Chapter 12. Conclusions and Implications

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This publication has assessed the impacts of information and communication technology (ICT) on the whole forest sector—from the forest itself to the end products at the market. The starting point was to identify how ICT has affected the forest sector to date, after which the possible future impacts were considered. The emphasis has been on a qualitative rather than quantitative analysis.

The study can be seen as a road map indicating the potential impacts of ICT on the forest sector. There are a number of different routes that the future could follow, and we have tried to provide visions or scenarios of these possibilities. In spite of this, ICT is quite likely to impact the forest sector in unexpected ways. This does not make the analysis a futile one. When the unpredictable happens, we can grasp its implications more quickly if we have engaged in prior thinking and visioning. Moreover, the success of this publication will not be assessed on the percentage of our predictions or visions that come to pass but (1) on how successful we have been in interesting the reader in the topic and (2) on how useful and stimulating readers find the concepts and visions we have presented.

In this chapter, we summarize some of the major findings and implications of the different chapters, providing linkage and feedback between them. We also present some general strategic and policy implications, based—but not strictly so—on these findings. We do this to raise awareness of the need for a thorough review of the implications of ICT for the forest sector as well as to draw attention to new questions and issues needing further analysis.

12.1 Dimensions of the Impacts

When technological revolutions take place, they also tend to fundamentally change societal structures. As shown, for example, by Perez (2002), revolutionary technological changes seem to have similar characteristics and patterns. A knowledge of history is thus likely to be useful when one is considering possible future technological revolutions. This type of reasoning leads Innes *et al*. (Chapter 3) to ask how the past can help us understand what to expect from future innovations in the field of ICT developments.

Case studies of past innovations show a mixed picture. Some of the societal implications of such innovations have clearly been misunderstood or could not be foreseen. Others have been anticipated with remarkable insight. Innes *et al.* provide examples of both, concluding that predictions are possible when there are trends in underlying technologies. They also point out that the forest sector has been heavily dependent upon technological changes that *originate outside the sector*. It is thus important for the forest sector and for forest researchers to closely monitor these technological developments.

The title of the chapter by Innes *et al*. is Surprising Futures. The title carries a message in it—be prepared for the unexpected: for that which we cannot foresee. That aside, the present study does not aim to identify all possible future developments but focuses on some important trends that are already visible. A number of future ICT impacts identified in this publication are what most of us would probably have expected, for example, that ICT applications have assisted, and will continue to insist in increasing efficiency and productivity in the forest sector. But in analyzing such impacts, we hope to provide *insights, conclusions, and implications* that are perhaps not so familiar to the reader.

One such insight is to consider how electricity and other general purpose technologies (GPT) have affected societies and the forest sector and apply this to ICT development. This idea has come out in a number of other studies (e.g., Perez, 2002; Carr, 2004) but has yet to be considered within the context of ICT and the forest sector. A basic feature of GPTs is that their impacts tend to follow

somewhat similar patterns. According to Perez (2002), these can largely be categorized into (1) installation, (2) deployment, and (3) maturity. (Perez further divides these into subsectors.) The Perez (2002) analysis is similar to theories developed by Kondratiev (1935), Schumpeter (1961), and Mensch (1979) that were used to analyze the forest sector in Lönnstedt *et al.* (1983).

In the *installation period*, which typically lasts two to three decades, the infrastructure for the new technology is established and a critical mass of industries applying the technology forms (e.g., the introduction of computing infrastructure and hardware and software industries from the 1970s to the 1990s). In the *deployment* stage, which also typically lasts two to three decades, the transformation potential of the technological revolution spreads across the economy, yielding its full development benefits. This is a period in which institutions start to form around the new technology. When electricity went through this phase, companies and sectors that were early adopters gained important competitive advantages. Apparently, ICT deployment in the forest sector is currently at the deployment stage. *Maturity* is the end of the deployment period and is a phase that combines signs of exhaustion in many of the original core industries of the new technology with low growth rates in the last few new industries within the same technology paradigm. For example, when electricity matured and was adopted by all, the competitive advantages disappeared—electricity became just another necessary input. This type of framework is, either explicitly or implicitly, behind many of the analyses in the current study.

The study has also tried to provide insights by considering the *important interlinks* between subsectors of the forest sector—that is, how ICT development and its impacts in one subsector may turn out to be an important driving force and determinant of the development in another—for example, how the changes in communication paper demand caused by ICT development may affect the demand for pulpwood, which, in turn, has important implications for how we use our forests.

12.1.1 Implications to date

Hetemäki *et al.* (Chapter 2) analyze how the forest sector has handled the implementation of ICT to date. The authors conclude that ICT implementation has strongly contributed to improving the productivity and efficiency of the different forest subsectors, thus contributing to the forest sector's overall continuing competitiveness. Consequently, ICT has had a similar role to that of GPTs in the history of the forest sector—the analogy with electricity being a good example. The other GPT-type impact of ICT relates to globalization. As in other sectors, ICT has enhanced the globalization of the forest sector. Indeed, without an efficient use of ICT, this development would probably not have been possible, at least not to the extent that has occurred.

In the early 1980s, many people were convinced that we would soon move toward a *paperless office*. The visionaries got the dates wrong; the paperless office has not arrived, nor will it, probably, in the near future. Indeed, perhaps the paperless office concept should not be taken too literally but rather understood as indicating that ICT could lead to a significant reduction in paper consumption. If we accept this view, the problem with the paperless office concept was not with the concept itself but with its premature arrival on the scene. It anticipated some of the developments visible today and that will probably be increasingly relevant tomorrow. These early visions of modern technology rapidly reducing paper consumption should not make us forget that, at the beginning of 1980s, a number of serious studies were already doubting the possibility of such a scenario taking place. Indeed, as discussed in Hetemäki *et al.* (Chapter 2), several important studies clearly point out that the issue was not a technological one but also involved economic, social, and human dimensions. Those studies also conclude that in the coming decades electronic media would probably cause an increase in paper consumption rather than a decline.

Hetemäki *et al.* (Chapter 2) also show that ICT impacts in the forest sector have not just been restricted to the forest industry and wood production. ICT has also played an obvious and essential role in raising consciousness about forest-related *environmental issues* among the public, politicians, and decision makers. This awareness has changed the way forest resources are managed and has

increased protected areas. These developments were mainly driven by the "green movement," which utilized new ICT efficiently to get its mission and message across.

Another sector, outside forest-industry activities, in which ICT development has had a significant impact is *forest recreation and tourism*. The Internet and global positioning system (GPS) technology have changed how national parks can be managed and advertised, monitor their visitors, and collect information about a large number of different topics related to forest recreation. An interesting but again under-researched topic is how ICT has influenced people's views on forests. To take one example, ICT may have led people to undervalue "everyday" or unspectacular forests because television nature programs and Internet pages have concentrated on the beauty of monumental and spectacular forests (e.g., the giant redwoods).

Summarizing ICT impacts on the forest sector to date, the following observations can be made. First, ICT implementation in the forest industry and wood production sector has been along "installation period" lines rather than making the kind of ground-breaking advances expected in the "deployment period." Perhaps the important exception is the globalization of the forest industry, which has been greatly enhanced by ICT development, with fundamental changes being made as a result to the industry's operating environment. Second, many ICT impacts on the forest sector are indirect. That is, ICT changes society in general which, in turn, changes the forest sector. There are also indirect ICT impacts within the forest sector itself, with many of the fundamental impacts relating to forest industries and their markets rather than to forests themselves. However, the changes in forest industries and markets have, in turn, important implications for how we use forests. The present study reflects that situation. It emphasizes the importance of having a good grasp of how ICT impacts on the forest industry and markets, before drawing conclusions about its impacts on forests.

12.2 Future Scenarios and Implications

Next, we turn to the possible future impacts of ICT on the forest sector by chapter. Although based on the earlier presentations, the discussion here also extends and adds to what has been stated in previous chapters and therefore draws on some publications not covered in the earlier chapters. Responsibility for the policy and strategic implications here rests with the authors of this chapter.

12.2.1 Forest businesses and e-commerce

The term *e-business* covers all business applications using ICT to improve a firm's efficiency. According to Porter (2001), e-business includes a firm's infrastructure development, human resources management, technology development, procurement, logistics, operations, marketing and sales, and after-sales service. *E-commerce* is one component of e-business and includes buying and selling over the Internet. Nyrud and Devine (Chapter 4) deal specifically with the e-commerce component, and Boston (Chapter 5) analyzes the development of the e-business concept.

There are two different views with respect to the impact of e-commerce. One emphasizes that e-commerce will lead to increased competition and decreased prices. The other stresses that e-commerce will generate new business models and opportunities that are completely different from those we are accustomed to in the industrial society. However, both agree that e-commerce will be a natural and substantial component of future business.

Despite many firms having high Internet access and a large proportion of employees using computers, the extent of firms using e-commerce is still very low, although increasing substantially (Leck *et al*., 2003). The proportion is smaller in the manufacturing sector (e.g., in the forest industry) than in the service sectors. E-commerce use is currently most significant in tourism, media and printing, banking, insurance, and ICT services and retail (e-Business W@tch, 2003). Some of these sectors are important for the forest sector, which may therefore need to move faster in the direction of e-commerce.

E-commerce in general has been dominated by business-to-business (B2B) trade and local and national operations (OECD, 2003). But it is becoming more and more international, and e-commerce

is increasingly applied for business-to-customer (B2C) solutions as well. It is assumed that e-commerce will spread increasingly in the emerging economies of the developing world (OECD, 2004). Low-cost producing countries entering e-commerce are also likely to affect the competitive environment, prices, and the structure of the global forest sector. Many developing countries are already reaching out to global markets through e-commerce.

There are good reasons to believe that e-commerce will lower information barriers in the forest sector markets, for example, as a result of greater price competition, more flexible trade arrangements, elimination of excess capacities, and gains in access to new markets and distribution networks (Obersteiner and Nilsson, 2000a). The forest sector has already seen the introduction of Internet marketplaces such as papiNet and Forest Express [see Nyrud and Devine (Chapter 4)]. In the future, forest products will increasingly be offered through large Internet retail platforms that will help to substantially reduce transaction costs. This, together with other emerging aspects of digital technology, is also likely to reduce, if not make obsolete, traditional market forecasting based on extrapolating from past trends (Obersteiner and Nilsson, 2000b).

Boston (Chapter 5) states that e-business in the forest sector can be grouped into three categories, namely, business/market intelligence, customer management, and operations management. He concludes that the forest sector has deployed ICT with respect to operations but has been less successful with other categories. There is thus a strong need for the forest sector to adopt a more holistic approach to e-business applications. Moreover, there is an important difference between small and large companies regarding implementation of efficient e-business concepts. Because of this, some observers anticipate that an e-business gap might emerge (CBI, 2002). If this happened, it could contribute to company consolidation in the forest sector too.

During the last two decades, the productivity, profitability, and competitiveness of the forest sector have largely been associated with the increase in production volume and the cutting of costs. However, investments to expand capacity to improve competitiveness will be more limited in the future. *Innovations* will thus be crucial for the forest sector's future competitiveness—and these innovations will be driven by technological developments and consumer preferences. They will not be caused by ICT in isolation but rather by the integration, for example, of ICT, biotechnology, and nanotechnology.

New technologies and their integration will create new business opportunities and product innovations (Tapscott, 2001). But the new technologies and evolutions in society are also likely to lead to a new generation of customers whose habits and preferences are different from those of current customers. Forest sector businesses in the future must focus more strongly on the customers. E-business can play a important role in the move from production orientation to market orientation (Ince *et al.*, Chapter 7).

12.2.2 Communication papers

Hetemäki (Chapter 6) analyzes the current and possible future impacts of ICT on communication paper markets. In terms of the quantity produced and the market value, communication papers make up the largest paper products group. Hetemäki shows that there has been a structural change in communication paper markets in a number of the countries of the Organisation for Economic Co-operation and Development (OECD) and that ICT has probably played a central role in these. The traditional market analysis and long-term consumption projections are also less useful here—and may even provide qualitatively false projections.

In the OECD, the future trend is likely to favor electronic media at the expense of printed newspapers. *Newsprint consumption* in a number of OECD countries has already declined and is likely to do so even more in the future. Developments with respect to *office and magazine paper* consumption and ICT have been less clear than with newsprint. The major exception is office paper consumption in the United States, where consumption has already stagnated or declined since the mid-1990s, mainly because online services have been substituted for the paper used for forms and stationery. There has also been a slowdown in the growth rate of the office paper sector in a number

of other OECD countries during the last five years. Whether this is a cyclical phenomenon or a structural break is too early to say definitively. In general, however, the underlying economic, consumer, technological, and environmental forces are tending to favor digital media over print media, and it appears that office and magazine paper consumption will follow the trend of newspapers and newsprint with a time lag. The length of this will vary across countries, and its exact timing is difficult to project.

In the medium term, ICT development also generates demand for new office paper grades. Printing and publishing industry projections show increasing demand for high-quality, digital color printing, both in offices and homes (CAP, 2003). The new paper grades require, for example, new surface properties that are typically achieved by increasing the amount of fillers (pigments) at the cost of wood fiber in the paper. This trend thus also has an important implication for the paper industry's raw material utilization.

While ICT development is generating demand for new office paper grades, environmental considerations are simultaneously tending to work toward reducing the use of office paper. Companies, government offices, and universities, for example, are introducing paper procurement and consumption polices that aim for a substantial reduction in paper consumption to achieve sustainability objectives.[1] The increasing use of ICT is seen as one possibility for reducing office paper consumption and hence the environmental side-effects of paper products. The net effect of these two offsetting trends for future office paper consumption depends, of course, on the relative magnitude of these impacts.

The incentives to move from print to digital media are generic or universal by nature. Thus, they are also likely to be relevant for *non-OECD countries*. However, at least in the next decade or so, the other driving forces determining communication paper consumption in those countries will be much stronger. For example, in most of the non-OECD countries, per capita consumption of communication papers is still at a very low level compared to OECD countries. Consequently, communication paper consumption is likely to increase rapidly in these countries in the near future.

ICT developments are also likely to indirectly influence communication paper *prices*, but with a price decrease as a result. These impacts are more immediate than the consumption impacts mentioned above. For paper industry profits, the price impacts of ICT can be more significant in the short and medium term than the consumption impacts.

In summary, the structural changes in communication paper markets due to ICT will probably be substantial both in terms of volumes and prices. These changes will, in turn, have a number of strategic long-term consequences for the forest sector:

- ICT will strengthen the ongoing geographical restructuring of the communication paper industry from OECD countries (North) to non-OECD countries (South);
- There will be decreased demand and prices for pulp wood, recycled paper, and other raw materials used for communication papers;
- The need for cost cutting will be strengthened, for example, by increased utilization of plantations for pulp raw material and decrease use of natural and seminatural forests;
- Employment will decrease in the communication paper and allied sectors in OECD countries; and

[1]Bank of America announced on 1 April 2005 that: "The bank will minimize the volume, by weight, of paper products it purchases, where cost, quality, and general business needs allow. This will be achieved via procurement best practices, such as light weighting; internal operations initiatives, such as business process digitization; and customer product offerings, such as providing online banking customers with the option of receiving electronic statements in place of paper statements." (Bank of America, 2005).

- New challenges for forest management and forest sector development will be created, especially in traditional major forest countries (e.g., Canada, Finland, Sweden, and forest-industry-dependent states in the United States); on the other side of the coin, there will be new opportunities in a number of non-OECD countries (e.g., Brazil, Chile, China, India, and Russia).

We are at the beginning of the process of paper substitution due to ICT developments. Substantial additional research and analysis are required for a better understanding of this process and its consequences for the forest sector. As illustrated in Hetemäki (Chapter 6), this research cannot be based on traditional analysis but requires new approaches that can capture the essential features of ICT impacts on the paper sector. The need to update current approaches is the most immediate so that more credible long-term projections of communication paper consumption and prices in OECD countries can be made.

12.2.3 Paperboard and packaging

In terms of consumption, the *paperboard and packaging* grades form the other large paper products group. Ince *et al*. (Chapter 7) analyze the possible impacts of ICT developments on this group of products. The authors conclude, in the same way as for communication papers, that ICT implementations in the paperboard and packaging sector to date have been driven by cutting costs (the cost-leader strategy) to maximize output and utilization of capacities (production-push strategy). Because of the very different nature of the end uses of the two paper grade sectors, however, there are also important differences in the ICT impacts on these grades.

In responding to customers' new demands, Ince *et al*. see *intelligent packaging* as a challenge and an opportunity for the packaging sector. Intelligent packaging uses electronic sensors and/or chemicals to sense or transmit information about the environment, transport conditions, product information, and management instructions, and can be seen as a further development of bar codes. Bar codes on packages and boxes have revolutionized the way stores manage inventory and the speed at which checkout lines move in supermarkets. But while bar codes have to be seen in order to be scanned, radio frequency identification (RFID) tags can be read at a distance and from any angle. RFID technology has recently arrived and is being used to tag everything from pets to shipping containers.

To date, the main obstacle to RFID adaptation to the packaging sector has been the cost. Most RFID designs are too expensive for mass markets, but technologies have been or are being developed that will allow costs to be reduced. For example, Plastic Logic of Cambridge, England, has developed ways of using inkjets to print semiconductors using polymer materials, resulting in performance equivalent to the silicon components used to create the active-matrix substrate for LCD panels. According to Plastic Logic CEO, Stuart Evans, "Low-cost RFID for intelligent packaging is coming, but it's going to have to rely on print technology" (see Poor, 2003).

Ince *et al.* (Chapter 7) discuss the future impacts of ICT on the paperboard and packaging sector in terms of "three speculative scenarios." The first scenario builds on the hypothesis that intelligent packaging coupled with e-business concepts can offer an expansion of packaging materials in the paperboard and packaging industry. It also implies that the industry will move into value-added markets by developing new packaging services. This development would have the potential to increase the volumes consumed (compared to business-as-usual) and the prices of the products, with producers possibly able to keep the value-added generated by the new products. But to see this happen, the industry must be able to implement a strategy *to move from a commodity-oriented industry to a packaging system industry*. To do that, the industry must form alliances, networks, and joint ventures with sectors outside the traditional paperboard and packaging sector.

The strong development toward a packaging system industry with higher value-added and higher prices could also spill over into better economic conditions for forest management. Another interesting side-effect of intelligent packaging could be more efficient recycling, with better sorting

of the recovered paper, more efficient reuse of recovered papers, less waste, and fewer environmental problems.

The second scenario builds on the assumption that the industry will stay commodity-oriented and that ICT implementations will aim for cost reduction and productivity increases and, in so doing, increase profitability. The theoretical analysis shows that this strategy will probably result in a future decrease in the price of and demand for paperboard and packaging grades. This, in turn, implies lower producer surplus and less profitability for the sector.

The third scenario assumes that a broad implementation of ICT will reduce not only production but also transaction costs and that, as a result, new and more efficient market segments (niche markets) could emerge. The analysis indicates, however, that even in this case producer surplus will be reduced, as will profitability for the sector as a whole.

The analysis also evokes the important question as to whether the paperboard and packaging industry is capable of moving sufficiently fast toward new interactive packaging systems. If this move is not implemented quickly enough, there is a danger that the paperboard and packaging sector will face increased substitution by other packaging materials. In general, the authors call for the paperboard industry to move away from production orientation toward market orientation when dealing with customer and market needs. They see that ICT and the e-business concept have the potential to support this move and, in so doing, could increase the value-added in the sector. Finally, one conclusion from Ince *et al*. (Chapter 7) is that important knowledge gaps exist about the market effects of ICT developments in the paperboard and packaging sector. This is an urgent challenge for the research community.

12.2.4 Wood products industry

Baudin *et al*. (Chapter 8) analyze ICT developments in the *wood products industry*, which comprises sawmilling, engineered wood production, furniture, joinery, and wood packaging production. The essential characteristics of the wood industries are that they produce standard products and have few barriers to entry. The current implementation of ICT in the industry has concentrated on the improvement of the supply chain management (the cost-leader strategy). However, the degree of ICT implementation in the wood products industries is substantially less advanced than in the pulp and paper industry. One reason for this is that the majority of industrial units are rather small and cannot afford large investments in advanced ICT implementation. However, new trends and requirements seem to be changing this situation.

The wood products industry is currently moving increasingly toward niche markets and value-oriented growth instead of relying on the volume-oriented growth and low-cost strategies of the past. The repair–maintenance–improvement (RMI) and do-it-yourself (DIY) markets are also huge and increasing. These markets require consumer-friendly or consumer-efficient products. Baudin *et al.* (Chapter 8) assume that e-business will be implemented in these markets on a large scale, resulting in substantial cost cutting. That does not necessarily mean, however, that the producer surplus will increase. The gains will mainly spill over to the consumers.

To sum up, ICT implementations in the wood industry are mainly expected to deal with efficiency and cost-cutting implementations in commodity and semicommodity strategies, resulting in increased productivity but lower producer surplus and profits (Hitt and Brynjolfsson, 1996). ICT will also possibly prove especially beneficial in the marketing process for small and medium-scale wood companies. These companies often have limited resources for marketing their products, especially abroad. Internet marketing, company Web sites, and e-commerce are likely to be of significant help in promoting products and handling customer transactions.

12.2.5 Forest resources and management

Above, it was concluded that ICT development is likely to strengthen trends in the forest sector that are already partly taking place for other reasons, for example, by increasing downward pressure on the real prices of wood raw material and by encouraging the geographic relocation of the forest

industry (especially pulp and paper) from the North to the South.[2] Both these trends have important implications for forest resources. When discussing these implications, however, it is essential to draw a distinction between the North and the South, as the implications are likely to be different for each region. We first summarize the implications for *the North*:

- Forest industry companies have growing incentives to relocate their production to rapidly growing markets (e.g., Asia, Latin America, Russia) and to areas where raw material and labor costs are relatively low (e.g., plantation forests in South America). As a result, the demand for wood in the North declines, as do the real prices for wood. These trends weaken the potential for profitable wood production and forest management in the North, which, in turn, reduces the supply of wood and employment in the forest sector in these countries. Moreover, there will be increased incentives for larger forest holdings in which economies of scale could help to maintain financially viable wood production despite lower real prices. These trends would, however, make the forest more likely to be used for other purposes, for example, energy, recreation, or biodiversity.
- For countries and regions heavily dependent on forest resources, it is important to find new forest-based businesses, whether in manufacturing or services. This would help them maintain a viable forest sector despite the structural changes brought about by ICT development and other driving forces.
- National forest policy, if it exists, should take into account these developments and help in the adjustment to new regimes. Investing in long-term research and development, which could create new innovations for the sector, should be an essential part of policy.

The major implications for *the South* are:

- There will be increasing investments in the forest industry and the forest sector in general. Demand for fast-growing plantation forests and their wood supply will especially increase. These trends strengthen the possibilities for profitable wood production and forest management in the South, increasing both the supply of wood and employment prospects in the forest sector in these countries. Depending, for example, on where the new plantation forests are located, how they are managed, and how they change the management of natural forests, the possibility of using the forest for energy, recreation, or biodiversity will either increase or decrease.
- The pressures to apply biotechnology to further increase the returns from plantation forests will be strengthened by the developments mentioned in the previous point.
- Education and research related to forest management will probably need to be increased in the countries where new investments are located.

In general, for both the North and the South, the new conditions are bound to bring new challenges for forest sector research.

Reynolds *et al*. (Chapter 9) analyze the impacts of ICT on operational *forest management and conservation*. They define forest management as ways of using forests to provide the values, goods, and services required by society. For example, forest conservation is regarded as an instance of forest management—an application of forest management in an area where conservation values are emphasized.

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[2] *The North* refers here particularly to important traditional forest regions, such as North America, the Nordic countries, Japan, and some of the countries in central and western Europe. *The South* is a looser geographical category referring to countries, such as China, India, Indonesia, Brazil, and Chile, as well as Russia, Poland, and the Baltic countries. Moreover, a few countries with a strong forest sector fall between these two groups in terms of possible ICT impacts on the sector. For example, Australia and New Zealand have some of the disadvantages of the North (e.g., relatively high labor costs) and some of the advantages of the South (high yield and rapid-growth plantation forests).

Society is posing considerable challenges to forest management through economic, social, and ecological objectives that often conflict over a range of spatial and temporal scales. Reynolds *et al.* (Chapter 9) show how ICT developments have substantially contributed to changes in forest management during the last 20 years or so, for example, through more transparent decision-making processes, improved access to information, improved public participation, and spatial inventory databases. In general, although ICT implementation has improved the efficiency and decreased the costs of forest management, it has not managed to substantially reduce the existing controversies over forest management issues and policy.

Future ICT developments could contribute substantially to solving the controversial issues of forest management. ICT could play an important role by:

- Helping to treat conservation more efficiently in the context of forest management;
- Facilitating participatory (interactive) planning processes and bridging the gap between general public concerns and gaining social acceptance of the management measure applied;
- Management across spatial scales—a necessity for ecosystem management;
- Management across ownerships—collective management; and
- Management for sustainability—the most pressing issue with respect to future forest management.

As well as helping solve conflicts, future ICT development will contribute to greater *effectiveness and efficiency* on the part of forest management through improved decision making and better resource allocation. These, in turn, could result in increased income and decreased costs.

12.2.6 Changing institutions, values, and governance

Earlier, we noted that ICT can be regarded as a general purpose technology that typically changes institutions and the way things are done (or not done). GPT is also likely to change societal values, as was the case when conflicts arose during the industrial revolution in England between traditional and modern textile-production methods. An unforgettable illustration of what this type of "technology revolution" can mean for our everyday life can be seen in Chaplin's film *Modern Times* which captures the frustrating struggle of a proletarian man against the dehumanizing effects of the machine in the industrial age.

Thomson and Colfer (Chapter 10) state: "Society and culture drive the adoption and use of ICTs and, in turn, are changed by their use." The authors describe some of the social and cultural dimensions of ICT development. Many ICT impacts in society, and in the forest sector, are indirect or difficult to quantify. How, for example, do you quantify ICT impacts that may change the mindset of society, some of which may become evident and identifiable only after a long time period? Clearly, assessing these type of affects on society and on the forest sector is challenging. However, we venture to illustrate some of these impacts in the following paragraphs.

One issue that Thomson and Colfer particularly address is the *digital divide*. Concerns have recently been expressed that ICT development causes unequal opportunities in developed and developing countries, with ICT diffusion in the latter being slower than in developed countries or even nonexistent. The digital divide, however, would appear to be an integral part of a much broader and wider development divide (Hewitt de Alcantára, 2001; UNRISD, 2004; Paludan and Worzel, 2004). Without solutions to basic development problems, ICT risks widening the current divide among and within countries, which may also constrain the development of the global forest sector. Future divisions between people and societies are, however, unlikely to strictly follow the North–South transect. Indeed, ICT may to some extent decrease the traditional divide between developed and developing countries, for example, by shifting outsourcing services and manufacturing from the North to the South. However, digital divides within countries could increase because of ICT development; compare, for example, the city of Bangalore with the rural areas of India.

ICT development could also contribute to a changed education profile, having, for example, a liberating impact for women in the developing world and giving them access to information that was previously denied to them (Ess and Sudweeks, 2001). On the other hand, using computers instead of printed material for learning and education could over time change the way people see and value the forest sector. The necessity and relevance of printed material could become more blurred, which could affect attitudes toward wood production and the forest industry. On the other hand, papers such as tissue paper are hardly affected by ICT use.

Unsurprisingly, ICT development has changed and will continue to change people's habits. New generations have always adopted new habits because of technological developments. One has only to compare the habits of people who were adults after World War II (in the late 1940s and early 1950s) with those of adults today. Some habits are similar, but many are not, simply because different technological possibilities have prevailed at different times. Changing habits are thus an integral part of technological development. Future ICT development will likely lead to new types of preferences and consumption patterns, with concomitant implications for the forest sector.

One dimension of the changes caused by ICT development in our societies relates to *governance*. Rametsteiner *et al*. (Chapter 11) analyze the links between ICT developments and international governance, defining governance "as the rules and procedures that states and other involved parties agree to use to order and regularize their treatment of a common issue." The principles and mechanisms of governance, including governance of the forest sector, have gained significantly from ICT developments. For example, ICT has helped the governance of sustainable forest management, sustainable use of forest resources, interactions among forest ecosystems, and the climate system. Because of ICT development, an increasing number of interest groups and individuals have become involved in deliberations on forest matters. Moreover, processes have become more open and transparent, accountability has increased, the effectiveness and efficiency of policy measures have improved, and there is more coherence among the different policymaking bodies.

The implementation of ICT has influenced national sovereignty and reduced the capacity of nations to manage national issues and international relations. The development of ICT has helped to integrate more institutions in both national and international forest affairs, affecting the process of coordination, rule setting, and governance of forest issues, and thus improving administrative efficiency. However, it has also brought an increased number of conflicting views on the policy issues debated. Managing these conflicting views would result in better decisions and policies because conflicting views can also result in blocked positions that cause problems in reaching any decision or policy. Rametsteiner *et al*. (Chapter 11) set out four scenarios, according to which ICT developments can influence the development of international forest governance:

- A few well-coordinated international governance bodies with associated implementing agencies, that can be private or public;
- Loose but well-coordinated networks of public and private institutions;
- A strengthening of regional policy processes, with institutions replacing global governance arrangements; and
- Creation of meaningful international governance arrangements with reliance on local governance arrangements.

It is difficult to assess which route the international governance of forests will take. However, it appears that ICT development may make possible a shift from top-down governance concepts to more transparent network governance. Irrespective of which of the above scenarios materializes, if any, the forest sector has to develop a more sophisticated governance process. To improve international governance that makes best use of ICT, resources must be assembled to tackle the many open questions still remaining. ICT brings with it not only technical but especially political, institutional, and organizational challenges for governance.

12.2.7 Changing forest education and science

The evolution of ICT will transform and change how education and science in general are organized, financed, governed, and executed. Education and science will increasingly become a global knowledge and learning industry and form alliances with other sectors of society; but how science will be executed in practice in the future is impossible to predict today (National Research Council, 2002). Forest education and science will be no exception to this development path. ICT can contribute to forest science, for example, by improving the distribution and management of scientific information, by generating more data and allowing better data handling, by improving instruments/tools to analyze already-observed phenomena, by allowing the detection of never-before-observed phenomena, and by enabling effective and rapid communication among scientists.

The primary means by which scientists have communicated with each other remained frozen in time until the Internet was introduced. Scientists formerly produced only ink-on-paper articles that were published in specialized scientific journals, the subscription price of which was substantial—a good source of business for commercial publishers. The Internet and electronic distribution is changing all that. Distributing scientific information online is less expensive than in print, and access by scientists around the world is much greater and easier. Documents can also be made available in less time. Information content is boosted via the electronic medium, allowing for publication of audio, video, large data sets, and interactive tools. Peer review can be made more inclusive and rapid. These are just few examples of how ICT development has helped the distribution and management of scientific information. Many new ways will undoubtedly be introduced in the future.

The data available in the future will also be greatly driven by ICT development. It will be many orders of magnitude higher even than today, when the amount of information is already daunting. Efficient knowledge management will be required in the research organizations of the future to provide the right information to the right person at the right time (Wernick, 2002; Pinte, 2004). It is knowledge management that will drive the reorganization of research organizations in the future (National Research Council, 2004).

Currently, different national laws, security concerns, and financial interests are constraining access to scientific data. The data produced in developing countries are among the least open because of economic, organizational and political constraints, and scientific protectionism. A major data problem is the lack of digital archives of historical data. However, while access to data per se will not solve the problems, the integration of data can generate new knowledge and breakthroughs (Schwartz, 2004; CODATA, 2005). The Scientific Committee for Problems in the Environment (SCOPE) and the Committee On Data for Science and Technology (CODATA) of the International Council for Science (ICSU) request *free access* to scientific data, open-source software, data networks, models used, and digital publications; and they argue that the research task is not over until these items have been publicly posted (SCOPE, 2002; ICSU, 2004). There are strong research needs for the establishment of efficient open-access policies on scientific results and data (National Research Council, 2004).

The demographic, societal, and technological (including ICT) changes in society will cause substantial changes in the educational system, including universities. For years, it has been argued that *distance education* through ICT is a great opportunity for dramatically improved educational levels in the developing world—distance learning can train more people simultaneously at a lower cost. But as experience shows, there are hurdles to be overcome if distance education is to be optimized, such as drawbacks due to capital-intensiveness, isolation of students from instructors, high drop-out rates, and inappropriate packaging of courses. In the developing world, culturally appropriate material and approaches must be developed; it is not enough to import off-the-shelf products from the North.

Experiences of *e-learning* in the developed world to date are: less administration, better study support, Internet links to international courses, better individual supervision, easier access to educational material, and the possibility of individual study time plans, place and time of studies, and

study strategies (University of Vienna, 2004). But successful e-learning platforms also require new study content structures, new content production, and new content management.

The world's students are increasingly conversant with hypertext, with multifunctional phones in their pockets, access to libraries through their laptops, and instant messaging. Many universities will become virtual because students do not want to be locked up in classrooms and limited in time, place, and media. The traditional curriculum and schedules will change and become continuous. Professors may have to change their mindsets—shifting from being content providers to designers of learning experiences. The university classes will be a *hybridized combination* of online and in-class instruction.

The demands on the workforce and workplace will change rapidly because of ICT development. The changes expected in society mean that bulk of the current global workforce will need retraining during their remaining working life just to keep up. The future will also bring a graying workforce that will need continuous reeducation to remain viable. Educational programs will need to be available at convenient times and places for working adults, which will mean a tendency toward *virtual educational institutions*. In the future, we can also expect many more global virtual laboratories and libraries, like the National Science Digital Library (www.nsdl.org) and the Global Library Initiative (www.globallibrary.org).

12.2.8 The challenge

The global forest sector appears still to be somewhat hazy and unprepared for the impacts of ICT. There are even some who seem to doubt the relevance of ICT to forests. This state of affairs is reminiscent of how biodiversity or forest carbon issues were viewed in the 1980s and even in 1990s in the forest sector. These issues were left in a drawer and taken out only when they had already grown into serious problems. As noted earlier (Chapter 1), it is such gradual and general trends that tend to be the most dangerous ones, as their relevance for current operations is often seen as minor.

Thus, the forest sector has not really made fundamental changes to current models, strategies, or policies as a result of ICT development. The business-as-usual approach still dominates. The paperless office debate may also have made many skeptical. When, despite rapid ICT development, the vision of the paperless office turned out to be inaccurate, this was taken as evidence that ICT development is not of great concern. For example, many industry analysts and forest economists still use the old models to project an ever-continuing growth in communication papers.

The analyses in this study show that the forest sector needs to pay more attention to ICT development. Long-term strategies to deal with the changes that will be caused by future ICT development are necessary. This study has identified a number of possible impacts of ICT developments, but their exact timing is difficult and, for some impacts, even impossible to identify. The analysis also stresses another overall conclusion, namely the *need to increase research* on ICT impacts on the forest sector. The forest sector and society need to thoroughly understand the ICT phenomenon and its links to the forest sector to prepare for the changes. This study has pointed to a number of issues that need further research.

An important overall conclusion from the study is that the forest sector needs to implement *new strategies* in the face of ICT development worldwide—but particularly in the traditional forest countries of North America, the Nordic countries, Japan, and central and western Europe. ICT development is likely to accelerate the trend of moving the forest sectors in traditional forest countries into the twilight zone of outsourcing, closing of mills, unemployment, and increasing difficulties in maintaining profitable and sustainable forest management. Without new strategies, restructuring, and prioritizing it is difficult to see how a viable forest sector could be maintained in these regions in the long run.

The mindset in the forest sector has to change from a cost-leader strategy to one of using technological innovations for the development of new transformational products. Combining forest resources with modern ICT and creating new innovative businesses, whether in manufacturing or

services, could be one way of keeping forest sectors viable in regions that are currently heavily dependent on traditional forest industries. However, current forest companies do not necessarily have strategies to focus on these new directions but may prefer to produce an ever-larger magnitude of current forest products and to develop new markets, such as China and India. For example, Rooks (2005) and Kenny (2005) conclude that the paper industry has been unable to make real progress in producing high-tech products and that its challenge is brand-new, high-tech applications.

The first step toward these new opportunities is to acknowledge the importance of ICT in shaping the future of the forest sector. For those interested in pursuing new developments and innovations in the forest sector, there is also a strong need to look at developments outside the sector. For example, the use of new ICT technologies, nanotechnology, and biotechnology, and the ability to make returns from these technologies, are likely to require the establishment of strong networks outside the traditional forest sector. This probably means that we also need to look for products and industries that do not exist today, rather than viewing future opportunities through the lens of existing assets and capabilities. Instead, it may be appropriate to ask the question: "What if we start anew?" This question requires a *changed mindset*, a change that the traditional forest sector should make if it wants to utilize the new opportunities.

National forest sector policies could play an important role in creating an environment in which new innovative forest sector strategies and businesses could evolve. The natural role for government would be to enhance research and development in new technologies and their applications as well as support investments in more-risky, long-term projects related to new innovations. Simultaneously, governments should seek to avoid the policy of direct subsidies to wood production and the forest industry. That is, governmental policy should emphasize advancing new innovations rather than securing existing structures. For forest policy, a first step would be to acknowledge that ICT developments have already made a contribution to ongoing structural changes in the forest sector.

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