20 Epilogue: GIS&S in the Service of Humanity

OVERVIEW

- Relates the key ideas introduced in the book to the grand challenges of GIS&S
- Describes the importance and value of inculcating spatial thinking in all strands of education

LEARNING OBJECTIVES

- **Just how differentiated world geography is, notably in the incidence of poverty and disease.**
- **The biggest challenges facing humanity.**
- **The interdependency between many factors causing these problems.**
- **How GI systems and science (GIS&S) can help us tackle these challenges.**
- **A number of issues that we need to resolve to progress.**

KEYWORDS

Poverty, Education, Social Equality, Health and Wellbeing, Global Partnership

OUTLINE

20.1 Introduction

- The authors ask what GIS can, should, or will be able to do for humanity faced with profound global challenges
- The four big contributions that geographical information systems and science (GIS&S) can make are identified as:

  The ability to help us discover and share new understandings in the physical, environmental, and social sciences.
  - From these, the means to help us devise new products and services that improve the quality of life, especially for the disadvantaged of the world.
  - Use of these new products or services to enhance the efficiency of public and private tasks so as to release resources for other valued things.
  - Achievement of all this in as sustainable a way as possible.

20.2 The Differentiated World

- The authors argue that the world is a very differentiated, heterogeneous, and hence unequal place.
  - GIS&S is fundamental to the conception, representation, and analysis of geographic variations in ways that are robust, transparent, and potentially open to scrutiny by every stakeholder

20.3 Grand Challenges

20.3.1 The Global View of Governments

- Millennium Development Goals are discussed which include:
  - Goal 1: Eradicate extreme poverty and hunger.
  - Goal 2: Achieve universal primary education.
  - Goal 3: Promote gender equality and empower women.
  - Goal 4: Reduce child mortality.

- Goal 5: Improve maternal health.
- Goal 6: Combat HIV/AIDS, malaria, and other diseases.
- Goal 7: Ensure environmental sustainability (this is expanded since it is key to what follows).
- Goal 8: Develop a Global Partnership for Development.

- Progress in achieving these goals has been slower than anticipated…

20.3.2 Challenges Amenable to Use of GIS&S

- The authors describe interdependencies between the challenges and how GIS practitioners might make a contribution to ameliorating them.

20.3.2.1 Poverty and Hunger

- Almost half the world—over 3 billion people—live on less than $2.50 a day, while at least 80% of humanity lives on incomes of less than $10 per day.
- 80% of the world's population lives in countries where income differentials are widening
- Mapping using GISystems adds greater richness and diversity to statistics such as these as illustrated in Figure 20.4
- Poverty also generally means poor levels of nutrition
- GIS contributes to our understanding of poverty and inequality because it improves our ability to integrate, analyze, and portray multiple datasets and to support logistics through the use of our tools
    - enables us to move from what-is descriptions to what-if analysis

20.3.2.2 Population Growth

- The global population as of January 2010 was estimated by the U.S. Bureau of Census to be 6.796 billion.
    - Many demographers now expect the total to level off to somewhere around 10 billion after the middle of the Twenty-First Century
- The geography of population change, as well as population density, is far from uniform
- GIS provides an excellent instrument for measuring the ebbs and flows of population movements
    - When measuring people by surveys getting reliable numbers is becoming more difficult; using multiple data sources is becoming highly sensible
    - GIS can be used to provide better linkage of data
- GIS can also be used to help understand why people move and examine the impacts of changed laws, other barriers, or incentives

20.3.2.3 Disease

- The spread of disease, access to care, and the treatment and prevention of illness are unevenly distributed across the globe
    - For example, every year there are 350–500 million cases of malaria in the world, with 1 million fatalities: Africa accounts for 90% of malarial deaths, and African children account for over 80% of malaria victims worldwide
- The science underlying GIS is once again important for what-if analysis of diffusion processes and remedial action scenarios

20.3.2.4 Access to Potable Water

- Water problems affect half of humanity: some 1.1 billion people in developing countries have inadequate access to water, and 2.6 billion lack basic sanitation.
- These problems are like to increase as a result of competing uses and climate change
- GIS has been used in climate projections using the best available data and models
- GIS practitioners have made significant contributions to the definition of international boundaries, many of which have followed the course of rivers and are foci of tension

20.3.2.5 Natural Disasters

- GIS technology has imposed itself as an essential tool for all actors involved in the different sectors of the disaster and conflict management cycle. For example:
    - Probabilistic statements of the likelihood of a disaster
    - Improving the effectiveness of post-disaster recovery work

20.3.2.6 Environmental Sustainability

- GIS plays a significant role in monitoring the state of the environment both globally and locally
    - For example, examining the magnitude of biodiversity and ecosystem loss and in developing possible coping strategies
    - To succeed, GIS&S specialists must work with other natural, environmental, and social scientists, and with decision makers.

20.3.2.7 Terrorism and Crime

- Attempts to overthrow governments or ways of life by violence are commonplace in many parts of the world.
- Most organizations related to security or defence are now assiduous users of GIS technology and related sciences.
    - For example increasing use of surveillance technology and sensors

- Surveillance of individuals can reduce risk of harm but endangers privacy.

20.4 Seeking the Root Causes

- It is normal in science to look for the root causes rather than the symptoms of problems
- However, the vast range of causal factors of the issues described above, the uncertainty involved in characterizing their geographic nature is considerable, and their only partly understood interdependencies and feedback loops make defining root causes difficult.
- Today's world is tightly interlinked: a disaster in one geographic area can trigger global impacts. This has major governance implications given the responsibilities of nation states.

20.5 Meeting the Challenges

- The authors describe how global problems face us all and that, while some challenges might seem consistently threatening and long-lasting, sudden changes of a catastrophic nature will occur
- Addressing these challenges requires collaborations that must be multidisciplinary, and geographically extensive in scale.

20.5.1 Why GIS&S Should Enable Us to Make a Difference

- The nature of the Grand Challenges enables those active in GIS&S to make particular contributions for the following reasons:
    - Many problems are manifested initially through geographical variations
    - Studying the geographical manifestation can help us to propose and test causal factors and hence identify possible solutions to the problems
    - The mechanics by which we have to tackle problems are normally geographically structured
    - There has been a significant change, at least in Western democracies, toward the requirement for quantifiable evidence to support and justify policymaking
- The potential contribution of GIS&S to the Grand Challenges is simply formalised in a 5 stage model highlighted in Figure 20.18

20.6 Conclusions

The technology and scientific understanding are necessary but not sufficient conditions for progressing. We need other skills (e.g. skilled and trusted communicators and educators)

and we need to embed spatial thinking as part of the curricula of many subjects across the world. Some specific challenges we face are:

- How do we support decision making where both quantitative and qualitative information needs to be combined in the analysis?
- How do we help to break down the silo thinking between different scientists and others who are necessarily working on meeting these challenges?
- How do we encourage all GIS professionals to become ambassadors to their clients and to the public at large for the contributions we can make?

Notwithstanding the difficulties, the authors conclude that GIS&S professionals can make a real difference in tackling the Grand Challenges by virtue of their skills, tools and commitment. They invite you to play your part.

ESSAY QUESTIONS

1. Why is the world so differentiated?
2. What do you think are the biggest challenges to humanity where GIS can make a contribution?
3. What is spatial thinking? Can you give some examples?
4. At the moment, only a small fraction of the global population is impacted by GIS. Would a world in which everyone had access to GIS be a better or a worse place and why?
5. Why should GIScience researchers bother about issues to do with GIS curricula?

MULTIPLE CHOICE QUESTIONS (MCQ)

There are none for this chapter.

Activities

1. You have been asked by the *International Journal of Geographic Information Science* to write a review of this book intended for the readership of that journal. The review editor is prepared to allow you 800 words of text. Provide him or her with a review.

2. Devise a curriculum for use in higher education for a year's course in geographic information science aimed at the senior undergraduate level. The class should meet formally for around three hours in each of, say, 24 weeks. In doing this, note that the concept of a 'curriculum' is wider than a list of lesson topics, and resist the temptation to list 'content', but instead take an approach based on intended learning objectives. See:

www.ncgia.ucsb.edu/giscc/units/u159/u159_f.html and Chapter 10 of Gold et al (1992), at www2.glos.ac.uk/gdn/gold/ch10.htm

3. Repeat Activity (2), but for an introductory course aimed at the first year in college in geographic information studies. The idea of GIStudies is developed in Forer, P. and D. Unwin (2005) Enabling progress in GIS and education, in: Longley P.A., Goodchild M.F., Maguire D.J. and Rhind D.W. (eds) 2005 *Geographical Information Systems: Principles, Techniques, Management and Applications* (abridged edition). Hoboken, NJ: Wiley., pages 745-756

4. The table below lists the grand challenges facing humanity as identified by the Millennium Development Goals. Attempt to rank them in order from most (1) to least (8) in orders of their difficulty and importance to humanity – and also on which ones are most amenable to help from GIS&S.

Challenge	**Difficulty**	**Importance**
Goal 1: Eradicate extreme poverty and hunger.		
Goal 2: Achieve universal primary education.		
Goal 3: Promote gender equality and empower women.		
Goal 4: Reduce child mortality.		
Goal 5: Improve maternal health.		
Goal 6: Combat HIV/AIDS, malaria, and other diseases.		
Goal 7: Ensure environmental sustainability.		
Goal 8: Develop a Global Partnership for Development.		

It is best to do this by systematic pair-wise comparison in a 'ripple sort'
Use rank correlation to correlate these scores. What do you conclude from this analysis? Do you agree with our choice of challenges?

5. On the Sunday morning of 26 December 2004 an undersea earthquake triggered a tsunami that devastated many coastal areas surrounding the Indian Ocean and killing

around a quarter of a million people. ‘Brainstorm’ a list of the ways by which GIS could supply information to help mitigate the worst effects of this disaster.

6. Organize a debate on the proposition that ‘This house believes that GIS has no place in a modern university department of geography’.

7. It is always useful to make a personal evaluation of your learning. This text has brought you a long way along a sometimes twisty, but always interesting, road. For each of the 20 chapters re-examine the stated learning objectives and evaluate the extent to which you think you have achieved them.

FURTHER READING

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NRC. 2009. Understanding and Adapting to a Changing Planet: Strategic directions for the Geographical Sciences in the Next Decade. Washington, DC: National Research Council, National Academy of Sciences.

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RELATED READING

Longley P.A., Goodchild M.F., Maguire D.J. and Rhind D.W. (eds) 2005 Geographical Information Systems: Principles, Techniques, Management and Applications (abridged edition). Hoboken, NJ: Wiley.

3. Geography and GIS, R J Johnston, pp. 39–47.

54. Enabling progress in GIS and education, P Forer and D Unwin, pp. 745-756