TRENDS IN INTERNET MAP USE

Michael P. Peterson
Department of Geography / Geology
University of Nebraska at Omaha
Omaha,NE 68182
e-mail: geolib@cwis.unomaha.edu

ABSTRACT

No longer restricted to paper, maps are now transmitted from place to place over computer networks. The exact number of maps that are distributed through the network of computer networks called the Internet is difficult to determine. The electronic distribution of maps has increased drastically with the introduction of the World Wide Web. Individual World Wide Web servers report up to 700,000 accesses to maps daily. The number of Web servers that distribute maps numbers in the thousands. Given the rate at which maps are downloaded and the number of World Wide Web map servers, the Internet is quickly becoming the major form of map distribution. The new medium has already had a major impact on GIS and the methods employed in digital mapping, especially methods of interactivity in the display of maps. Three aspects of the Internet and map use are examined – internet growth, trends in map types, and trends in map use.

Internet use has been growing rapidly during this decade. The dramatic increase in the use of the Internet can be attributed to the World Wide Web. In June of 1993, there were only 130 World Wide Web servers. Four years later, that figure had grown to over 660,000. Although web servers are primarily located in North America and Europe, usage is extends throughout the world. To test the international aspect of the Internet, a server was established in January of 1996 (maps.unomaha.edu). Material was added that included names of countries and was indexed by the AltaVista search engine. By March of 1997, individuals from 69 countries outside of the United States had accessed the server.

Trends are also evident in the types of maps are available through the Internet. Many of the maps are are interactive, allowing the user to change the scale or otherwise alter the view. Other maps are static – presenting only a single view, as with a map on paper. Static maps are a major component of the Internet map traffic, most likely because the maps can be easily created by computer mapping and GIS software and they require fewer server resources to distribute. However, the map sites that receive the most usage are those that implement some type of interactive or dynamic (frequently updated) form of map.

To determine the extent of Internet map use, data on accesses to the major map servers are examined. In addition to depicting monthly, daily, and hourly variations in access, the data show major growth over time. Although results vary between map servers, in general, usage is currently doubling on an annual basis. Speed (network and server) and cost of access seem to be the major limitation on future growth.

The Internet, and particularly the World Wide Web, may soon represent the major medium for cartography. It is apparent that methods of map access and map use are changing rapidly. Further research is needed to better understand this form of map use.

INTRODUCTION

From modest beginnings in the late 1960's, the Internet has developed into a major form of communication. From e-mail, all forms of documents, computer programs, and multimedia presentations, the Internet has transformed the way data and information are distributed, including spatial information in the form of maps. Although difficult to monitor, it appears that literally millions, perhaps tens of millions of maps are distributed via the Internet on a daily basis.

The Internet has been described in many ways. In the simplest sense, the Internet may be thought of as a system for transferring files between computers. These files, manipulated as numbers and ultimately stored and transferred in binary 0s and 1s, may consist of text, pictures, graphics, sound, animations, movies, or even computer programs. Defined in terms of hardware, the Internet may be thought of as a physical collection of computers, routers, and high-speed communication lines. In terms of software, it is a network of computer networks that are based on the TCP/IP protocol. In terms of content, the Internet is a collection of shared resources. Finally, and most importantly, from a human standpoint, the Internet is a large and ever-expanding community of people who contribute to its content and use its resources.

The dramatic increase in the use of the Internet during this decade can be attributed to the World Wide Web (WWW). The World Wide Web was conceived at the European Particle Physics Laboratory (CERN) located near Geneva, Switzerland in 1989. Tim Berners-Lee played a large role in designing the system. It was intended to assist researchers in high energy physics research by linking related documents. The developers wanted to create a seamless network in which information from any source could be accessed in a simple and consistent way. The WWW introduced the principle of "universal readership," a concept that networked information should be accessible from any type of computer in any country with a single program. A prototype of the new protocol was finished in 1991 and was largely accepted by 1994. The system was quickly embraced because it also incorporated the previous protocols for file exchange, including FTP, newsgroups, and e-mail.

Three aspects of the Internet are examined here: (1) trends in Internet growth, including international usage; (2) trends in the types of maps that are available through the WWW; and (3) trends in the use of maps with this electronic medium.

I. INTERNET TRENDS

In a few short years, the WWW has emerged as the predominant form of Internet data traffic. In June of 1993, there were only 130 web servers (computers that distribute web documents). One year later there were nearly 3,000. By mid-1995, there were 23,500 web server. A year later there were 230,000 servers. Estimates in early 1997 put the number of web servers as high as 660,000. This exponential growth is expected to continue for some time to come. Figure 1 shows the exponential growth through web servers indexed by the Webcrawler search engine from April 1994 to April 1996.

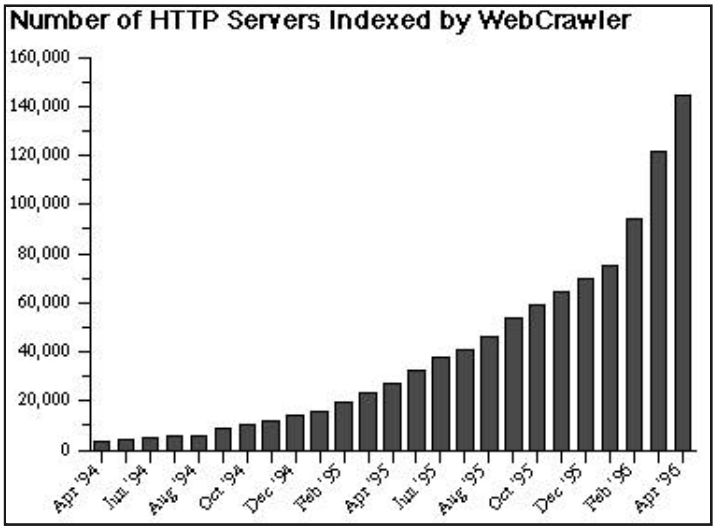


Figure 1. Web Servers indexed by WebCrawler
http://webcrawler.com/

From an international perspective, most web servers are in the North America, Europe, Japan, Australia, and New Zealand (see Figure 2). However, a considerable amount of web traffic can be attributed to users outside of these countries (Dodge 1996).

To assess the level of internationalization of the web, an experiment was conducted to attract and monitor international access to a web site. On January 25, 1996, a web site was established at the University of Nebraska at Omaha (http://maps.unomaha.edu). The web site was registered with a single web search engine called AltaVista

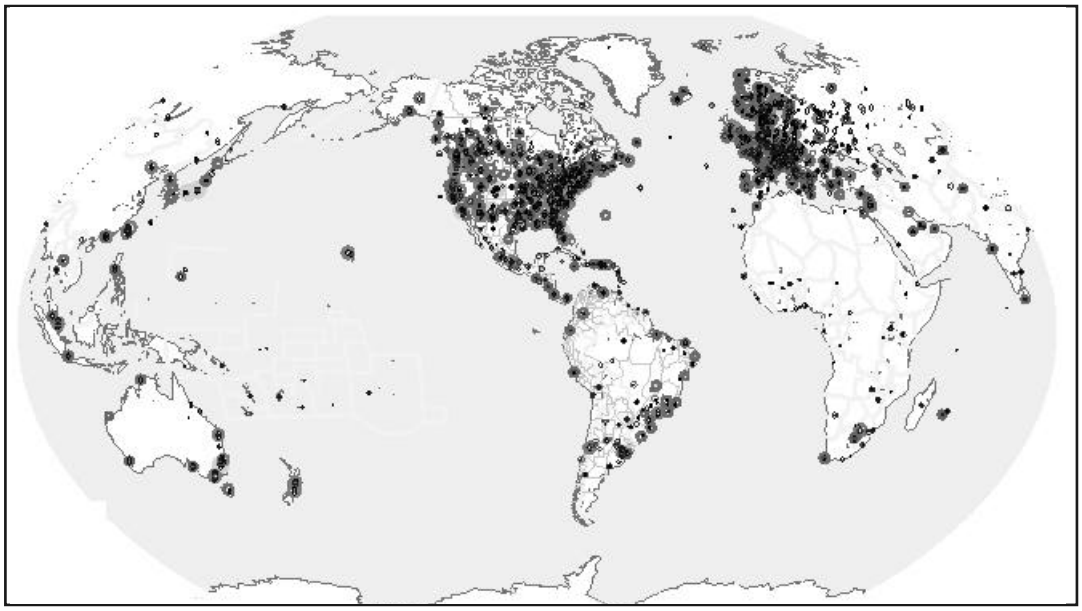


Figure 2. World Distribution of Internet Hosts in July 1996.
http://www3.mids.org/mapsale/world/

(http://altavista.digital.com/), a web indexing engine operated by Digital Equipment Corporation. Search engines index material at known web sites and respond to search requests based on keywords.

In the following months, material was added to the web site that included names of almost all countries in the world. Some of the files were maps, but most were lecture notes from an introductory world regional geography course. By May of 1996, AltaVista had indexed all of the files on the new web site. An assumption was made that international users of the WWW that accessed the AltaVista search engine would at some point type in the name of their own country to determine what materials were available. In response to this query, AltaVista would then return a list of web documents that contained the name of the country. Among this list would be a document from the maps.unomaha.edu server. If the international user selected this document, the server would register it as a "hit" or an access. The address of the user was then analyzed to determine from what country the access had originated.

By November 17, 1996, the site had distributed files to 64 different countries. This means that individuals from this many countries found and downloaded a file from this server. Three months later (March 7, 1997), the list had grown to 69 countries (see Table 1). Although this is only about a third of the existing countries, the amount of web traffic from outside of the United States was fairly large. One can say that the World Wide Web is truly an international network.

Country	**# of Files**	Hong Kong	45	Panama	1
		Hungary	60	Peru	1
Argentina	202	Iceland	12	Philippines	7
Australia	828	India	29	Poland	33
Austria	166	Indonesia	26	Portugal	103
Bahrain	4	International	15	Qatar	4
Belgium	108	Ireland	32	Romania	2
Bolivia	4	Israel	124	Russian Fed.	16
Brazil	293	Italy	287	Singapore	195
Canada	1715	Jamaica	1	Slovakia	4
Chile	25	Japan	240	Slovenia	34
China	4	Korea, Republic	128	South Africa	49
Colombia	14	Kuwait	2	Soviet Union	8
Costa Rica	9	Luxembourg	20	Spain	208
Croatia (Hrvatska)	13	Malaysia	55	Sweden	755
Cyprus	3	Malta	4	Switzerland	113
Czech Republic	42	Mexico	26	Taiwan	12
Denmark	90	Micronesia	9	Thailand	66
Egypt	7	Morocco	2	Turkey	8
Estonia	59	Netherlands	666	Uganda	1
Finland	461	New Zealand	153	United Arab Em.	18
France	298	Nicaragua	2	United Kingdom	767
Germany	772	Norway	339	Uruguay	3
Greece	144	Pakistan	17	Yugoslavia	6

Table 1. Access by country to the MAPS.UNOMAHA.EDU web server from January 1996 to March 1997.

II. TRENDS IN MAPPING ON THE WEB

Graphics, including all forms of maps, have become a major component of the web. One of the reasons for this is cost. It is simply less expensive to place color graphics on the web than it is to print in color on paper. When the additional costs of shipping and distribution are factored into the printed product, the cost advantages of distributing maps and images over the Internet become even more apparent.

One of the major advantages of the medium for cartography is that it allows more interactive forms of mapping (Peterson 1995). Among the different forms of mapping on the web, it is the interactive sites that have gained the most interest and financing. The most popular of the interactive sites have been those that make street or road maps (see Figure 3). These sites make it possible to create a street map of a city, or plan an itinerary for travelling between cities. The star in the middle of the map in Figure 3 indicates the location of a user-defined address.

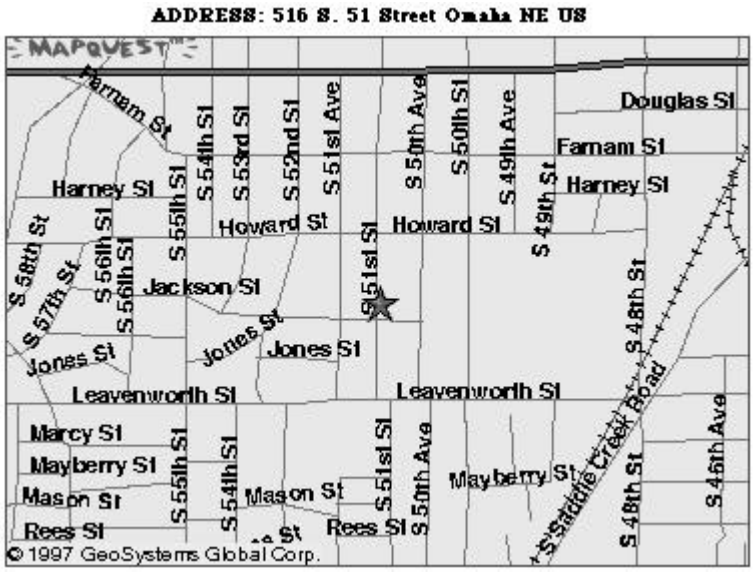
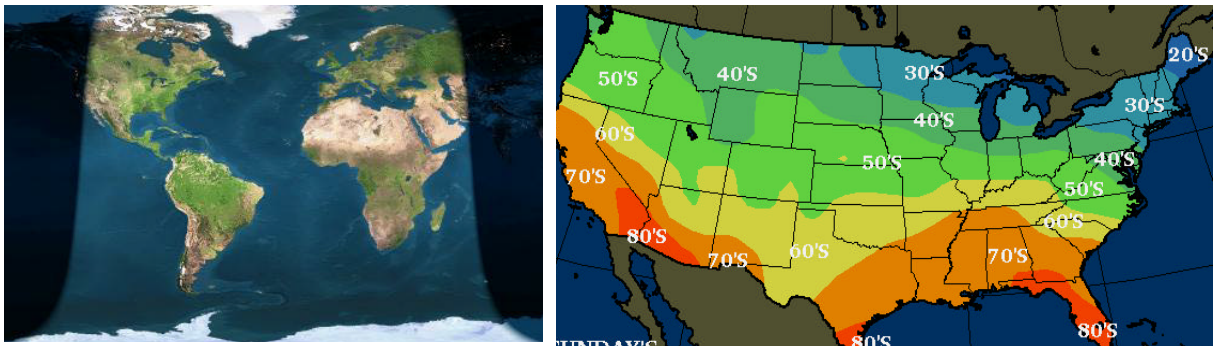


Figure 3. Interactive Street Map from GeoQuest (http://www.mapquest.com/)

Other forms of dynamic mapping available through the web include those depicting current weather conditions, cloud cover, sun position relative to the earth, even traffic patterns (see Figure 4). While not interactive in the same sense, these sites indicate the potential of the medium to display up-to-the-minute maps. Some of these sites support themselves through advertising.

Static maps that do not allow any type of interaction are the most common types of maps available through the Internet. The most prevalent type of static map are those that have been scanned from paper maps and stored in a GIF or JPEG "picture" format (http://www.lib.utexas.edu:80/Libs/PCL/Map_collection/). While the scanning of maps represents a quick way to transform a map into digital form for transmission, the maps are often not legible. Sometimes, so little care is taken in the scanning process that the text on the back side of the paper map will be appear in the scanned version. In addition, the screen pattern will be visible on printed maps, particularly those printed in color. A second form of static map are those that have been specifically designed for display on a computer monitor. These maps are more legible but are not suited for printing. Finally, a Postscript™ format is used for PDF (Page Description Format) files and this can be used for both screen viewing and printing. An advantage of all static maps is that they are relatively easy to incorporate into a World Wide Web site.

Finally, the web also supports the distribution of animated maps. Map animations are usually stored in a format designed for the display of movies, such as QuickTime or MPEG. The most common examples of animated maps on the Internet



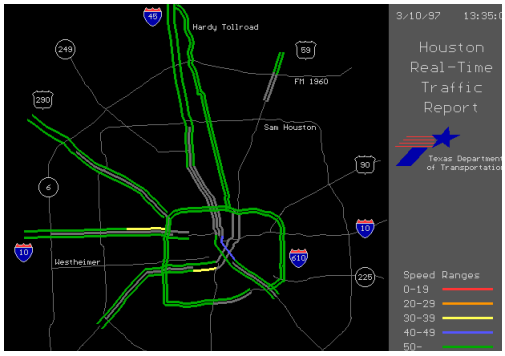


Figure 4. Solar map of the World March 9 14 UTC. Temperature map of U.S. for March 9, 1997. Traffic map of Houston, TX March 10, 1997 at 1:37 PM.

(http://www.fourmilab.ch/cgi-bin/uncgi/Earth/action?opt=-p) (http://www.intelli-cast.com/weather/usa/hitemp/) (http://traffic.tamu.edu/traffic.html)

are those of weather patterns, most often depicting the movement of clouds as seen on television weather forecasts. The movement of clouds associated with hurricanes is especially suited for viewing as an animation. Other types of animated maps include terrain fly-throughs in which a landscape, usually somewhat mountainous, is viewed as if it were being flown through with an airplane or jet. Animations are also available showing population growth in a region. Here a shading is applied in a progressive fashion to depict the pattern of population growth. Finally, animations are available that depict temporal trends of alternative methods of data classification, such as a changes in the classification method or number of classes.

III. TRENDS IN INTERNET MAP USE

Monitoring map use on the Internet is not an easy task. There are a large number of web sites that distribute maps but no coordinated method of assessing the number of maps that are downloaded. Beyond this, of course, there is no way to determine if the maps are effectively utilized. A centralized “counter” is perhaps needed to at least determine the number of maps that are distributed via this new medium.

One source of data are the commercial map sites that accept advertising. These sites maintain accurate statistics on the number of “hits” that their sites receive, statistics that are often verified by independent companies. The reason that these data are maintained is to attract advertising revenue. The more hits they receive, the more they can charge a potential advertiser. However, many companies view this information as being proprietary and will only share the information with potential advertising customers.

Some data are publically available. For example, according to its press releases, GeoSystems, Inc., operator of the GeoQuest interactive mapping site (map depicted in Figure 3), has seen tremendous growth in its first year of service. The company opened its web site on Feb. 3, 1996. By the end of April, it was generating 200,000

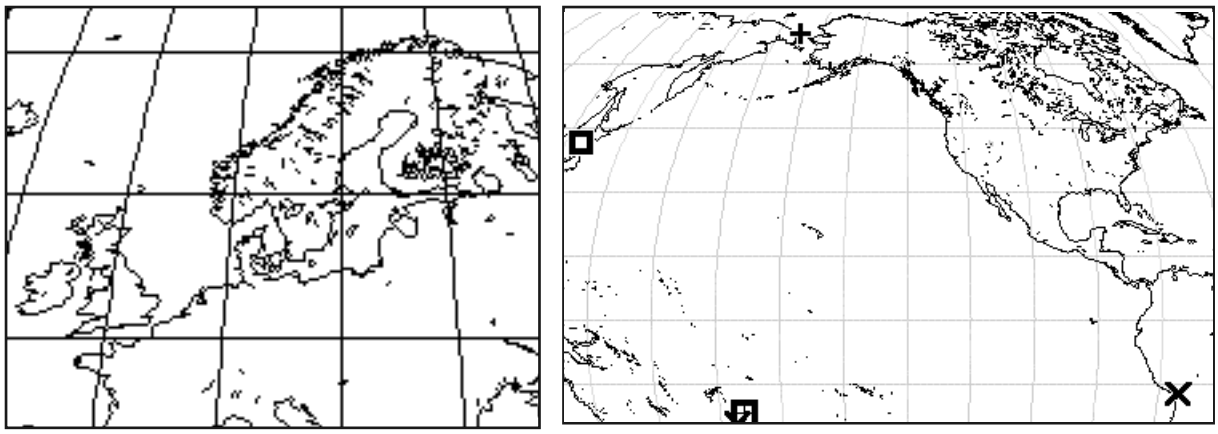


Figure 5. Maps from Xerox Parc site. Areas of the world can be selected for display as in the map on the left. Point data can also be shown such as earthquakes in the in the Pacific region for the first week of March, 1997, as in the map on the right. (http://pubweb.parc.xerox.com/map) (http://www.civeng.carleton.ca/cgi-bin/quakes)

user-specified maps per day. By November, the figure had grown to 500,000. One year after beginning its service, the site was generating 700,000 maps every day at a rate of up to 1000 maps a minute (GeoSystems 1996, 1997).

A few non-commercial sites provide access data as a user service. The Xerox Parc site, an early example of interactive mapping on the web, receives a considerable amount of map requests. The site creates interactive maps of the world using several different projections. Clicking on the map creates a larger scale map centered on the location (see Figure 5). Additional map data bases can be selected for display. The site can also be used to map point data. For example, another site that maintains earthquake information uses the Xerox Parc map service to map the location of earthquakes. This is an example of the type of interactivity and cooperation between sites that is possible on the web.

The Xerox Parc site has maintained data on usage since it began its service in 1993. The graphs indicate an rapid increase in usage that peaks in June of 1996. At that time, the single Sun SPARCstation 2 computer handled over 100,000 daily map requests. Usage has been declining since that time. Three explanations for this are given. The first is that the server is comparatively slow (more than ten seconds for the map to appear). The second is that usage has become cyclical based on the school schedule. A decrease in usage always seems to occur during the summer vacation months (June, July, August). Finally, the site is suffering from competition. There are now other map sites that are faster and provide more interactive forms of mapping.

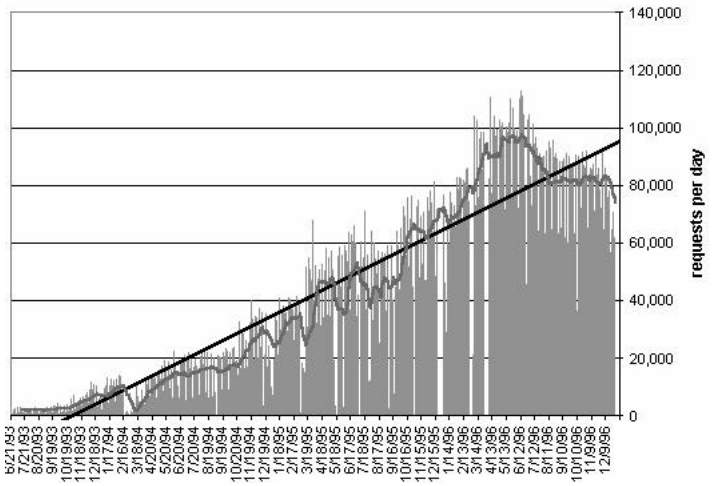


Figure 6. Trend in Xerox Parc site usage from June 1993 to December 1996. (http://pubweb.parc.xerox.com/mapdocs/usage.html)

Other popular interactive mapping sites also report a considerable amount of usage. The Tiger Mapping Service operated by the U.S. Census Bureau reports making 25,000-30,000 maps daily (http://tiger.census.gov/faq.html). The EarthViewer site (see solar map in Figure 4) reports having created over 18,755,588 maps between Dec. 1, 1994 and March 7, 1997 and currently responds to about 35,000 daily requests (http://www.fourmilab.ch/serverstats/access.html). Sites that maintain weather maps receive a considerable amount of traffic. The Michigan State University site (http://wxweb.msu.edu/weather/) reports 159,000 daily requests in early March 1997.

IV. CONCLUSION

The Internet has changed how maps are distributed and used on a world-wide basis. It is apparent that the Internet has already improved the distribution of maps. If done properly, the Internet also has the potential of improving the quality of maps as a form of communication, thereby influencing both the mental representations that people have of the world and how people mentally process ideas about spatial relationships.

The international implications of the Internet for cartographic are enormous. Data suggest a large base of users from many parts of the world. The increased access to spatial information has implications for all countries, even those with limited connections to the Internet. A considerable amount of work still needs to be done to expand the network and improve methods of map distribution and map interaction.

IV. REFERENCES

CERN EARTHVIEW (1997). EarthView Mapping Site. (Located at: http://www.fourmilab.ch/serverstats/access.html).

DODGE, M. 1996, "Mapping the World Wide Web", GIS Europe, September 1996, Vol. 5, No. 9, pages 22-24.

GEOSYSTEMS, INC. (1996-1997). Press Releases. (Located at: http://www.mapquest.com/).

MICHIGAN STATE UNIVERSITY. (1997). Weather Site FAQ. (Located at: http://wxweb.msu.edu/weather/).

PETERSON, M. (1995). Interactive and Animated Cartography. Englewood Cliffs, NJ: Prentice Hall.

U.S. CENSUS BUREAU (1997). Tiger Mapping Site FAQ. (Located at: http://tiger.census.gov/faq.html)

XEROX PARC MAP SITE. (1997). Parc Map Site FAQ. (Located at: http://pubweb.parc.xerox.com/mapdocs/usage.html)