CENTRE FOR ADVANCED SPATIAL ANALYSIS
Working Paper Series

Paper 8

THE GEOGRAPHIES OF CYBERSPACE

Martin Dodge

Centre for Advanced Spatial Analysis
University College London
1-19 Torrington Place
Gower Street
London WC1E 6BT

Tel: +44 (0) 171 391 1782
Fax: +44 (0) 171 813 2843
Email: casa@ucl.ac.uk
http://www.casa.ucl.ac.uk

http://www.casa.ucl.ac.uk/cyberspace.pdf

Date: May 1999

ISSN: 1467-1298

ABSTRACT

In this I paper I explore the need for a new field of geographic enquiry called cybergeography. This is the investigation of the complex and multifaceted structure, use and experience of the online world inside global computer-communications networks, most obviously represented by the Internet and the World-Wide Web. In particular I focus on how one can study the geography of Internet diffusion from publicly available statistics. Then I consider ways that the landscapes of Cyberspace can be mapped to enhance our understanding of their evolving form and texture using examples of a real-time "weather map" of Internet congestion and maps of the urban structure of virtual world.

(An earlier version of this paper was presented at Association of American Geographers Conference, Boston in March 1998.)

Introduction

> *"There is a new geography in the making. …. It is almost upon us and, within a generation, it is destined to change our view of geography as dramatically as anything since the cartography of Claudius Ptolemy"*. Batty & Barr 1994, page 699.

A new space is being created and geographers need to focus their research on understanding its many dimensions and distinct characteristics. This "new geography", referred to by Michael Batty and Bob Barr in their prescient 1994 article, should be called cybergeography for the space we are talking about is Cyberspace - the world that lies beyond our computer screens in the vast network of computers.

The 'space' of Cyberspace has many aspects which require research and analysis from the geographical perspective. I believe geographers can contribute much to the human understanding of this digital world, how it is taking shape, how it is being used, what the impacts on the real-world will be and the implications for people's lives. I would argue that geographers have been slow to realise the importance of Cyberspace as a space requiring rigorous academic investigation, particularly compared to other social sciences such as sociology. This is changing as more geographers focus attention on Cyberspace, for example, Rob Kitchin, a human geographer at the National University of Ireland, recently published a wide ranging review of Cyberspace, with a geographical perspective, in his book "Cyberspace : the world in the wires" (Kitchin 1998). Whilst the National Center for Geographic Information & Analysis (NCGIA) in their Project Varenius have a theme examining the geographies of the information society (NCGIA 1998).

In this paper we hope to encourage greater interest in the study of Cyberspace by geographers by presenting a review of current research. I will pay particular attention to the Internet as it is the most well know element of Cyberspace and so far the most well studied. Much of the research I will review is being undertaken outside mainstream academic geography, so may not be familiar to many geographers. Clearly, there are many aspects of Cyberspace worthy of study, including economic, cultural and political aspects to name but three, however, in this paper we shall examine the

statistical geography of Internet diffusion and mapping cyberspace.

The statistical geography of the Internet

I begin by reviewing the key people and organisations who are measuring the geographical growth and spread of the Internet. The nature of the Internet means there is no single census bureau responsible for monitoring the growth of the Internet, instead there are a disparate group of Cyberspace "census-takers" who are trying to satisfy the demand for hard data on the geography of the Internet. The data which is publicly available generally measures the Internet in relation to the real-world geography, using countries, regions and cities as convenient units. A good place to start grappling with the statistical geography of the Internet are the reports by the International Telecommunications Union (ITU) entitled "Challenges to the Network" (ITU 1997, 1998). The ITU is an international agency, based in Geneva, responsible for the global co-ordination of telecommunications. The reports contain a wealth of statistics and analysis which provides a valuable introduction to the geography of the Internet. Another recommended source of information is a recent paper in the Communications of the Association of Computing Machinery by Larry Press entitled "Tracking the global diffusion of the Internet" which presents a detailed and accessible overview of the key Internet "census takers" (Press 1997). Larry Press is Professor of Iinformation Systems at California State University and has long researched and published on the theme of the geographical diffusion of the computer networking, particularly in the developing nations.

The fundamental question we want to know the answer to is who uses the Internet and where are they located? We can answer this questions to varying degrees of precision. To begin, I draw on one of the most widely used Internet statistics, the number of Internet connected computers (known as hosts) calculated by Network Wizards in their "Internet Domain Survey". They have been counting the number of Internet hosts since 1981 and their figures are available on their web site (Network Wizards 1998). In their Internet Domain Survey for January 1998, they estimated that there were 29.67 million hosts on the Internet. I have used the data from this survey to calculate Internet hosts per capita for all major countries, which is shown in figure 1 as a 3-d map. (The "taller" the countries in the map, the greater the number of Internet hosts per capita.) It is clear from this map that Internet computers are most prevalent in the USA, Northern Europe (particularly Scandinavia) and also

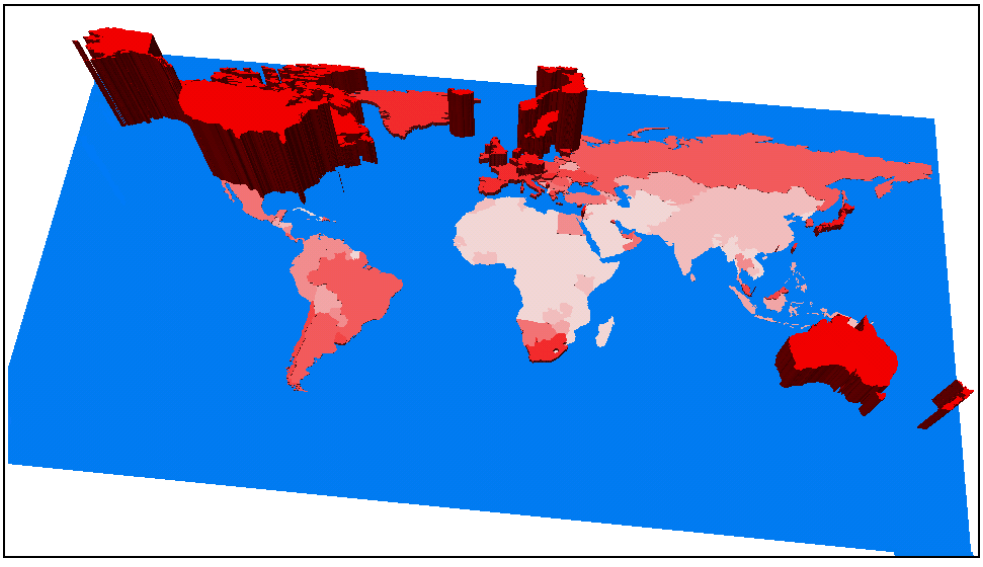


Figure 1 : Internet Hosts per Capita - January 1998

Australia/New Zealand. A secondary group of countries in south-east Asia (Japan, Hong Kong, Singapore and Malaysia) with lesser rates are also evident. The highest rate was in the USA with 967 hosts per 10,000 people, but this is artificially inflated because it includes all the top level, non-geographic domains like com, org and net, which in reality are not all registered in the US. The next highest rate was found in Finland with 915. (It should be noted that there are problems assigning Network Wizards host counts to actual geographical countries, see the Press (1997) paper for details, but their data is the best that is freely available.)

The Network Wizards data provides an indication of the geography of Internet computers around the world, but this does not equate to the number of people online. This is often calculated by multiplying the number of hosts by some estimates of the number of people who use. The problem is that no one can really knows the crucial person per computer ratio. A wide range of values have been used, from one to ten or more, giving widely differing estimates of Internet users. Another approach is to use local demographic surveys to provide an estimate of the number of Internet users. Nua, an Internet consultancy and developer in Dublin, Ireland, monitors the best available demographic surveys to produce their estimate of "How many online?" (Nua 1998). In February 1998 they estimated there were 112.75 million users online globally, which breakdown as follows.

Africa	1 million
Asia-Pacific	14 million
Europe	20 million
Middle East	0.525 million
North America (Canada / USA)	70 million
South America	7 million

Estimates at the country level are also available, see Appendix 1 for Latin America.

A particularly interesting continent is Africa, where a number of organisations are promoting Internet connectivity and access (Jensen 1998a). One of the best informed "census-takers" of the state of the Internet in Africa is Mike Jensen, an independent Internet consultant in South Africa, and he publishes a on "Internet Connectivity in Africa" (Jensen 1998a, c). These reports provide an overview of the current situation, with 47 of Africa's 54 nations having some degree of Internet connectivity. Although access is often limited to the most wealthy in society and is restricted to the major cities. Jensen estimates there to be around 700,000 Internet users in Africa (Nua's estimate is one million), but a large majority of these are in South Africa, which has easily the most Internet hosts of any country in Africa (see figure 1). Jensen has also published a breakdown of estimated Internet users by country for the continent (Jensen 1998b). We have used this data to calculate a per capita measure which is mapped in figure 2.

Another important dimension of the geography of the global Internet is the political freedom to access the Net and to choose what you want to see and do. In a surprising number of countries around the world these freedoms are limited to varying degrees. At its most severe a few governments are attempting to prohibit the Internet completely, for example Myanmar, or strictly limit and control access (e.g. China and Vietnam). In other nations there are restrictions and censorship of what people can do online, most often related to pornography (e.g. Singapore). The political geography of the control and censorship of cyberspace is likely to become more important as existing territorial authorities and governments attempt to exert their jurisdiction in a new world without physical

borders that can be policed. Leila Conners in Wired magazine made a valiant attempt to map the "freedom to connect" to the Internet in August 1997 (Conners 1997), but this is an area deserving of much more attention.

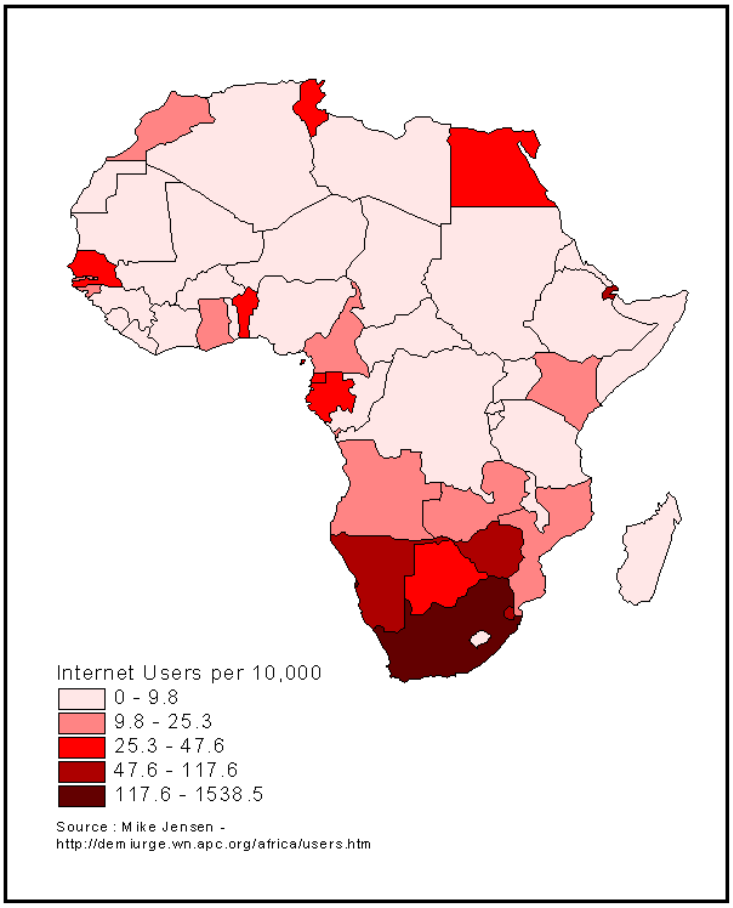


Figure 2 : Internet Users per Capita - January 1998.

How do we begin to explain the global variations in the Internet evident in the various "cyberspace censuses"? Clearly there are many factors which have shaped the current geographical diffusion of the Internet. At a fundamental level, the wealth of a nation and its people is likely to be a powerful determinant of the level of Internet access and use. The Internet Society has graphed the relationship between GNP and the number of Internet hosts (figure 3a), showing a definite positive relationship. While Larry Press has modelled the relationship between Internet hosts with a more sophisticated measure of social and economic development, the UN's Human Development Index (Press 1997). Figure 3b shows a scattergram of the two variables, again demonstrating the relationship between social development and the degree of Internet penetration.

So far I have considered the geography of the Internet at the scale of nations. It is likely that the penetration of the Internet will vary within countries as well as between countries. There may well be variations in the availability, cost and use of the Internet between urban and rural areas, and even within cities themselves. A number of researchers are looking at the detailed geography of the Internet within countries. The most exhaustive geographical measuring is being undertaken by John S. Quarterman, and his research consultancy Matrix Information and Directory Services (MIDS), an Internet research consultancy. MIDS is probably the leading Internet "census bureau" monitoring and mapping the geography of the Internet and other computer networks at scales from individual

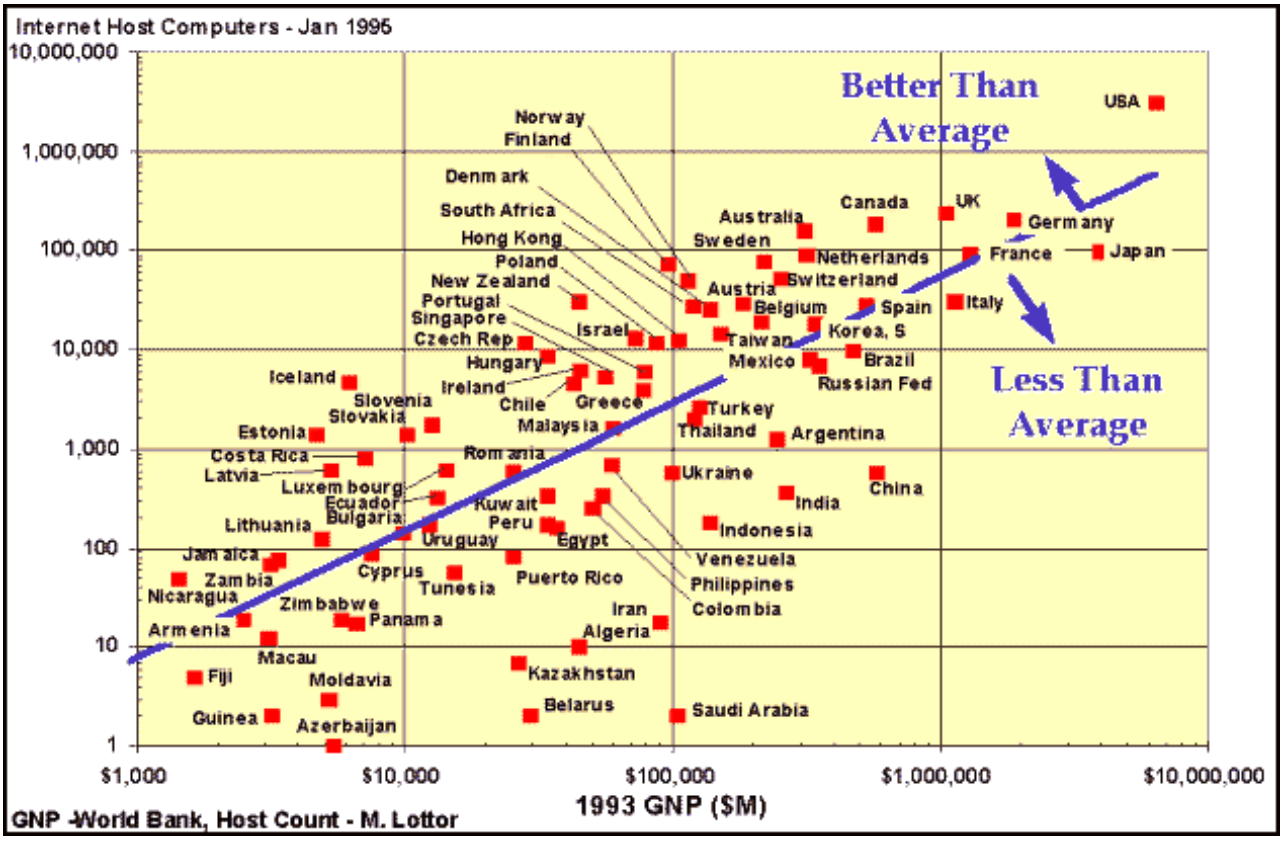


Figure 3a : GNP v Internet Hosts (source : Internet Society - http://www.isoc.org/).

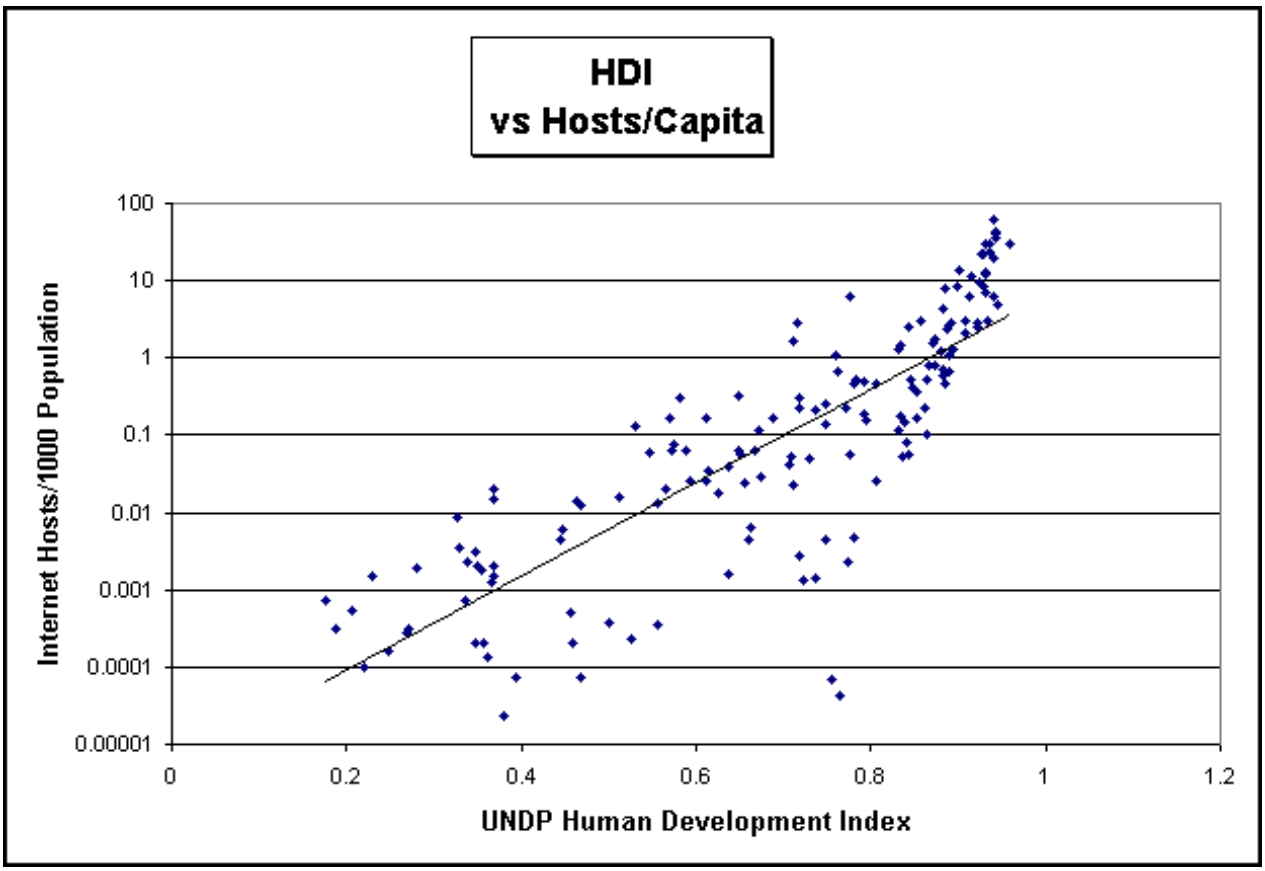


Figure 3b : Human Development Index v Internet Hosts per Capita (source : Press 1997).

cities to the whole world. Quarterman published the first book on the geography of computer networks in 1990 entitled "The Matrix" (Quarterman 1990). We will examine one of MIDS city-level Internet maps in the next section of this paper.

Myself and Narushige Shiode are analysing the geographical patterns of ownership of Internet addresses in the UK at a very detailed scale. Preliminary results were presented at the Telecommunications and the City conference in Athens, Georgia (Dodge & Shiode 1998). Other notable research is being performed by Mitchell Moss and Anthony Townsend at the Taub Urban Research Center, New York University and Matt Zook, Department of City and Regional Planning, Berkeley (Zook 1998). Moss & Townsend examined the density of domain names for cities in the USA as a means of analysing the geographical patterns of Internet growth (Moss & Townsend 1997). They conclude that major "information-based" urban centres have been in the vanguard of Internet development, in particular "…New York city has the largest Internet presence of any city in the United States, and in all likelihood, the entire world." (Moss & Townsend 1997:52).

There has been increasing interest in examining the spatial intersections of Cyberspace on the real-world, particularly cities (Graham & Marvin 1996). It is likely that the impacts of Cyberspace technologies on the notions space and place will be significant but complex. (Couclelis 1994 and 1996, NCGIA 1996). Attempting to analyse impacts is made more difficult because the infrastructure of Cyberspace is largely invisible (Batty 1990). Economists have been particularly notable in their recent predications of the "death of distance" due to telecommunications and cyberspace (Coyle 1997, Cairncross 1997, Lewis 1998).

Mapping cyberspace

An important element in understanding the geographies of cyberspace is to be able to see the space. We need to make cyberspace visible to comprehend them. One way to achieve this is to map cyberspace. However, as with Internet statistics, there is not yet a USGS or Ordnance Survey that maps cyberspace, but there are a number of freelance Cyberspace "cartographers" around the world, who are charting the virtual spaces that lie beyond our computer screens. These cyber-cartographers are often in non-geographic fields and are applying a wide variety of graphic metaphors and styles to map the landscapes of Cyberspace (Jiang & Ormeling 1997, Anders 1998, Card et al. 1999, Dodge 1999a). In this paper I do not have the space to consider the theme of cyberspace maps in any great detail, so I limit myself to consider two exemplars of particular relevance to geography and planning. However, further information can be found in the annual TeleGeography reports which have been cataloguing the maps of Cyberspaces, with review articles by December (1995) and Dodge (1997). There is also an online Atlas of Cyberspaces produced by Cyber-Geography Research (Dodge 1999a) which contains a comprehensive collection of examples.

Our first example map of Cyberspace is a "weather" map of conditions in the Internet created by Matrix Information and Directory Services (MIDS). Their Internet Weather Report (IWR) calculates the level of congestion and delays in the global Internet and presents the results as an animated map. IWR forecasts are made six times a day, every day of the year at over four thousand Internet sample points all around the world. If you watch the animated IWR maps you can often see what have been termed "storms" of congestion strike parts of the Internet. While two social physicists, Bernardo Huberman & Rajan Lukose from Xerox PARC, have used the MIDS Internet "weather" data to try to model the social behaviour of users that is causing this congestion (Huberman & Lukose 1997).

Figure 4 shows three sample frames from the an IWR for 27th February 1998, focusing on the Boston area of the USA. In the IWR maps the circles represent conditions at each Internet sample point and their size representing the measured delay (latency in milliseconds) - the larger the circle the slower the response. The colour of circle is used to indicate how many Internet connected computers are at each sample location. The frames in figure 4 do not really convey the dynamic nature of these maps, to see the full glory of “storms” of congestion sweeping through the Internet go to http://www.mids.org/weather/.

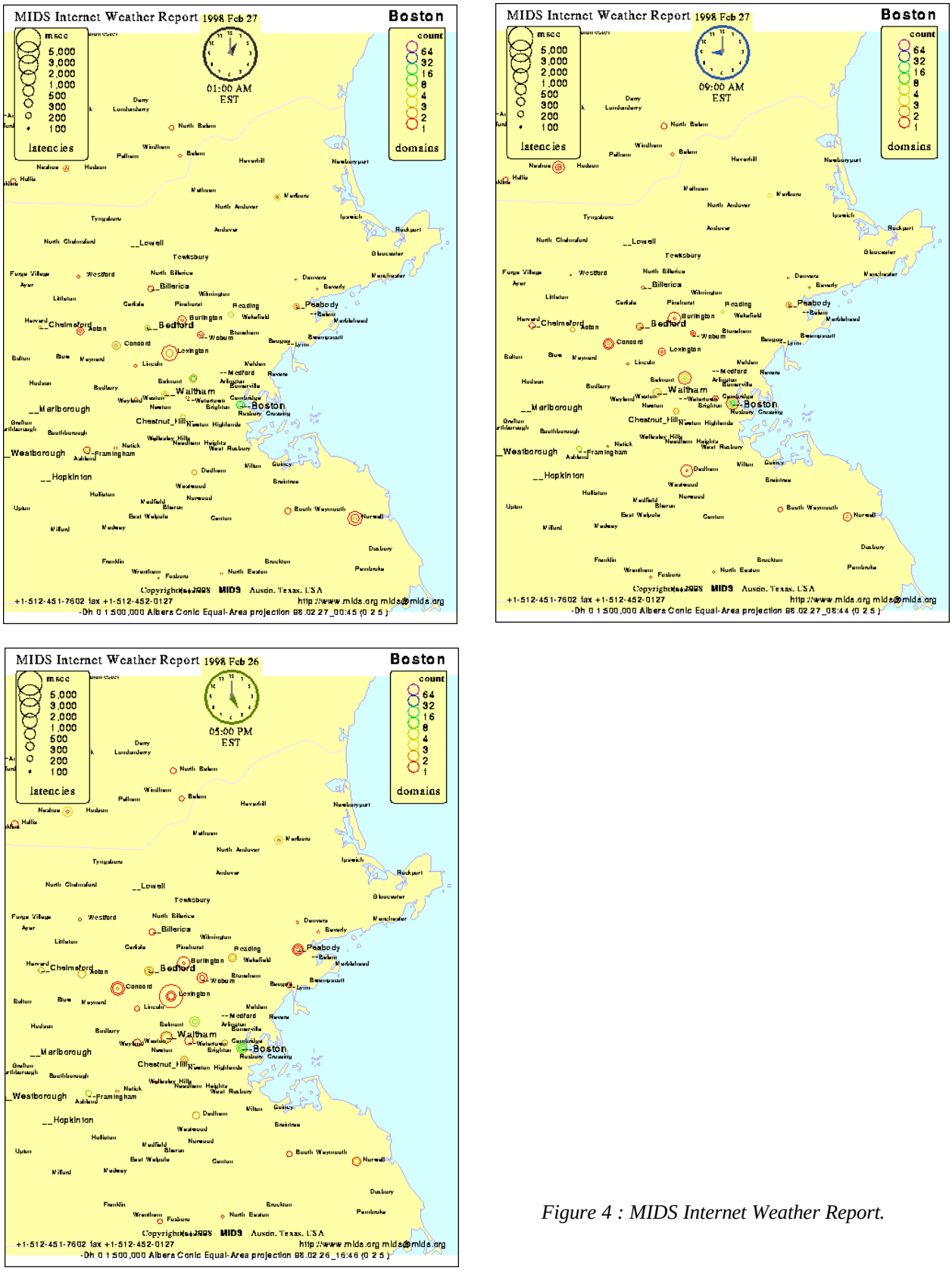
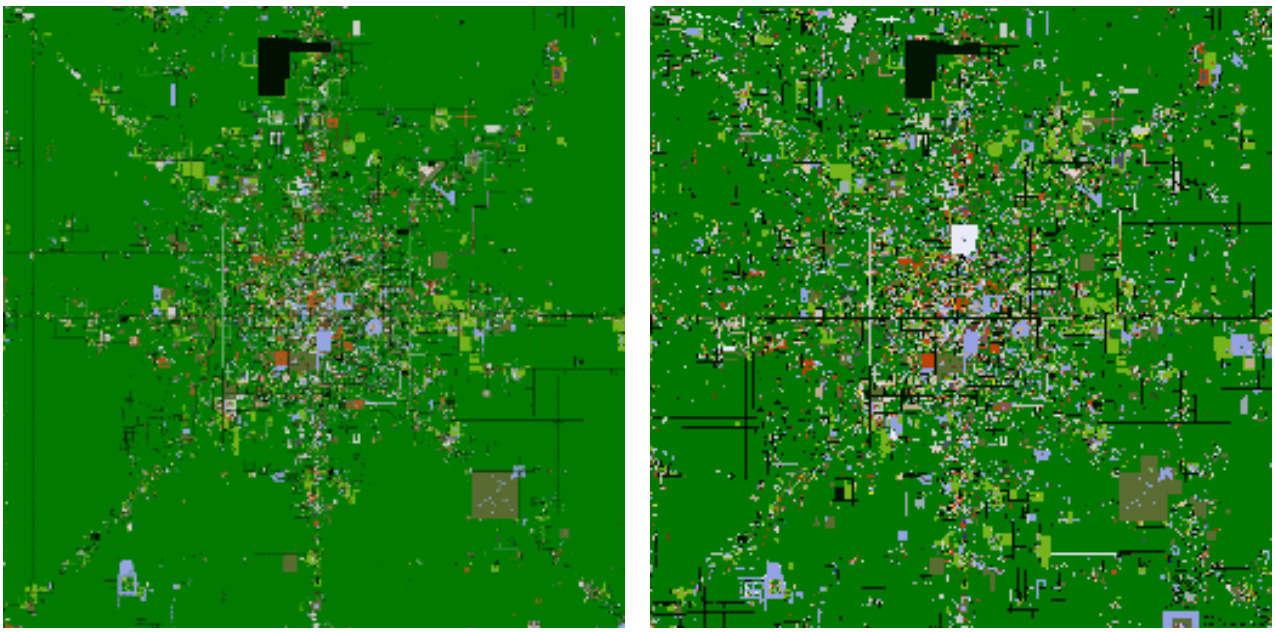


Figure 4 : MIDS Internet Weather Report.



December 1996 *February 1998*

Figure 5 : AlphaWorld "satellite" land use maps.

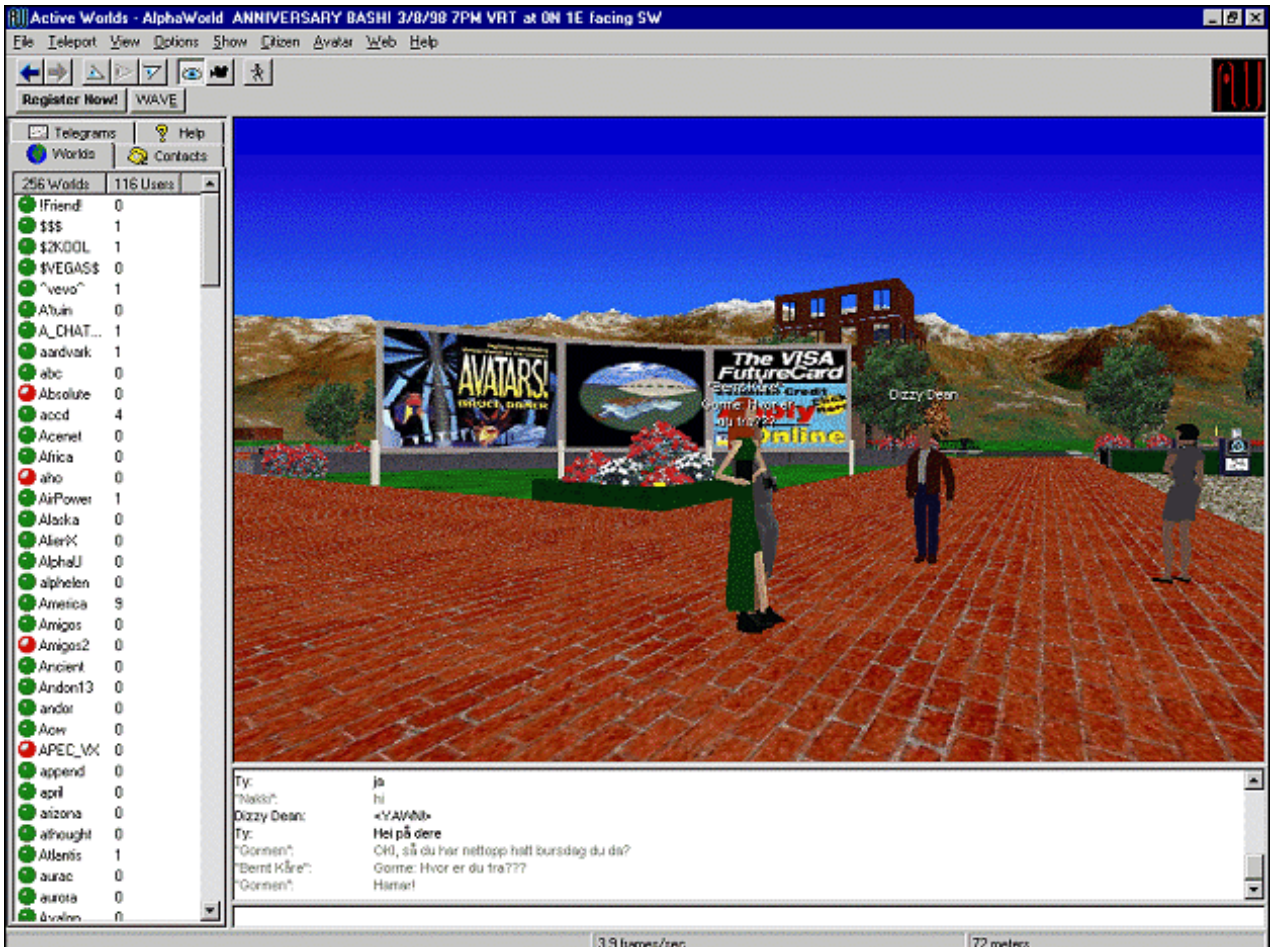


Figure 6 : Life in AlphaWorld.

Our second exemplar are two fascinating maps of a virtual space called AlphaWorld (Vilett 1998). The maps show the "land use" in the centre of AlphaWorld (figure 5) a huge three-dimensional virtual world on the Internet, which is inhabited by thousands of people, represented as avatars, who can meet and socialise with each other. Figure 6 shows a screen-shot of what it is like to be in AlphaWorld, with its realistic three-dimensional buildings and people represented as avatars. There are a growing number of virtual worlds on the Internet providing new spaces for people to colonise (Damer 1998). The geographical aspects of virtual worlds has been little studied, but the papers by Taylor (1997) and Dodge (1999b).

Roland Vilett, a programmer on the AlphaWorld system, created the two "satellite" maps of the land use at two snap-shots in time - December 1996 and February 1998 - showing the urban growth over time (Vilett 1998). This urban development is caused by the thousands of AlphaWorld citizens who "own" plots of virtual land and are able to design and build homes and businesses on them. The maps reveal a fascinating crystal-like urban morphology of a virtual city growing in cyberspace. The heart of AlphaWorld is the densest area of development in middle of these maps. This "centre of gravity" is at 0,0 in AlphaWorld's geographic grid and is the location where users "enter" the world every time they log-on. Development occurred first around what can be thought of as the CBD, with construction then spreading out from it along radial axes.

Movement in AlphaWorld is via walking for short distances (there are no cars, trains or planes) and by teleporting for longer journeys. You can teleport instantly to any location, with no costs in time or money, a friction free world. Distance is dead in AlphaWorld (cf. Frances Cairncross's "the death of distance"). Although a central location still seems to be important as there are benefits to being located as close as possible to the centre of the world (0,0). To teleport you simply enter the x and y co-ordinates of your desired destination into a control panel and you are instantaneously whisked to that point on the AlphaWorld plain. Human nature means that people tend to select regular and memorable co-ordinate pairs, such as 10,10, when teleporting which has given rise to the radial spokes of development emanating from the AlphaWorld CBD. The spokes are clearly evident in the December 1996 map, although in the second map, taken just over a year later, they are becoming less pronounced as fill-in development is taking place. The geographical patterns of teleportation in virtual worlds has been mapped by Andy Smith as part of his research into virtual urbanisation (Smith 1999).

Although these maps appear similar to satellite land use maps of the real-world, they are totally synthetic maps created from sampled data points from the large computer database that stores all the objects in AlphaWorld. Despite being computer rendered maps of a totally virtual space they exhibit interesting morphologic structures that are characteristics of real cities. Perhaps these virtual worlds will provide virtual planning laboratories that will help our understanding of real cities (Batty et al. 1998).

You can go and explore the virtual city of AlphaWorld for free (as long as you have a PC, an Internet connection and Windows95!), to find out more go to the Active Worlds web site at http://www.activeworlds.com/.

Conclusions

I have reviewed two particular dimensions of Cyberspace that will be of interest to geographers - understanding the geographical diffusion of Cyberspace by relating statistical measures of the

Internet to real-space. I then considered how Cyberspace can be mapped to help us begin to comprehend it. There are many other dimensions of this "new geography" - cybergeography - that require due consideration by geographers of all kinds.

Acknowledgement

I would like to thank Professor Larry Press for his prompt assistance and for permission to use his graph. I am also grateful to Roland Vilett for creating the AlphaWorld maps and allowing them to be used.

References

Anders P., 1998, **Envisioning Cyberspace: Designing 3D Electronic Space**, (New York: McGraw Hill).

Batty M., 1990, "Editorial : Invisible Cities", **Environment and Planning B : Planning and Design**, Vol. 17, pages 127-130.

Batty M. & Barr B., 1994, "The Electronic Frontier : Exploring and Mapping Cyberspace", **Futures**, Vol. 26, No. 7, pages 699-712.

Batty M. et al, 1998, "Modelling Virtual Urban Environments", **Centre for Advanced Spatial Analysis Working Paper Series**, Paper 1, University College London, January 1998.

Card S.K., MacKinlay J. & Shneiderman B., 1999, **Readings in Information Visualization: Using Vision to Think**, (Morgan Kaufman Publishers).

Cairncross F., 1997, **The Death of Distance: How the Communications Revolution Will Change Our Lives** (Harvard Business School Press).

Conners L., 1997, "Freedom to Connect", **Wired**, No. 5.08, August 1997, pages 106-107.

Couclelis H., 1994, "Editorial : Spatial Technologies", **Environment and Planning B : Planning and Design**, Vol. 21 pages 142-143.

Couclelis H., 1996, "Editorial : The Death of Distance", **Environment and Planning B : Planning and Design**, Vol. 23, pages 387-389.

Coyle D., 1997, **Weightless World: Thriving in the Age of Insecurity** (Capstone Publishing).

Damer B., 1998, , (Peachpit Press, Berkeley, USA).

December J., 1995, "A Cybermap Gazetteer", **TeleGeography 1995 : Global Communications Traffic Statistics & Commentary**, edited by Gregory C. Staple (TeleGeography Inc., Washington DC, USA).

Dodge M., 1997, “A Cybermap Atlas : Envisioning the Internet”, **TeleGeography 97/98 : Global Communications Traffic Statistics & Commentary**, edited by Gregory C. Staple (TeleGeography Inc., Washington DC, USA).

Dodge M. & Shiode N., 1998, “Where on Earth is the Internet? An Empirical Investigation of the Spatial Patterns of Internet “Real-Estate” in Relation to Geospace in the United Kingdom”, paper presented at the **Telecommunications and the City conference**, Athens, Georgia, March 1998.

Dodge M., 1999a, **An Atlas of Cyberspaces,** available at http://www.cybergeography.org/atlas/.

Dodge M., 1999b, “Explorations in AlphaWorld: The Geography of 3D Virtual Worlds on the Internet”, paper presented at **RGS - IBG Annual Conference - Geographies of the Future**, Leicester, 4th-7th January 1999.

Graham S. & Marvin S., 1996, **Telecommunications and the City : electronic spaces and urban places** (Routledge : London).

Huberman B.A. & Lukose R.M., 1997, “Social Dilemmas and Internet Congestion”, **Science**, Vol. 277, pages 535-537, 25th July 1997.

International Telecommunication Union (ITU), 1997, “**Challenges to the Network: Telecommunications and the Internet**”, September 1997.

International Telecommunication Union (ITU), 1998, “**Challenges to the Network: Internet for Development 1999**”, December 1998.

Jensen M., 1998a, **Internet Connectivity in Africa**, January 1998, available at http://demiurge.wn.apc.org/africa/afstat.htm.

Jensen M., 1998b, **African Internet Density**, January 1998, available at http://demiurge.wn.apc.org/africa/users.htm

Jensen M., 1998c, **African Internet Status**, December 1998, available at http://www3.wn.apc.org/africa/afstat.htm

Jiang B. & Ormeling F.J., 1997, “Cybermap: The Map for Cyberspace”, **The Cartographic Journal**, December 1997, Vol. 34, No. 2, pages 111-116.

Lewis T.G., 1998, **Friction Free Economy: Strategies for Success in a Wired World** (HarperBusiness, USA).

Kitchin R., 1998, **Cyberspace: The World in the Wires** (John Wiley & Sons: Chichester, England).

MIDS, 1998, **Matrix Information and Directory Services** - http://www.mids.org/

Moss M.L. & Townsend A., 1997, “Tracking the Net : Using Domain Names to Measure the Growth of the Internet in U.S. Cities”, **Journal of Urban Technology**, Vol. 4, No. 3, December 1997, pages

47-59.

NCGIA, 1996, Spatial Technologies, Geographic Information, and the City, September 9-11th 1996, Baltimore, USA. **NCGIA Technical Report** 96-10.

NCGIA, 1998, **Project Varenius**, available at http://www.ncgia.ucsb.edu/varenius/.

Network Wizards, 1998, **Internet Domain Survey**
http://www.nw.com/zone/WWW/top.html

Nua, 1998, **How Many Online?**
http://www.nua.ie/surveys/how_many_online/index.html

Press L., 1997, "Tracking the Global Diffusion of the Internet", **Communications of the ACM**, Vol. 40, No. 11, November 1997, pages 11-17.

Quarterman J.S., 1990, **The Matrix: Computer Conferencing Systems Worldwide**, (Digital Press: Mass., USA).

Smith A., 1999, **Mapping 30 Days**, available at http://www.casa.ucl.ac.uk/30days/mapping.htm

Taylor J., (1997), "The Emerging Geographies of Virtual Worlds", **The Geographical Review**, April 1997,Vol. 87, No. 2, pages 172-192.

Vevo, (1998), **About the AlphaWorld Map**, Greg Roelofs and Pieter van der Meulen, Advanced Technology Group at the Philips Multimedia Center, Palo Alto, California. Available at http://awmap.vevo.com/about.html

Villet R., 1998, **AlphaWorld map**, available at
http://www.activeworlds.com/events/satellite.html

Zook M.A., 1998, "The Web of Consumption: The Spatial Organization of the Internet Industry in the United States", paper at the **Association of Collegiate Schools of Planning 1998 Conference**, Pasadena, CA, November 5-8, 1998. (http://socrates.berkeley.edu/~zook/pubs/acsp1998.html)

Appendix 1 : Nua's "How Many Online?" estimates of Internet users in Latin America (source : Nua 1998).

COUNTRY	DATE	NUMBER	% TOTAL POP.	SOURCE
Latin America	November 1997	7 million	1.66	Nazca S&S
Latin America	July 1997	5.5 million	1.30	Star Media
Latin America	June 1997	1 million	0.23	Avantel
Argentina	October 1997	61,000	0.17	ITU/Siemens
Argentina	June 1997	170,000	0.49	PROMERK
Bolivia	October 1997	8,000	0.11	ITU/Siemens
Brazil	November 1997	1 million	0.61	IBOPE
Brazil	October 1997	764,000	0.47	ITU/Siemens
Brazil	June 1997	475,000	0.29	PROMERK
Chile	June 1997	200,000	1.30	PROMERK
Colombia	October 1997	63,000	0.17	ITU/Siemens
Columbia	June 1997	120,000	0.32	PROMERK
Costa Rica	June 1997	50,000	5.78	PROMERK
Ecuador	October 1997	5,000	0.04	ITU/Siemens
Mexico	November 1997	370,000	0.38	PROMERK
Paraquay	October 1997	1,000	0.01	ITU/Siemens
Peru	October 1997	31,000	0.12	ITU/Siemens
Peru	June 1997	65,000	0.26	PROMERK
Uruquay	October 1997	9,000	0.27	ITU/Siemens
Venezeula	October 1997	12,000	0.05	ITU/Siemens
Venezuela	June 1997	35,000	1.20	PROMERK