why ‘geovisualisation’ is not just a fancy term for ‘mapping’ but a considered art and science of ‘condensing and abstracting and indexing the great buzzing confusion of information that comes from the world around us’ (Boulding, 1970, p. 2). The increasing sophistication of the role of visual language in maps is demonstrated by reference to 3D mapping, interactive maps, animation and maps which play around with space itself (for example, maps emphasising connectivity or time over distance). The chapter discusses the problems that arise from having *too much* data, and presents practical ways of synthesising, analysing and presenting spatial information, at all times mindful of a set of principles of the ‘orderly loss of information’. A range of good practice examples and case studies are provided.

In **Chapter 6**, we attempt to provide a more practical guide to mapping and the built environment. We do this because we want to provide readers with a resource they can return to again and again for advice about making maps with GIS. Part art and part science, the activity of making maps is fraught with

complexity, and without careful thought it is very easy to produce misleading maps. In fact, the ease with which we can produce maps in modern GIS packages now sometimes seems inversely proportional to the quality of maps we see in the public domain. *That is, it is now very easy to make maps but it remains very difficult to make good maps.* We offer advice here that we hope will help improve maps from both a technical and a communicative perspective. This is not an exhaustive coverage but we do look at some of the most common map types, including land use maps, choropleth maps and mapping the urban fabric, in addition to individual map elements like titles, scale bars and legends.

The final pair of chapters before the conclusion (Chapter 9) deal more explicitly with *spatial analysis* – formal techniques by which the spatial arrangement of entities and phenomena in the real world can be studied with a view to generating new knowledge and insight. **Chapter 7** takes as its starting point the late Waldo Tobler's famous 'First Law of Geography': that 'everything is related to everything else, but near things are more related than distant things' (Tobler, 1970, p. 236). This is used to set out the key principles for the use of spatial analysis in answering a set of specifically *spatial* questions in relation to planning and the built environment. The role of integrated processes of analysis, involving different tools in helping to provide insights, is discussed. The chapter cautions, however, against the view of GIS and spatial analysis as a hegemonic approach that serves to exclude other forms of knowledge. As we say in the introduction to Chapter 7, the optimal approach to a planning problem will require 'a careful mix of spatial analytical and people-centred decision making'.

Chapter 8 is about connectivity. It shows how the use of 'network analysis' can be used to solve tricky planning problems where distance is not the prime concern but where time, costs or other measures of connectedness might be more important. This chapter shows how many core GIS concepts explicitly or implicitly favour Euclidean geometry and the role of straight-line distance, but that in some important cases planners need a more nuanced understanding of space. The chapter defines key terminology used in network models and shows how such models have actually come to pervade many aspects of modern life, being as they are the backbone to such technologies as satellite navigation and critical in achieving optimality in the delivery of parcels or fast food, or the routing of public transport or Uber cabs. The key classes of 'network problem' are set out in this chapter, together with strategies for solving them using GIS tools.

Finally, **Chapter 9** turns its attention to the key problem that is associated with everything else the book covers: *how can better decisions be made?* In this chapter we return to the types of issues and problems typically facing planners, and we discuss how the information and wisdom that might come from the application of GIS and spatial analysis might be deployed within a broader framework of decision making. We consider some common pitfalls in presenting maps and the products of spatial analysis within broader decision-making structures such as those found within government and private companies, and how best to account for uncertainty within GIS models. We look at the example of multi-criteria evaluation methods as a way of bringing together information

on a range of different factors to help guide decision making. We also sound a cautionary note around the heavy premium that is placed on ‘ground-truthing’ data, ‘road-testing’ analytical approaches and building and maintaining stakeholder consensus.

How to use this book

It may seem odd to include advice on ‘how to use’ a book, yet it is important because we did not write this book as one that can or should be read sequentially in one sitting. It is designed to support a programme of learning, perhaps across an academic semester or perhaps over the course of a year as readers are learning GIS. If you want to learn how to use a particular GIS package that is normally best done through taught sessions with a professor or at a professional training event, or in directed learning courses online. If you want comprehensive coverage of GIS from beginning to end, then we recommend readers refer to Longley and colleagues’ (2015) *Geographic Information Systems and Science*, now in its fourth edition and firmly established as a classic and comprehensive overview text.

If you are a student of city, urban, regional planning or just interested in the subject and how GIS can help you, what it can do, and how to make better maps and conduct sound analysis then this textbook is aimed at you. With this in mind, each individual chapter can be read as a stand-alone piece and Chapter 6 in particular is intended to provide the kind of practical guidance that can help you make better maps, or just more accurately assess the quality and validity of existing ones.

With this in mind, we end this chapter by posing a number of questions and suggesting which part of the book you might turn to if you want to find an answer. At times, with some important topics, we use text in separate boxes if a particular issue is of great importance so that they are easier to find.

How can I make better maps?

For this, turn to **Chapter 6**. We include specific advice on different map types, but also on the use of colour, data classification and mapping at different scales, and we also suggest three principles of a ‘good map’: simplicity, appropriateness and value added.

What do I need to know about data in GIS?

In this book, we refer to data as being the ‘currency’ of GIS because of its importance and the inability to do much without it. We provide examples of the kinds of data you may come across and explain the relationship between data, information, knowledge and wisdom. We also discuss how this is not necessarily a simple relationship! For this, see **Chapter 4**.

I'm looking for inspiration: what new stuff can you show me?

In order to highlight the fact that GIS is about so much more than making simple static maps, **Chapter 5** has been put together partly to educate readers on what is possible and partly to inspire readers about what is possible.

Why does everyone go on about the 'First Law of Geography'?

If you take a class in GIS or spatial analysis, or any kind of quantitative geography, you are likely to come across Waldo Tobler's famous – and often misunderstood – 'First Law of Geography'. Here we attempt to explain it more simply in relation to spatial analysis, in **Chapter 7**. We also refer to the lesser-known 'Second Law of Geography', which we think is important, and often overlooked.

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