Google Earth as a tool for participatory 3-D modelling and elicitation of Traditional Ecological Knowledge (TEK)

Alan J. Thomson
Canadian Forest Service, Natural Resources Canada
Pacific Forestry Centre, Victoria, BC, Canada

Abstract

Success of participatory GIS processes may depend on exploring the interactions of ethics, technology and society. Previously, tools were custom-built for particular processes, but Google Earth has features that capture many of the important aspects of these collaborative systems. The features relate to the following topics: Landscape perception, polygon entry, sharing data, comparing data, including images, and tracking debate. Polygon entry in particular focuses on the difference between mountain GIS and more general applications. The features are discussed in relation to Training, Tools and Systems.

Introduction

While linking GIS and remote sensing studies has a long history (Goodenough *et al*. 1994a,b, Hawkes *et al*. 1995, Bhogal *et al.* 1996), and must deal with complex issues of data integration and interoperability (Thomson 2004, 2005b), use of these technologies in participatory planning settings involves many additional considerations. Other disciplines such as anthropology and sociology become involved, dealing with different forms of traditional and stakeholder knowledge, and new approaches to knowledge elicitation and management are required (Akenhead *et al.* 1996, Thomson 2000a, 2005c, Thomson *et al*. 2000). New technologies may be developed relating to the particular form of the participatory process, such as Adaptive Management (Thomson 2000b), or to implementation of new planning codes (Thomson *et al.*1996, Thomson and Akenhead 2000). Success of the participatory process may depend on exploring the interactions of ethics, technology and society (Thomson 1993, 1996, 1997, Thomson and Colfer 2005a, Thomson *et al*. 2004, Haggith *et al*. 2003, Thomson and Schmoldt 2001, Innes *et al*. 2005).

Interaction of ethics, technology and society can be explored using the related concepts of Information Ecology and Knowledge Ecosystems (Davenport and Prusak 1997, Por 2000, Nardi and O'Day 1999, Thomson 2006, 2007). "In the context of an evolving information society, the term information ecology was coined by various persons in the 1980s and 1990s. It marks a connection between ecological ideas with the dynamics & properties of the increasingly dense, complex and important digital informational environment and has been gaining progressively wider acceptance in a growing number of disciplines. 'Information ecology' often is used as metaphor, viewing the informational space as an ecosystem."[1]

[1] http://en.wikipedia.org/wiki/Information_ecology

Thomson (2007) defined a Knowledge Ecosystem as “the complex and many-faceted system of people, institutions, organizations, technologies and processes by which knowledge is created, interpreted, distributed, absorbed, and utilized.” That is, Information Ecology (IE) is the approach based on analogy with the science of ecology, whereas a Knowledge Ecosystem (KE) is a specific community of interacting individuals and organizations in a particular environment or habitat. The study focused on how technologies could be developed to allow integration of different forms of knowledge in a way that permitted individuals or groups to track how their knowledge was used, and Internet-based systems were discussed that would permit the process to be distributed over time and space, allowing different formats of meetings. The technology discussed had to be custom-built for the processes described, but Google Earth has features that capture many of the important aspects of collaborative systems, and the present document discusses their use in a hypothetical setting, based on my experience of developing a wide range of systems and working with a broad range of stakeholders, including Canadian First Nations, in mountainous areas of British Columbia. The suggested uses can be adopted either by individuals entering their own information, or by those involved in working with others to elicit their knowledge.

Google Earth Features

1) Landscape perception:

Using the menu Tools > Options > 3D View, the Elevation Exaggeration factor can be set to reflect the perception of the landscape held by the person whose knowledge is being captured. Perceived ruggedness and memory, such as of effort to traverse, can all influence acceptance of a computer generated view of landscape when not actually present at the site. Figure 1 shows a feature (Location 1: at 51°30'53.64"N 117° 2'15.67"W) at the default elevation exaggeration factor of 1.0, compared with an exaggeration factor of 2.0. A maximum factor of 3.0 is allowed.

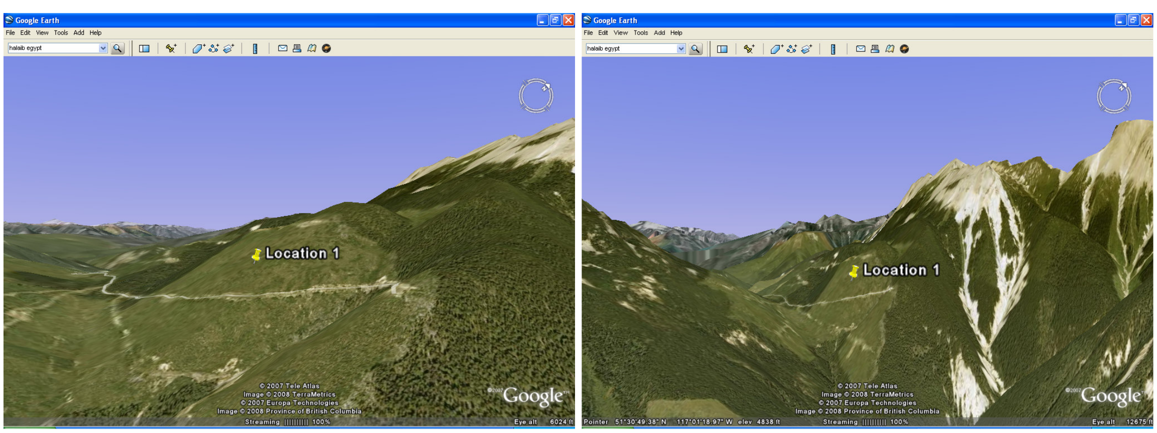

Figure 1. Use of the elevation exaggeration feature in relation to landscape perception.

2) Entering polygons:

Some people have difficulty showing the locations of their information on 2-D maps. However, with Google Earth, not only can polygons be entered directly onto the 3-D view, but the view can also be rotated during entry, using keyboard commands in conjunction with a mouse-wheel, to extend into locations not visible from the initial view (Fig. 2). Figure 3 shows the polygon as on a 2-D rendition: it would have been difficult to conceptualize this shape without the 3-D view.

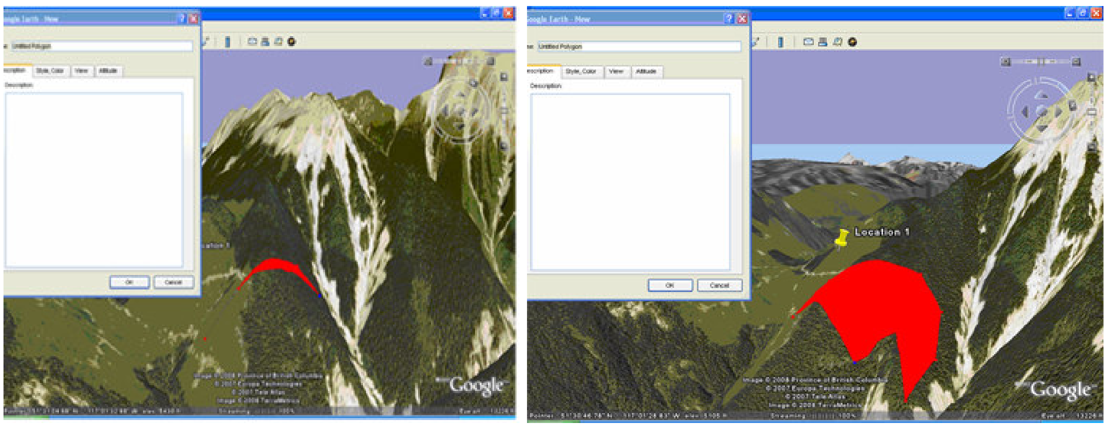

Figure 2. Entering polygons on the 3-D view, including rotating the view during entry.

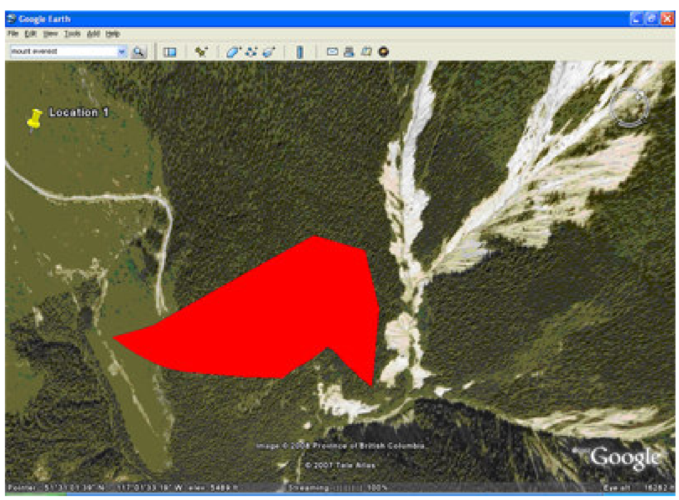

Figure 3. 2-D view of the polygon entered in Figure 2.

3) Sharing data:

The tools discussed by Thomson (2000b, 2007) allowed for the fact that open source, free software with limited but carefully designed features is appropriate for some aspects of participatory processes. However, other aspects of these processes may involve high-end commercial GIS systems, particularly when government agencies are involved. Attributes of objects such as polygons and placemarks can be saved, by right-clicking on the object in the “My Places” list in the “Places’ window in the sidebar, as .kmz or .kml files (see the Google Earth user guide) that include coordinates, such as those of the points bounding the polygon. These files can then be e-mailed or otherwise shared, allowing import of the information into other systems.

4) Comparing data:

By right-clicking on an object in the “My Places” and selecting its properties, the opacity can be set (Figure 4). Alternatively, opacity can be temporarily modified using the slider at the bottom of the “Places” pane while the object is selected.

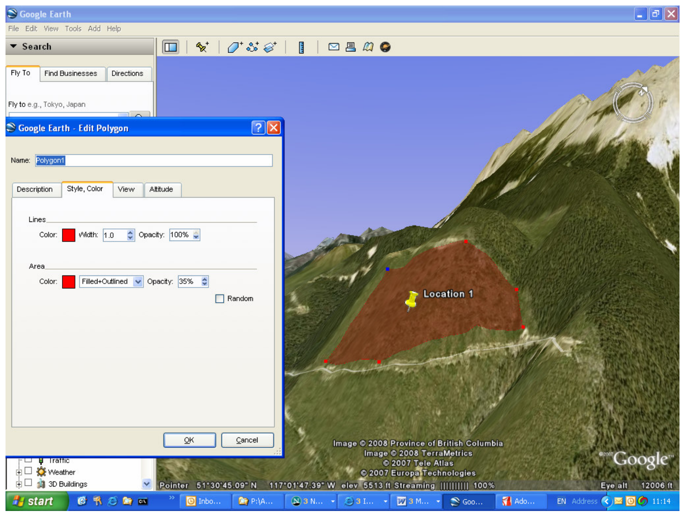

Figure 4. Setting the opacity of an object - a polygon in this case.

When multiple polygons have been created, and combinations selected for viewing, overlaps are easily determined (Fig. 5). If desired, a new polygon can be digitised to capture the common area: this is where the features of a full GIS become more valuable, where the overlap of polygons can be computed rather than requiring new entry. However, the overlay feature described here is suitable for many purposes.

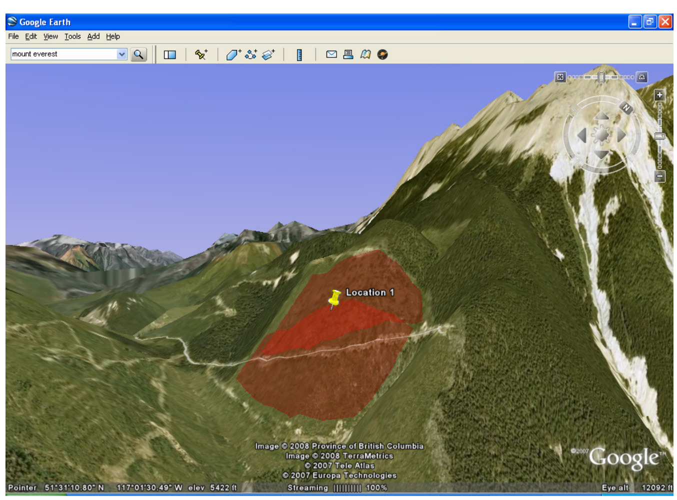

Figure 5. Overlaying two polygons with opacity set to 35%

5) Including images:

Pictorial representations are often used in participatory GIS processes. While links to photographs are a commonly-used feature of Google Earth, Images can be actually be incorporated as scaled objects onto the landscape (Fig. 6), using the menu option Add > Image Overlay. Initial placement of the image is easiest when the landscape is viewed directly from above, but thereafter can be moved, scaled and rotated on the 3-D view.

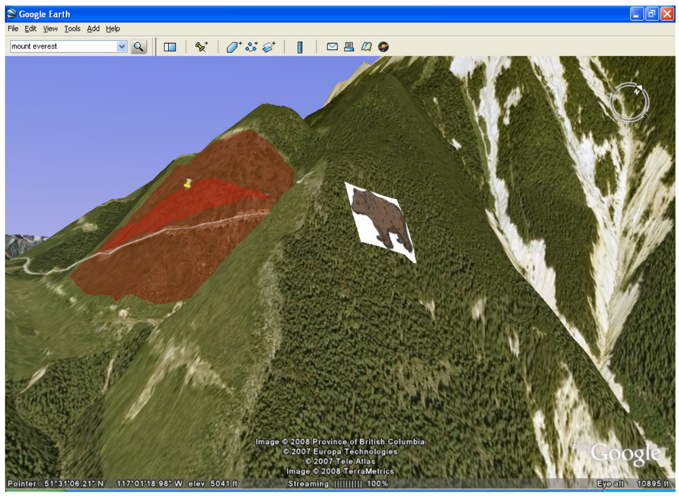

Figure 6. Incorporating an image.

6) Tracking debate:

The tools discussed by Thomson (2000b, 2007) addressed the topic of tracking debate in distributed systems. Objects such as polygons could be entered into the system through a web-based interface by someone, with an associated commentary, possibly including reference to a web site, journal article or data set. Other individuals could not change information entered by others, but a hierarchical process (Figure 7) was provided to indicate suggested extension or modification. Newsgroup, Forum or Discussion group software with links to .kml files could be used to capture this type of activity

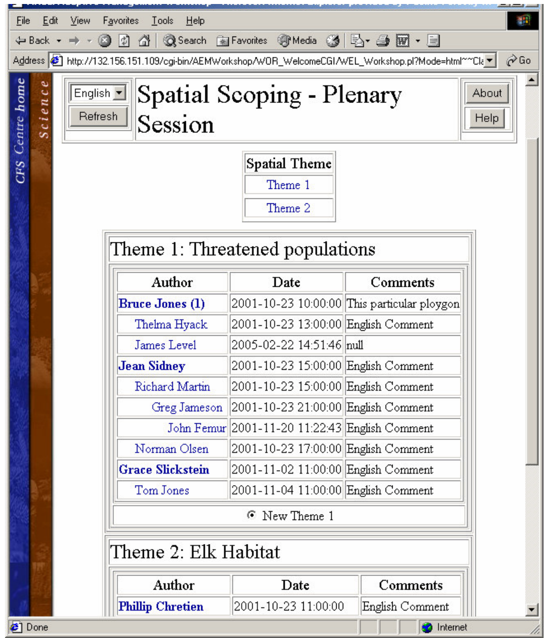

Figure 7. Figure 27.7 from Thomson (2007): tracking debate using the spatial scoping tool in a hypothetical example.

A standardized format for polygon coloring was adopted to allow for three forms of polygon information: “polygons”, “openings” and “flows”. “Polygons” are as described above. “Holes” are polygons within other polygons to allow for defining areas with absence of a feature within a larger area. “Flows” were polygons entered in the shape of an arrow to indicate a directional movement (Figure 8), although the Goggle Earth “Path” feature could be used in this case.

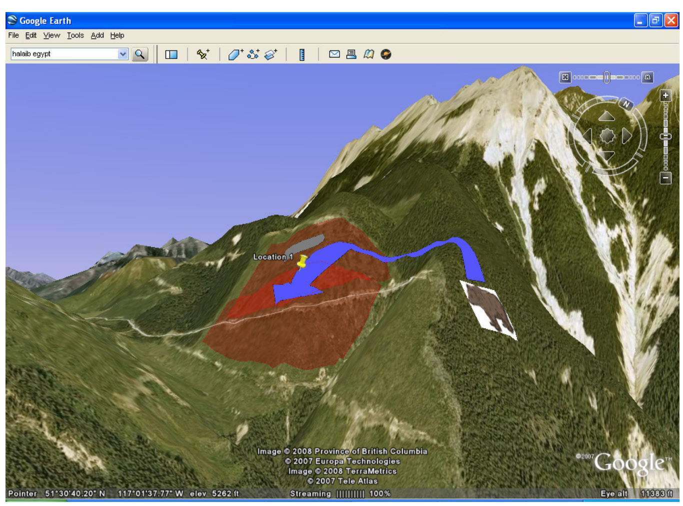

Figure 8. Convention: red for general polygons, grey for “holes” and blue for “flows”. For example, the blue arrow might be named “morning feeding route”. Both the blue and grey polygons here are set to 100% opacity.

In Figure 8, the polygon for the "hole" or the "flow" might have been proposed by a different individual from the one who proposed the main polygon. The relationship could be established using a polygon naming convention or subdirectory structure. The rationale for the change can be included in the "Description" box of the polygon properties. The description box could also include use of a controlled vocabulary to facilitate searching among .kml files.

Training, Tools and Systems

There is considerable debate about the extent to which GIS should be included in formal courses, who should be trained and to what extent. As Google Earth is designed for general use, it offers the opportunity to put a significant level of knowledge entry into the hands of individuals within communities. This could be facilitated by creation of a step-by-step online/downloadable workbook that could make use of downloadable .kmz and .kml files. Excellent free tools area available[2] to provide added information about .kml objects, such as polygon area or perimeter, although provision of a web service allowing upload of a .kml file and returning relevant object properties may be helpful in some situations.

An organization promoting such use could enhance the features by developing supporting web services. For example, a distributed collaborative project could allow upload of .kml files into a common data base permitting search for other information (including overlay functionality) that could then be downloaded in .kml format. It might even be possible to provide online expert systems as in other domains such as disease diagnosis (Thomson *et. al* 1998) or provision of vegetation management advice (Thomson and Willoughby 2004). Other online systems that integrate with Google earth, for managing related information may be used to extend the collaborative functionality, such as Panoramio[3] for photographs.

Summary

Elicitation and representation of spatial knowledge involves many considerations. In the past, special tools have been developed for this purpose, but Google Earth provides many features that capture the basic elements of these earlier systems in a manner that makes full use of the 3-dimensional display capacity. The objects created can be easily shared using Google Earth's .kmz and .kml file types. Simple naming conventions can be used to capture object relationships, and the object "Description" box used to provide details and pointers to source data. The approaches described here could form the basis of a distributed participatory GIS infrastructure.

---

[2] (e.g. http://www.sgrillo.net/googleearth/gepath.htm)

[3] http://www.panoramio.com/google-earth/

References

Akenhead, S.A., A.J. Thomson, D. Morgan, B. Adams and W.M. Strome. 1996. Planning sustainable forestry when there are complicated rules and many stakeholders. Proc. Eco-Informa '96, Lake Buena Vista, Florida, 4-7 November 1996. 399-404.

Bhogal, P., D.G. Goodenough, D. Charlebois, S. Matwin, F. Portigal, H. Barclay, A. Thomson and O. Niemann. 1996. SEIDAM for Forestry: Intelligent fusion and analysis of multi-temporal imaging spectrometer data. Proc. 26th International Symposium on Remote Sensing of Environment. March 25-29, 1996. Vancouver, B.C. Canada.

Davenport, T.H. and L. Prusak. 1997. Information Ecology, Mastering the Information and Knowledge Environment. Oxford, Oxford University Press.

Goodenough, D.G., D. Charlebois, S. Matwin, and A. Thomson. 1994a. Queries and answers in a DSS integrating remote sensing and GIS. In: J.M. Power, M. Strome and T.C. Daniel (eds.). Proc. Decision Support - 2001. Toronto, Ontario, September 12-16, 1994. Vol 1: 74.

Goodenough, D., D. Charlebois, S. Matwin, D. MacDonald and A.J. Thomson. 1994b. Queries and their application to reasoning with remote sensing and GIS. IGARSS 94 Proceedings.

Haggith, M., R. Prabhu, C.J.P. Colfer, B. Ritchie, A. Thomson and H. Mudavanhu. 2003. Infectious Ideas: Modelling the Diffusion of Ideas across Social Networks. Small-scale Forest Economics, Management and Policy, 2(2): 225-239.

Hawkes, B., D. Goodenough, B. Lawson, A. Thomson, W. Sahle, O. Niemann, P. Fuglem, J. Beck, B. Bell and P. Symington. 1995. Forest fire fuel type mapping using GIS and remote sensing in British Columbia. Proceedings GIS' 95. Ninth Annual Symposium on Geographic Information Systems, March 27-30 1995, Vancouver, Canada. 647-656.

Innes, T., C. Green, and A. Thomson. 2005. Surprising Futures. Pages 24-48 In: L. Hetemaki and S. Nilsson (eds.), Information Technology and the Forest Sector. IUFRO World Series Volume 18. Vienna, Austria: International Union of Forest Research Organizations. 235 pp. (http://www.iufro.org/download/file/437/362/ws18complete.pdf)

Nardi, B.A. and V.L. O'Day. 1999. Information ecologies: Using Technology with Heart. Cambridge, Massachusetts, MIT Press.

Por, G. (2000) Nurturing systemic wisdom through knowledge ecology. The Systems Thinker 11(8), 1-5.

Thomson, A.J. 1993. Paradigm Green: AI approaches to evaluating the economic consequences of changing environmental viewpoints. AI Applications 7(4): 61 - 68.

Thomson, A.J. 1996. Asimov's psychohistory: vision of the future or present reality? AI Applications 10(3): 1-8.

Thomson, A.J. 1997. Artificial Intelligence and Environmental Ethics. AI Applications. 11(1): 69-73.

Thomson, A.J. 2000a. Elicitation and representation of Traditional Ecological Knowledge, for use in forest management. Computers and Electronics in Agriculture 27: 155-165.

Thomson, A.J. 2000b. Knowledge elicitation tools for use in a virtual Adaptive Environmental Management workshop. Computers and Electronics in Agriculture 27: 57-70.

Thomson, A. 2004. Information Management and Data registration for National Forest Assessments. In: Knowledge Reference for National Forest Assessment. FAO-IUFRO. http://www.fao.org/forestry/foris/webview/nfa-ref/index.jsp?siteId=2881&sitetreeId=7817&langId=1&geoId=0

Thomson, A.J. 2005b. Editorial: Information Interoperability And Organization For National And Global Forest Information Systems. Computers and Electronics in Agriculture. 47(3): 163-165.

Thomson, A.J. 2005c. Indicator-based knowledge management for participatory decisions-making. Computers and Electronics in Agriculture 49: 206-218.

Thomson, A.J. 2006. Adaptive Management of Knowledge Ecosystems. In: Proc Conf. "Sustainable forestry in theory and practice: recent advances in inventory and monitoring, statistics and modelling, information and knowledge management and policy science." University of Edinburgh, Edinburgh, UK. 5th - 8th April 2005. Gen. Tech. Rep. PNW-GTR-688. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. [CD-ROM] http://www.fs.fed.us/pnw/pubs/pnw_gtr688/papers/IM&IT/session2/Thomson.pdf

Thomson, A.J. 2007. How should we manage Knowledge Ecosystems? Using Adaptive Knowledge Management! Chapter 27 in: Reynolds, K., Thomson, A., Köhl, M., Shannon, S., Ray, D., and Rennolls, K. (eds.) 2007. Sustainable Forestry: From Monitoring and Modelling to Knowledge Management and Policy Science. CABI Publishing, Wallingford, UK: 461- 479.

Thomson, A.J., and S.A. Akenhead. 2000. Designing sustainable mountain landscapes in British Columbia. In: 'Forests in Sustainable Mountain Development: A State-of-Knowledge Report for 2000'. M. Price and N. Butt (eds.). CABI Publishing, Oxford. 215-218.

Thomson, A. and C. Colfer. 2005a. ICT and Social Issues. Pages 172 – 196 In: L. Hetemaki and S. Nilsson (eds.), Information Technology and the Forest Sector. IUFRO World Series Volume 18. Vienna, Austria: International Union of Forest Research Organizations. 235 pp. (http://www.iufro.org/download/file/437/362/ws18complete.pdf)

Thomson, A.J., and D. Schmoldt. 2001. Ethics in computer software system design and development. Computers and Electronics in Agriculture 30: 85-102.

Thomson, A.J., and I. Willoughby. 2004. A web-based expert system for advising on herbicide use in Great Britain. Computers and Electronics in Agriculture 42: 43-49.

Thomson, A.J., E. Allen and D. Morrison. 1998. Forest tree disease diagnosis over the World Wide Web. Computers and Electronics in Agriculture. 21: 19-31.

Thomson, A., M. Haggith and R. Prabhu. 2004. Innovation diffusion: predicting success of system development. Proc. 15th International Workshop on Database and Expert Systems, Zaragoza, Spain, 30 Aug-3 Sept 2004: 627-631. IEEE Computer Society.

Thomson, A.J., M. N. Jimmie, N.J. Turner, and D. Mitchell. 2000. Traditional knowledge, western science and environmental ethics in forest management. In: 'Forests in Sustainable Mountain Development: A State-of-Knowledge Report for 2000'. M. Price and N. Butt (eds.). CABI Publishing, Oxford. 181-186.

Thomson, A.J., D.G. Goodenough, R. Archibald, D. Morgan, B. Adams, D. Hawkins, and D. Say. 1996. Landscape management and biodiversity: automating the design of Forest Ecosystem Networks. AI Applications 10(3): 57-65.