Publish or Perish (4) – Electronic Publishing

Alfred E. Hartemink

ISRIC, PO Box 353, 6700 AJ Wageningen, The Netherlands
e-mail: Hartemink@isric.nl
fax: ++ 31 317 471 700

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Reality is what I see, not what you see.
Anthony Burgess (1917-1993)

1. Introduction

In order to catch the attention of busy readers a paper has to start with a bold statement, and whether that statement is entirely true is less relevant. So I thought of starting with a quote from Burgess' masterpiece "A Clockwork Orange", but instead I come up with the following: The best the British have given to the world so far are the BBC, Nature and The Economist.

I am sure that many of you would disagree and perhaps find British cuisine, poetry, football or popmusic the best it has brought forward. But I do have some arguments for this statement. Firstly, the BBC is free of advertisements and can be relied on as a source of news information, which is important in a world where information is imperative and where commercialisation has become a new sort of religion. The Economist and Nature deal with society and science, and reports are usually factual, critical and fairly unbiased. Many other journals claim to do this as well but none are as good, or they are written in a language I cannot understand. Both The Economist and Nature have a long tradition of publishing, a very experienced writing staff, and occasionally publish articles that look ahead: what's in the future of science and society.

In July 1999 The Economist published “The road to 2050 – A survey of the new geopolitics” in which they looked into political and cultural developments up to the year 2050. Nature has started publishing the Millennium Essays in which scientists from various disciplines have given us a glance of their thoughts on the future. There is also an excellent essay on soil science (Yaalon, 2000). It is interesting that these future outlooks are either short term based on extrapolation of the recent past and therefore fail to excite, or they are long-term predictions and thus become science-fiction - a literature genre which I find indigestible. The risk of predictions is not whether they excite or can be checked, but whether they are utterly wrong in the end which is likely to occur in a speedily changing society. Let us look at some examples which have almost become classical.

When home videos became affordable in the 1980s, numerous people believed that cinemas and theatres would eventually had to close their doors. People would simply drive to a videostore, collect their favourite movie and sit and watch in the comfort of their homes at a convenient time. At the same time, personal computers became available. Firstly in the offices and some years later at people's homes. Many believed that unemployment rates would increase dramatically as man would be replaced by the machine. Some thought that it would result in paper-free offices (saving the trees) and that people would communicate by exchanging floppy disks. The brightest prophets foresaw that books and magazines were no longer needed - we would just read from the screen.

As we now know, these predictions have not all come out. Theatres and cinemas are flourishing business. People like to go out and socialize and the quality of the video is not quite matching the 35 mm film. The personal computer brought many things but few redundancies, and unemployment in Western Europe is lower than it was for many decades. With the personal computers came the printer. In the mid-1980s noisy matrix printers were the standard, but these have been replaced by fancy laser printers, which produces paper that looks good and can be sent around. Laser printers are also fast and in many offices there is more paper than ever floating around. Paper consumption keeps on increasing in many institutes. For example at ISRIC, paper consumption has increased from about 1.5 million sheets of A4 in 1990 to 2 million in 2000 without an increase in the number of staff. Over the same period the cost of paper decreased by 10 to 15%. The use of note-pads at ISRIC has almost disappeared and so has the demand for diskettes whereas the consumption of CD ROMs has grown exponentially following the introduction of affordable CD writers some years back. So the dream of the paper-free office was not realized. Also books are still being printed and the number of titles keeps on increasing each year. For example, in Japan 66,000 new titles were published in 1998 compared with 48,000 in 1993 (The Economist, 2nd October 1999).

The personal computer brought us things we could not have thought of 20 years ago. An important change is that personal computers are not so personal anymore because they are all hooked up to networks in offices and eventually the entire world. The apparent contradiction of this situation is that society as such is getting more and more individualised whereas at the same time people are de-individualised by being hooked up to the biggest computer network in the world: the internet. The PC has become the people’s computer.

The internet has caused already many changes and its effects will continue to evolve. It will affect the exchange of scientific information and many traditional ways will be replaced by internet based media. This paper looks at some of the main aspects of electronic publishing of science. Firstly, developments and trends in electronic publishing and science are summarised, followed by a discussion on electronic publishing in soil science. A brief overview of the future outlook of our scientific journals is given in the next "Publish or Perish" column. I have restricted myself, as the first paragraphs suggest, to some of the ideas published in Nature and The Economist on the subject of electronic publishing. The paper is therefore not an authorative

review of electronic publishing but aims to contribute to the discussion on the future of publishing in soil science.

2. The world goes electronic

Small things can have big effects. The Dutch biologist and writer Dr Tijs Goldschmidt, studied the spreading of starlings in the USA. In the 19th century, there was the American Acclimatization Society in New York which aimed to bring in each and every bird mentioned in the works of Shakespeare and that was not present in the USA. Very noble, and thus in 1890 and 1891 European starlings were released in New York. For several reasons the starling population boomed and currently there are hundreds of million starlings in the USA. It is considered a plague as they severely compete with natural birds and because flocks of starlings darken American skies. "Poetry can change a landscape", was his conclusion and what started as a admirable initiative resulted in something totally unforeseen (Goldschmidt, 2000).

There is an interesting analogy between this story and the internet. Internet will not change the landscape but will change society and our way of thinking. Not all at once but perhaps at a faster rate than the spreading of starlings in the USA. The internet is nothing but a network of information resources (Tu, 2000) and when it started, no one foresaw the tremendous growth it would make. It continues to grow exponentially and it is predicted that by 2002 global telephone communication will equal no more than 1% of the internet traffic (Queau, 1999). There are various reasons for its growth (porn seems to be a driving force), but a major factor is that it was made available free by the scientists who developed it. Just imagine how the web might look today had it been invented by Microsoft and made proprietary (Anon., 2000).

Books on the WWW

The Japanese are the bookworms of the world reading no fewer than 1.5 billion books a years as they commute long hours on trains so packed that nobody can open a newspaper (The Economist, 2nd October, 1999). As elsewhere, the book industry in Japan has realised that today's publishing with nearly half its stock winding as pulp is a rotten way of doing business. Therefore in November 1999 a trial started in which some 500 people have been given electronic-book readers, a gadget the size of a paperback with a screen like that of a laptop computer and a slot to take a memory card that can store three of four novels. This is following the trend away from paper-based products as the technology for downloading and displaying text electronically gets cheaper, more convenient and easier on the eyes. But the road to electronic publishing is littered with abandoned attempts to avoid paper and ink, because e-books can be relatively easily pirated. Also the quality of print has not been matched yet by a liquid-crystal screen (The Economist, 2nd October, 1999).

Go to any search engine on the web and type ELECTRONIC PUBLISHING and there will be hundreds of URLs offering e-books. Some books are offered in PDF format or HTML format, others are available on CD ROM (not quite electronic). One of the main book sellers on the WWW has recently opened an e-book store. The Amazon e-book store supports the

Microsoft Reader format, which allows customers to download titles to a laptop or PC, and download digital audio titles. Download times are estimated to range between 2.3 seconds to 2 minutes, according to connection speed. "E-books are already opening up a whole new world for readers," said Lyn Blake, Amazon.com Books general manager. "What's exciting for readers is that we are just scratching the surface today with the technology and the content, and the potential for both is amazing. While customers will continue to be impressed with the technology as it advances, we think it's the unique and exclusive content that will really delight customers. The e-book store also offers recent best sellers and traditional works. The store features more than 30 free e-book titles available for download, providing customers a risk-free opportunity to experience e-books and test drive the reader," said Blake. Other WWW book sellers deliver similar features, but some famous authors have used the internet to get around the publishers and regular publish chapters which can be downloaded after entering your credit card number.

Scientific journals on the WWW

The exchange of scientific information is currently in a period in which most journals are offered as printed copy, and as soft copy delivered via e-mail or papers can be downloaded from the internet. It is, however, a transition period as in the future the printed version of a scientific journal is likely to disappear. At least that seems to be opinion of the major publishers and experts.

A chief-executive of Elsevier Science, the main scientific publisher in the world which aims to reinvent itself as internet company, thinks that within two years the printed version of many journals will no longer exist and that articles will only be available on the internet. Articles will be offered through the internet, they will reviewed through the internet and will be made available on the internet. This seems to drastically reduce subscription prices and the USA is upfront with this technology. Elsevier Science hopes that by 2002 more than 60% of its scientific revenues will come from internet projects. An interesting development is that Elsevier Science attempts to make older material available and that it is possible to click through in the list of references to the next paper.

Experts believe that the plethora of print journals is doomed to extinction as it makes no economic sense and is increasingly a hindrance to science itself (Butler, 2000d). Not all journals will disappear and journals whose content can command a large readership will continue to exist and flourish in print as their economics are akin to those of the magazine market. The bulk of journals are consulted no more than 50 times a year in a typical library, and only 15% is consulted more than 250 times. Subscribing just to the handful journals will save several thousand dollars whereas the costs of print are difficult to justify for most journals. Therefore in a free-market, high-cost/low-circulation journals would be forced to go electronic, or disappear (Butler, 2000d).

Developments in science journals on the web are rapid. Since 1995 there is an Journal of Electronic Publishing which is published by the University of Michigan Press: http://www.press.umich.edu/jep/. This journal regular published feature article on progress of the electronification in the class and lecture room as well as in the publishing of science. In many disciplines of science there are electronic journals, especially in the biomedical sciences where there seems to be so much need for prompt publication of a research

finding. They have also more money than in other sciences although competition is stiff.

Some concerns have been expressed by librarians to increase the efforts to provide electronic services. The call has recently come from German's science council, the Wissenschaftsrat, which finds that there as yet no satisfactory solutions for reliable long-term archiving of digital media (Schiermeier, 2000). They further pointed out that contrary to many predictions the emergence of electronic publications has not led to a decrease in print publications.

Internet publishing also renews some hostilities between commercial publishers and those who believe that scientific literature should be available free on the internet (Macilwain, 2000). It mainly concerns the battle between the bio-medical CrossRef (from the commercial publishers) and PubMed Central which is the US National Institutes of Health's (NIH) repository for peer-reviewed primary research reports in the life sciences (for details see http:/pubmedcentral.nih.gov). PubMed Central is a free online public archive of peer-reviewed and non-peer-reviewed literature in biology which began accepting journal articles in January 2000. Biomedical research has set up a similar site (BioMed Central) and according to some of electronic publishing experts "..scientists will soon find that unless their papers are freely available, they might as well not be written" (Butler, 2000c). That is probably exaggerated but the idea of a seamless, searchable and freely accessible database is exciting. There are many other initiatives under way.

Early 2000 the initiative was taken for a Europe-based global website of the scientific literature, E-biosci, which was endorsed by research organisations, commercial publishers and the EU (Butler, 2000a). The E-Biosci website would hold abstracts covering a range of disciplines, linked to the full text of the articles. It would be much more complete than PubMed. Whether it is free would be a 'per publisher' decision (Butler, 2000a). Another recent initiative was taken by HighWire Press which is a not-for-profit organisation set up by Stanford University in 1995. The goal is to provide free access for all life sciences by making the back issues available representing more than 137,000 articles (Butler, 2000b). Late 1999, some 12 major commercial publishers agreed on a deal to link journals on the web and as many as 3 million articles across thousands of journals will be linked. It is expected that eventually between 5 to 10 million articles and their references will be interconnected in this way. Not for free of course.

Search engines

With the advent of the internet, the publication of science can be democratised as the dissemination of scientific information no longer needs to be regulated by publishers via peer review and by librarians through their purchase of the journals (Allen et al., 1999). Although this deregulation will speed the flow of valuable information around the world, a negative side effect may be the increase exposure of students and the public to misleading or biased science or to opinion masquerading science (Allen et al., 1999). Search engines should be assisting in this respect, meaning that they should indicate somehow the quality or origin of the information. Finding good quality science on the web through search engines is not easy.

Locating science on the web can be tedious business because much information is not well structured. Previously one would walk into a library and search either in cardboxes, microfilm, or computers to the locations of journals or books. Now it is possible that scientists download papers and information from behind their desk – provided they can find it. Search engines cover only parts of the web and it has been estimated that Northern Light, the search engine with the largest coverage, is estimated to index only 38% of the web in 1999 (Albert et al., 1999) to 25% in 2000 (Butler, 2000e). Other engines seem to index only 7 to 16% of the web. Overall there are substantial limitations to search engines and they have bigger implications for scientists than for regular consumers (Butler, 2000e). Some have argued that standardized addresses would make the web easier (Rajkumar, 2000). The pressing question is, however, not what percentage of the web a search engine covers, but how much of the web is worthy of coverage and how to identify that fraction (Fainzilber, 1999) A science-oriented search engine, together with a set of scientific metadata to help us trawl the oceans of information, seems to be needed (Gardner, 1999)

3. Soil science going electronic

Before discussing the status of electronic publishing in soil science, I would like to take a step back and see how scientific publishing started. Scientific journals first developed in the 17th century to systematize the letters and circular letters through which intellectuals interested in science had begun communicating their discoveries to each other. In January 1665, Le Journal des Sçavans appeared in France and in the same year The Philosophical Transactions of the Royal Society of England were first published (Burnham, 1992). The Philosophical Transactions was in fact an attempt to deal with the enormous volume of correspondence that the Royal Society had engendered. In the decades that followed a large number of other journals appeared and by the 19th century the explosion in scientific communication was well under way (Burnham, 1992). Science's exponential growth over the last three centuries has been astonishingly steady. The doubling time in the number of journals since 1700 has been around 15 years and, because journals expand in size, the doubling time in the number of papers has been about 10 years (Kealey, 2000).

The first soil science journal appeared at the close of the 19th century and a large number of soil science journals saw the light in the 20th century. Table 1 presents some of the main agricultural and soil science journals and their first year of publication. Prior to the second World War, there were only few scientific journals in which soil investigations were published. A considerable number of journals was established directly after the war and another peak occurred in the early 1980s. Only two journals were established in the 1990s and both focus on soil biology. It should be noted that there are some other soil journals as well like the Journal of the Indian Society of Soil Science which is published since 1953.

Table 1. Some of the main agricultural and soil science journals and their first year of publication

Journal	First published	Journal	First published
Pochvovedenie	1899	Australian Journal of Soil Research	1963
Journal of Agricultural Science	1905	Geoderma	1967
Agronomy Journal	1907	Soil Biology and Biochemistry	1969
Soil Science	1916	Commun. Soil Science and Plant Analysis	1970
Journal of Plant Nutrition and Soil Science [1]	1922	Catena	1973
Tropical Agriculture	1924	Agricultural Systems	1976
Experimental Agriculture	1933	Field Crops Research	1977
Soil Science Society of America Journal	1936	Agriculture, Ecosystems & Environment	1980
Journal of Soil and Water Conservation	1946	Soil and Tillage Research	1980
Plant and Soil	1948	Nutrient Cycling in Agroecosystems [2]	1980
Advances in Agronomy	1949	Biology and Fertility of Soils	1985
(European) Journal of Soil Science	1949	Soil Use and Management	1985
Australian Journal of Agricultural Research	1950	Arid Soil Research and Rehabilitation	1987
Netherlands Journal of Agricultural Science	1953	Soil Technology [3]	1988
Soil Science and Plant Nutrition	1955	Land Degradation and Development [4]	1989
Outlook on Agriculture	1956	European Journal of Soil Biology	1992
Canadian Journal of Soil Science	1957	Applied Soil Ecology	1994

[1] Zeitschrift fur Pflanzenernährung und Bodenkunde

[2] Up to 1996 the journal was titled Fertilizer Research

[3] Soil Technology merged with Soil & tillage Research in 1998

[4] Up to 1997 published as Land Degradation and Rehabilitation

It is unlikely that the coming 100 years will yield a similar impressive list of new journals in soil science. Perhaps in some hundreds year from now historians will summarize the developments as follows: in the 19th century the systematic study of soils started and was made a true science when agrogeologists and agricultural chemists combined their efforts; in the 20th century a large number of soil science subdisciplines developed, many journals were started and hundreds of thousand papers were written; in the 21st century these journals gradually disappeared again when the world went electronic. I think there are two reasons why the number of soil science journals will decrease the coming century. Firstly, science demonstrates diminishing returns and one day science's exponential demands on national incomes will become excessive causing the rates of scientific growth to slow (Kealey, 2000). That economic law is likely to affect soil science and to some extent that is already occurring in a number of countries. Secondly, the current number of journals is too large which requires too much time to monitor the large number of publications in order to keep abreast of developments in any field of interest. Internet journals may postpone a decrease in number of soil science journals, but the effect will be only temporarily. Titles will merge and journals will disappear. There is scope, however, for a review journal in soil science particularly now information and review papers are scattered over a great number of soil science journals. Except for Advances in Agronomy which has regularly papers on soil science there is no review journal solely dedicated to soil science. It may be one of the very few new soil science journal to emerge in the 21st century.

A fascinating book on the literature of soil science was edited by Peter McDonald from Cornell in 1994 (McDonald, 1994). The book contains 14

chapters on subjects like characteristics of soil science literature, bibliometrics of tropical soil science, core monographs in soil science, and soil science societies and their publishing influence. The book has not received a lot of attention in the soil science community (it is widely available on second hand book websites). Nowhere in the book it is mentioned that publishing media will change in the future. It seems that for soil science the WWW was out of sight in 1994.

Going electronic – a new paradigm?

The ideas of the American philosopher Thomas Kuhn (1923-1996) entered the world of soil science in the 1990s when some started to speak about "paradigms". In short, Kuhn unleashed the notion that science is not a smooth, authorative progression, but lurches forwards in a series of semi-rational fits. Kuhn, who was based at Harvard and influenced by Aristotle, has been much criticised because paradigm shifts are more gradual and less irrational than he had proposed. His theories on paradigms are not easy to apply in soil science as changes seem to go gradually with fuzzy boundaries. For example, it is not likely that Dokuchaev's and Jenny's CLORPT will be replaced by something else or that someone discovers that plants suddenly require 26 elements or only 6 to come to maturity.

With all respect for Kuhn and his faithful followers, I do believe that currently something is taking place that, if you wish, could be named a paradigm shift. And that is the internet or the linking of billions of pieces of information from computers all over the globe. For the first time since scientific publishing started in the 17th century there is major change coming up in the exchange of scientific information. The internet is ideal for aiding the core journal function of regrouping work scattered across many disciplines (Butler, 2000d). This is particular important for soil science with its many specialisations which are essentially interdisciplinary in character. Currently there are many journals which occasionally publish a paper on soils and climate change. There is no better mechanism than the web to trace and keep abreast of developments in a particular area of research.

We are currently in a period of transition, and most soil science journals offer print copy and on-line versions. There is little difference between the journals of the commercial publishers and those of national soil science societies and both offer similar packages. Since most soil science journals have a relatively low circulation it is likely that they will either go electronic or disappear – at the least that is the experiences in many other science journals (Butler, 2000d). Therefore soil scientists should become involved in the discussion on what will happen with our journals - the main outlet for our investigations and an important evaluation criterion for institutes and individuals. If we do not get involved the publishers will sort it out for us. Currently there is only one journal which is fully electronic: Sciences of Soils which started in 1998 - see http://hintze-online.com/sos/index.html.

Another electronic development which is taken place is that soil science textbooks are being replaced by CD ROMs. Some years back when Prof. Alex McBratney reviewed the second edition of White's "Principles and Practices of Soil Science", he wondered how much longer the textbook as we have to come to know it will last, and whether the next edition of White's book will be on CD

ROM or perhaps on a publishers' home page. Since then a number of soil science CD ROMs have appeared and it is likely that an increasing number of introductory and advanced soil science texts will be published in electronic format in the future. The problem with a number of these CD ROMs is that they are little else than a book in electronic format having the additional possibility of clicking highlighted text. Not much is gained by that. For the advancement of soil science much more can be expected from electronic publishing on the internet.

Electronic publishing

Some believe that scientific publishing means that "…scientists have to take full control of the publishing process and that they insist that it is free, untaxed by the parasites in the publishing world" (Macilwain, 2000). The web would be ideal for that as it allows a continuum of publication that has become possible in the electronic environment (Elliott and Frankel, 1999). Electronic publishing means that papers can be widely distributed for a very reasonable price but it all depends on how the internet will evolve. The internet revolution is depending on many factors including burgeoning bandwidths and new digital formats. The computer brought us speed and convenience – the internet brings us quantity and even more convenience.

Currently our scientific output increases with about 5% per year meaning that each year some 500 papers extra are being produced (Hartemink, 1999). Quality control is mainly guaranteed by the peer-review process but if we move to electronic publishing can quality be guaranteed, will we write differently, and is peer review going to be abolished? And will it affect the way we conduct soil science and how will impact or citation be measured? These are difficult questions and I will attempt to address some of them.

It is likely that electronic publishing will affect the style of scientific writing (Gerstein, 1999). The length of on-line articles will be less restricted and it will be possible to use hypertext and to connect to supplementary material on other websites or in external databases. This enables to reduce the size of the main text and to make it less technical, moving the details to linked sections. The use of hypertext in papers raises the issue whether authors will be free to modify linked material in their own websites, or whether the content related to a paper should be frozen on submission, which is especially relevant to refereeing (Gerstein, 1999).

Will internet publishing affect peer review? New systems may develop by which manuscripts are put in a internet archive of un-reviewed papers for some months after a first quick screening by a specialist. Other specialists in the field may give comments and the author considers these and resubmit the manuscript to an editor, who makes the final decision. Than the paper may either be removed or put in the peer reviewed archive. Will it work? I don't think so because not many people will voluntarily look for papers to review, and those who do give their comments might not be the busy specialist whose opinion you are after. Such an open system will not be easy to maintain and editors remain needed. Open systems go round the publishers but it requires a drastic change of culture in publishing soil science. A more radical approach would be to break the link between publishing and peer review altogether. In effect, the journals would be "hollowed out" so that they merely act as service

bureaux providing peer-review and editing services. They would no longer handle printing, publishing and distributions, this would be done on the internet, via a distributed global database which is currently being set up under the banner of the Open Archives initiatives. Journal subscriptions would be abolished, and the review process would be financed by fees paid directly by scientists' institutions, using the money that would otherwise have been paid for subscriptions (The Economist, 13th May 2000). This plan, which has been long-championed by someone at the University of Southampton, is likely to work if all institutions in the world which have publishing staff, would have a large number of subscriptions to reduce. In effect the system is based on page charges – those who publish pay for refereeing and everyone has free access to all information.

Closely related to the question how the internet will affect scientific publishing is the question whether the internet will affect the way we conduct science. It seems to be occurring in other disciplines. For example, in bio-informatics using intelligent search engines and a large number of databases on the web, new combinations of information can be made. “Surfing on DNA” yield novel insights or information on functions of unknown genes. Could something similar be done in soil science using bits of information published on the web to create something new? It all depends on the quality and quantity of soil information which is put on the web. It also relies on the availability of databases, soil information systems and metadata and the willingness of institutes to put it on the WWW. In a rapidly commercialising world where information is valuable, that willingness may be limited. I do think, however, that free availability of information of good quality would be beneficial for the advancement for soil science.

What about developing countries?

Three-quarters of the earth’s population does not have a telephone, let alone access to the internet. The internet is also not evenly spread over the world. Of some 360 million internet users round the world, only 3.1 million are thought to be in Africa, and most of them are either in South Africa or north of the Sahara. Nigeria probably has 100,000 users and Kenya has even fewer (The Economist, 9th September 2000). In 1997, something like 84% of global expenditure on information and communication technologies took place in North America, Western Europe and Japan. Such spending encourages what has been called “The digital divide”. It is for these reasons that some fear electronic publishing, because it will affect the availability of soil science information to developing countries where telephone lines are unreliable and internet connections are not available or slow. It will exclude them from access to information as well as to contribute because submissions need to be electronic. The fear is certainly justified in many countries, but it is questionable whether it remains valid in the long-term. Firstly, scientific information is currently also problematic in developing countries because many libraries had to cut their subscriptions to scientific journals because of extraordinary price increases. This also happened in many libraries of developed countries. Electronic journals which are cheaper, will increase the potential availability of soil science articles in developing countries, but much depends on the publishers. The remaining hurdles are obviously related to telephone lines,

optic-fibre cables, bandwidths and internet providers. Developments in these areas in many developing countries seem to proceed.

Internet in Africa is spreading fast and has tripled in 1999. In August 2000, Somalia became the latest African country to offer local access to the internet, and for the first time surfers can use the net in Kiswahili. Internet cafes have been springing up in African cities wherever people have the money to use them. On a larger scale, an East African company, Africa Online, based in Nairobi works in eight countries. Also the UN has puts it faith in the internet as a means for poor countries to leapfrog stages of development, and the SG speaks of building "digital bridges". The internet could be a way round one of Africa's greatest weaknesses: its feeble infrastructure like poor roads but it will remain affected by uncertain power supplies and bad telephone lines. Computers and the internet make the contact richer and cheaper: e-mailing a 40-page document from Madagascar to Ivory Coat costs 20 cents, faxing it about $45 and sending out by courier $75 (The Economist, 9th September 2000).

In summary internet is spreading fast in many developing countries which may enhance the availability of scientific information. Since we are currently in a transitional period it is hoped that improvements in the reliability and availability of the internet are as fast as the speed with which journals go out of print.

4. Some conclusions

As made clear in the introduction of this paper, it is difficult to predict where technological advances will be taking us and wrong predictions are easily made. That certainly applies to electronic publishing which is still in its infancy. Soil science journals are in a period of transition between the printed copy and the download. Many libraries seem not be able to make up their mind whether to go electronic and to drop print subscriptions. The same applies to the publishers which still have to consider the realities of a changing market and the needs of their customers (Reader, 1999). I have no doubt that we will be moving to the download stage only, and think that it will enhance the distribution and availability of soil scientific information. Moreover it will save paper - scientists will still print the articles they would want to read, or have, but will not bother about the other 80 or 90% of the articles in the same journal issue.

A point of concern is that soil scientists are not actively involved in the discussion on electronic publishing. We therefore may end up with publishing systems in which we as a scientific community had little or no say. If large databases of soil science information are being formed by combined effort of the commercial publishers, it is important that the journals of the national societies link up so that practising soil scientists have access to both information sources.

The internet will change the way soil scientists conduct literature searches and will result in on-line publishing which will look different from our current publications. We should not forget, however, that the format in which we exchange soil scientific information is only of secondary concern. The

primary goal of scientific publication is, after all, not validation but communication (Liu, 2000), but more importantly the overall goal of soil science is to contribute to society - now and in the future. Perhaps we can do that even better through the internet.

I started this article with some notes on the future and predictions suggesting that it is unlikely that paper free offices will ever occur. This reflects in which century I was brought up where pens and paper were the first thing one received entering primary school. Times are changing and at many primary schools pen and paper are being replaced by keyboard and computer screen and young children learn to play on-line. Within 40 years society will be led by those for whom handwriting is perhaps as obsolete as the sliderule is for us. It is impossible to make any serious predictions on the effects that may have for soil science and society at large.

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