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ABOUT THE IPTS REPORT

The IPTS Report is produced on a monthly basis - ten issues a year to be precise, since there are no issues in January and August - by the Institute for Prospective Technological Studies (IPTS) of the Joint Research Centre (JRC) of the European Commission. The IPTS formally collaborates in the production of the IPTS Report with a group of prestigious European institutions, forming with IPTS the European Science and Technology Observatory (ESTO). It also benefits from contributions from other colleagues in the JRC.

The Report is produced simultaneously in four languages. The master copy is in English and translated versions are produced in French, German and Spanish. The fact that it is not only available in several languages, but also largely prepared and produced on the Internet's World Wide Web, makes it quite an uncommon undertaking.

The Report publishes articles in numerous areas, maintaining a rough balance between them, and exploiting interdisciplinarity as far as possible. Articles are deemed prospectively relevant if they attempt to explore issues not yet on the policymaker's agenda (but projected to be there sooner or later), or underappreciated aspects of issues already on the policymaker's agenda. The multi-stage drafting and redrafting process, based on a series of interactive consultations with outside experts guarantees quality control.

The first, and possibly most significant indicator, of success is that the Report is being read. The issue 00 (December 1995) had a print run of 2000 copies, in what seemed an optimistic projection at the time. Since then, readership of the paper and electronic versions has exceeded the 50,000 mark. Feedback, requests for subscriptions, as well as contributions, have come from policymaking (but also academic and private sector) circles not only from various parts of Europe but also from the US, Japan, Australia, Latin America, N. Africa, etc.

We shall continue to endeavour to find the best way of fulfilling the expectations of our quite diverse readership, avoiding oversimplification, as well as encyclopaedic reviews and the inaccessibility of academic journals. The key is to remind ourselves, as well as the readers, that we cannot be all things to all people, that it is important to carve our niche and continue optimally exploring and exploiting it, hoping to illuminate topics under a new, revealing light for the benefit of the readers, in order to prepare them for managing the challenges ahead.

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ERRATUM

In the article "Information Society Strategies for the Candidate Countries: Lessons from the EU -15", published in issue 77 (September 2003), and specifically on page 7 the sentence: "In some countries (the Czech Republic, Estonia, Hungary, Slovakia, Slovenia and Turkey) fixed line penetration has overtaken that of the EU-15." should instead read: "In some countries (the Czech Republic, Estonia, Hungary, Slovakia, Slovenia and Turkey) mobile penetration has overtaken that of the EU-15."

EDITORIAL

Science and the Humanities – Bridging the cultural divide

Dimitris Kyriakou, *IPTS*

Maybe there will come a time when the twain shall meet... When it comes to science and humanities the "twain" have been far apart for the better part of the last two hundred years. Their drifting apart which began at glacial pace with the advent of the modern era and gradually picked up pace, and by the time C.P. Snow delivered his acclaimed lecture on the 'two cultures' in 1959, he was famously naming and diagnosing a condition which had long become chronic.

This lamenting of the gulf of mutual incomprehension between the two cultures, if not outright hostility and condescension, was appropriate in 1959 and is still relevant now. This gulf robs thinkers of countless possibilities of cross-fertilization between disciplines, and causes serious communication problems among them. This is further exacerbated by the time-honoured tradition whereby each discipline puts at the top of its agenda the creation of an internal jargon, largely impenetrable even to those disciplines closest to it.

In the context of policy-making and policy advice the problem manifests itself in the difficulty scientists from one side of the cultural divide often have in communicating with policy-makers from the opposite side.

It is therefore heartening to see that recently there are signs that the twain are meeting again, indeed in quite unlikely ways, such as using fictional devices to write about science. Examples include Imperial College Prof. Magueijo's "Faster than the speed of light", a novel of and about physics, putting forth, among other things, the claim that the speed of light is not necessarily constant; Berkeley University Prof. Papadimitriou's: "Turing: A novel about computation"; and 'The One True Platonic Heaven", a novel about quantum logic by Prof. John Casti affiliated with the Vienna Technical University. Perhaps the most striking example is cognitive scientist Dan Lloyd's new theory of human consciousness conveyed in the form of a novel (titled "Radiant Cool") accompanied, for good measure, by a long annex which spells out the theory in drier, non-literary terms.

This rapprochement does not come out of nowhere. Sometimes, by the time we identify and name a pattern of behaviour, it may be already receding. Soon after the seminal Snow lecture, some well-known scientists started breaking the implicit taboo on scientists writing for lay audiences. Biologists such as Gould, Watson, physicists such as Weinberg and Sagan published essays and books which proved both very popular and highly influential in shaping the ways of thinking of the public and of

The views expressed here are the author's and do not necessarily reflect those of the European Commission.

policy-makers. Some of these books became best-sellers, which added economic incentives for this rapprochement.

The bottleneck in extending the trend further has been the scarcity of scientists who can write well – bad (or at least, impenetrable and unappealing) writing seems to be rewarded in scientific journals. "The less attractive the writing, the pithier the message" seems to be the dominant credo. Dismissing good writing skills seems to be a rite of passage for many scientists – which harks back to Snow's cultural divide, with good writing being a 'humanities' skill, looked down upon by those on the other side of the rift. Even exceptionally good and influential writers and scientists, such as Princeton economist Paul Krugman, indirectly confirm the rule (tellingly, Krugman credits his attractive and lucid writing to the fact his first degree was in history, not in economics).

The more recent forays of scientists into the humanities is an extension of that trend and takes the rapprochement a step further: not simply popularising science for the lay public, but actually using literature as part of the scientific pursuit itself. Benefits from bridging this divide will accrue to science and to the pursuit of knowledge, enhancing it, as well as, indirectly its potential for boosting economic growth. There is another dimension of this however, which involves the interaction of policy-makers, scientists, the public, and the press as intermediaries. The further the rapprochement between the two cultures, the easier communication will be between all the actors concerned. A strengthened mutual respect for the skills and premises of each side, and a renewed emphasis by scientists on the written word as the building block of convincing narratives will make communication with the wordsmiths, the journalists reporting on science smoother. We are entering, however, here questions on which an entire future issue of the IPTS REPORT will be dedicated.

In closing, if the twain shall indeed meet, we may be coming full circle to what was standard practice a very long time ago, before the divorce between the two cultures set in. After all often the intellectual forefathers of today's scientists wrote in verse, as reading works by Empedocles or Heraclitus would confirm.

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4 Information and Communication Technology

Balancing Security and Privacy in a post-September 11 Technological world

Bernard Clements, Ioannis Maghiros, Laurent Beslay, Clara Centeno, Carlos Rodríguez and Yves Punie, *IPTS*

Issue: The increasing use of "subliminal" network interactions to track users and usage of the Internet, carries with it new risks to the privacy of personal data. It is important to manage the balance between individuals' freedom, as reflected in the protection of their privacy, and the needs of the state to maintain law and order through appropriate security policies; even more so since the tragic events of 11 September 2001.

Relevance: In a world where digital information and real information are intertwined, and risk, vulnerabilities, actors and devices are constantly changing, the role of technology– both as a driver of change and as a source of solutions– needs to be better defined. New policy measures will be required to improve the management of the consequences of such risks as well as a further understanding of the possibilities presented by current and future technologies.

In response to the terrorist threat, many governments have responded by strengthening security and gathering intelligence by means of mass surveillance systems

No matter what the outcome of the technological 'arms race' in the fight against crime, the human factor in achieving security is still by far the most important

Introduction

Trends in information society technologies will impact significantly on citizens' security and privacy, and particularly on the balance between them. The security and privacy implications of three emerging technologies: identity management, location-based services and virtual residence in an ambient intelligence environment are analysed. New policy measures are required to restore the balance in favour of privacy as these technologies, once implemented, will stretch the ability of current legislation to provide adequate personal data protection.

Moreover, in response to the threat of terrorism after the tragic events of 11 September 2001 many governments, and predominantly the US government, responded by strengthening security through a range of ambitious intelligence gathering programmes using mass surveillance systems. Steps were also taken there to improve EU and US legal cooperation and operational mechanisms in the areas of law enforcement and intelligence coordination.

This article refers to the findings of a report[1] analysing underlying technology trends and explaining how these may affect personal privacy and the security of the citizen and the balance between privacy and security. The report (IPTS, 2003) discusses privacy and security challenges posed by technology and identifies issues that policy-makers will need to address. Three examples of the application of identification technologies at various le-

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vels of development and commercialization, will be discussed below.

Security

The events of 11 September 2001 have led to a move towards an intelligence-gathering form of policing through the use of powerful mass surveillance technologies. In general, technology will transform both how crime and terrorism are perpetrated and new forms of control and policing will develop. However, no matter what the outcome of the technological 'arms race' in the fight against crime, the human factor in achieving security is still by far the most important. Even the tightest security controls may be undermined through appropriate social engineering or human negligence.

In this new environment, the impact of surveillance technologies should be carefully assessed with regard to their efficiency, and because they generate sensitive data. In some cases the benefits of technology may not outweigh the costs given the level of risk and the results delivered. Additionally, surveillance systems are themselves vulnerable to misuse and can be turned to purposes other than those for which they were originally intended (i.e. the identification and tracking of crime and terrorism). The potential for misuse by third parties will become more significant as surveillance activities spread among commercial organizations. So-called "little brother" type surveillance of both clients and employees, and individuals such as parents watching over children or baby-sitters with web cams, will raise important privacy invasion issues.

In general, more appropriate surveillance mechanisms will result from better impact evaluation of the costs and benefits of technological monitoring, and public education on the results, assessing the proportionality of anti-terrorist measures (i.e. how much more privacy invasion will result in more adequate protection) and their possible side-effects (regarding convenience and probable financial impact), as well as audit-tracking of the implementation processes. The displacement of crime and terrorism towards less closely monitored areas, the globalization of crime, and the impact of technological developments on criminal and terrorist activity also need to be considered when defining efficient security mechanisms.

A further question is whether the balance of responsibility lies with the citizen or the state. Citizens have an individual responsibility (e.g. to be vigilant as individuals and to secure their own private or commercial property). An increasing number of private firms are, in fact, operating their own surveillance systems. However, the state seems to be better placed to aid in the collection and evaluation of data on risks and communicate them to citizens where appropriate. Since a large share of the required data is in the hands of commercial entities, public-private relationships need to be developed to ensure that security authorities can access and evaluate them without unduly compromising privacy, something that will require some adaptation of the legal framework. This is a tricky issue since there is not much consumer pressure or economic incentive for firms to address this point.

Privacy

The multiple identification and authorization processes involved in Internet transactions lead to a growing quantity of personal information being collected and stored in an ever greater number of information systems, with a consequent increase in the risk of privacy abuse. Data collection, data aggregation and data mining carried out by third-party organizations, and their use for marketing purposes, also contribute to increased privacy invasion. Moreover, privacy abuse not only follows what some would claim to be a familiar pattern of

The displacement of crime and terrorism towards less closely monitored areas, the globalization of crime, and the impact of technological developments on criminal and terrorist activity also need to be considered when defining efficient security mechanisms

The multiple identification and authorization processes involved in Internet transactions lead to a growing quantity of personal information being collected and stored in an ever greater number of information systems

The current data protection framework does not envisage invasion of privacy "horizontally" by agents other than governments, such as employers or other people

governments and other public sector institutions utilizing privacy-invasive procedures; the private sector and, in a new trend, other citizens are increasingly the perpetrators of such abuse.

The legal framework (whether at local, national or international level) has in the past protected –and continues to protect– citizens from the abuse of their personal data. Both privacy and data protection tools guard individuals against excessively invasive measures by governmental authorities or private actors. However, there are a few issues that are not fully covered by this type of protection. One of them is the problem of the 'horizontal effect' of contemporary human rights, meaning in this context the threat to privacy posed by the actions of employers, firms or other citizens, not just governments. Citizen rights are in fact better protected against governmental infringements than they are against infringements from other citizens or from the private sector. Also in the case of individuals trading their privacy for perceived commercial benefits, the protection offered by current EU legislation could be strengthened.

Technologies are available to allow individuals to protect their privacy. However, these may come into conflict with security concerns, and so far appear to lack a viable business model

Identity-related technologies will enable citizens to manage security and privacy risks and as such will become an essential part of communicating via the Internet

Location computing technologies combined with 'always-on' mobile broadband connections will enable the provision of Location-based Services (LBS) that will be attractive to consumers and provide useful revenues to operators

Current legislation defines a category of data referred to as 'sensitive data' which receives a higher level of protection, although all data (even ordinary data such as names or addresses) are also protected. However, in cases where a specific technology is used in such a way as to render the protection of the data processed inadequate, then specific legislation, usually of a strictly limiting type, is drafted so as to envisage potential abuse or misuse. For example, although the processing of DNA samples is completely covered by the Data Protection Directive, the serious implications of any unauthorized access to the information content of DNA samples is such that additional specific measures are deemed necessary. Thus Member States have decided to supplement the general Data Protection Directive with specific prohibitive clauses on the use of this technology and the data it produces. In concert with the legal measures in force in Europe, technology has a complementary role to play in protecting against privacy abuse. Emerging technologies called Privacy Enhancing Technologies (PETs) are being employed to stem the erosion of privacy discussed above. These frequently go hand-in-hand with security technologies, given that the protection of privacy-sensitive data in transit or in storage needs adequate security mechanisms. There is an inherent tension between privacy and security. It is anticipated that the development of PETs will be widespread, especially in the areas of data minimization, privacy preferences and identity management systems. However, there is currently limited market demand for PETs due to their development costs and lack of a viable business model.

Technology Areas affecting Privacy and Security

While technologies can be used to invade privacy, they can also help enhance protection of personal data and increase transparency in security processes. The following three specific areas involving the application of new and emerging technologies were selected for an analysis of the extent to which they each compromise the traditional balance between security and individual privacy:

- **Identity-related technologies**, which enable new ways of defining and expressing identity. These include identity management systems (IMS), radio-frequency based identity devices (RFID) and biometrics;
- **Location-based Services**, in which mobile communications devices, typically mobile telephones, are used to provide services to users based on where they are located at a particular moment (near restaurants or shops, for example);
- **Ambient Intelligence technologies**, including the concept of 'virtual residence'. Work on these technologies is at the forefront of IST re-

search in the Sixth EU RTD Framework Programme, and if successfully implemented, they promise to bring radical changes to future working and living patterns.

Identity-related Technologies

Identity-related technologies will enable citizens to manage security and privacy risks and as such will become an essential part of communicating via the Internet for whatever purpose. The digitization of identity may be regarded as a bottleneck to the engagement of citizens with Information Society services because without it there is effective exclusion. Ironically, exclusion provides the only real privacy protection for the citizen, and this might exacerbate any reluctance on the part of citizens to embrace identity technologies. Multipurpose and multilateral Identity Management Systems reflect security and privacy needs that are closely intertwined. Discussions as to which architectural designs would encompass all beneficial characteristics are on-going, as are discussions related to which regulatory environment would be most conducive to their widespread adoption. Optionally, such systems could also make use of biometric technologies, which enhance security but raise additional privacy concerns, and still pose some technological challenges in terms of their implementation.

While an appropriate legal framework would facilitate the greater diffusion of identity management systems, there are reservations about how reliable their widespread usage would be. Early experience has shown that the larger the size of the user group to which the system is applied, the greater the number of errors in its functioning. Convenience is yet another factor that inhibits adoption as the reliable use of identity management systems requires certain additional conditions; the stronger the security required, the more time-consuming the process is. Finally, in the longer term, new less intrusive –and even invisible– systems (such as radio-frequency based identification, bio-implants or DNA sniffers) will deserve particular attention as they raise a new set of security and privacy issues regarding both off- and on-line identification.

Location-based Services

Location computing technologies combined with 'always-on' mobile broadband connections will enable the provision of Location-based Services (LBS) that will be attractive to consumers and provide useful revenues to operators. However, they will also have a substantial impact on the security/privacy balance for the citizen. It is important to note that there are obvious benefits, in terms of enhanced security, in being able to know where a person is at any particular time. Emergency services may be provided more efficiently or vulnerable individuals may be tracked in real time to ensure their safety. However, the vast majority of usage will be for commercial services and will thus expose users to the risk of unauthorized access to data from which their personal movements and habits can be deduced. The ability to make such inferences can be enhanced by the use of data mining and data surveillance techniques which combine data from different sources in order to draw conclusions on personal behaviour way beyond those implied by the location data itself. The ability to infer citizens' behaviour by combining data from different sources represents an important vulnerability for privacy, the implications of which policy-makers and law enforcement agencies may need to consider. In addition, the number of actors having access to and making use of citizens' location information is increasing, mainly with a view to their providing new value-added services. This also introduces new privacy risks.

In developing policies to address these issues, a number of fundamental questions need to be con-

Ambient intelligence consists of an environment in which people will be surrounded by intelligent intuitive interfaces embedded in all kinds of objects. The way in which such an environment tracks and responds to individuals inevitably raises privacy issues

The aim here is not to define an optimum point of equilibrium for the privacy/security balance but rather to highlight the fact that the balance established over years of democratic process is changing

A further factor that has helped tip the balance in favour of security interests and away from privacy protection is the increasing use of technology by market agents to collect and process personal data for profit

About the authors

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sidered. These include the ownership of user location data and the legal meaning of consent in this context. Should regulation allow the so-called push model of added-value service provision (i.e. provided without an explicit request) rather than one based on a specific or general user request? Another set of questions relate to data retention and what kinds of data law enforcement agencies should be legally permitted to use.

Ambient Intelligence Technologies and Virtual Residence

The concept of Ambient Intelligence provides a wide-ranging vision on how the Information Society will develop. The emphasis is on greater user-friendliness, more efficient service support, user-empowerment, and support for human interactions. In this vision, people will be surrounded by intelligent intuitive interfaces that are embedded in all kinds of objects. The overall Ambient Intelligence environment (referred to in the jargon as "AmI Space") will be capable of recognizing and responding to the presence of different individuals, and will work in a seamless, unobtrusive and often invisible way. This vision, although still far from being a reality, calls for a new security paradigm and for new privacy measures. The new environment will blur the traditional boundaries between private and public domains. Ambient Intelligence is a prime example of the trade-off between safeguarding personal data and obtaining the benefits of technology. Indeed, it depends for its successful functioning on the widespread adoption by citizens of these technologies and acceptance of the underlying tradeoffs.

The concept of Virtual Residence is an important starting point for identifying future security and privacy needs in the new environment. Virtual Residence is the smart connected home of the future and its critical domestic infrastructure, as well as the citizen's life on-line and on the move. Like the physical residence of the real world, the individual's virtual residence will require suitable legal protection. The areas of that protection will include the security of critical domestic infrastructure; the type and content of the personal data that will need to be exchanged; and the legal definition of an individual's private 'digital territory'.

The Balance between Security and Privacy

Even before September 11 the security/privacy balance was being altered by the increasing capabilities of the existing technology, the rising incidence of cyber-crime and the lack of an internationally accepted legal and policy framework. Within the numerous fluctuations in the balance in favour of more security and control, either as a result of new technology or simply as a result of post September 11 policy initiatives, two main kinds of security measures may be distinguished:

- Privacy-invasive measures arising directly out of counter-terrorism initiatives. These measures are responses to an immediate need for a safer environment, and should therefore be limited in terms of time and scope (adapted to the threat not the threat perception). However, their efficiency needs to be carefully evaluated.
- Measures which will facilitate development of the Information Society. These should endeavour to strike an appropriate longer-term balance between security and privacy. Some rebalancing actions in favour of privacy may be required to achieve this, although it is difficult to imagine that combating terrorism will not also have a long-term effect.

As already noted, another factor that has helped tip the balance in favour of security interests and away from privacy protection is the increasing use of technology by market agents to collect and process personal data for profit. However, the aim here is not to define an optimum point of equili-

brium for that balance but rather to highlight the fact that the balance established over years of democratic process is changing, to assess the potential impact of this change, and to identify factors that could help redress the balance. It still remains to be seen what role technology could play in the design of security measures that deter data misuse or abuse. For example, by announcing the location of surveillance cameras in public places, the monitoring instrument works equally as a deterrent and as a surveillance mechanism.

An important contributory element to the rebalancing mechanism could be provided by new regulations and enhanced educational policies. In many cases, privacy abuse is the result of a lack of knowledge and education on the use and potential effects of new technologies. More awareness and control on the potential side effects of new technologies could minimize these risks. The current regulatory framework for privacy protection will need continuous review to take account of the effects of new technology, but the mechanisms are already in place to enable this to happen. On this basis it can be argued that the current framework is adequate and future-proof.

Policy Issues

The evolution of technology and its capabilities is continuous and rapid, so achieving a suitable balance between security and privacy inevitably means aiming at a moving target. A number of examples of emerging technologies and their applications have been looked at here in the light of this balance. The three examples given above have been chosen because they are associated with inherent security/privacy risks –although there is scope for policies to influence R&D in certain directions – it is the implementation and use that is made of technology, once available, that most affects the security/privacy balance. Analysis of the examples described here allows us to highlight a number of policy issues, which are listed below.

- **Human factors, education and awareness.** Human factors, in addition to technology, are an important part of combating crime and terrorism, and are accompanied by the need to educate and raise the awareness of citizens.
- **Identity Theft.** Identity theft in the real and virtual worlds is already a growing problem and appropriate safeguards need to be introduced. The risks are exacerbated by current commercial practices which encourage consumers to trade their identity in exchange for commercial benefits, as well as a lack of harmonized regulation at a European level.
- **'Digital Evidence'**. The need for development, standardization and diffusion of new digital evidence tools. There is a need to establish these methods for their use and legal acceptance in legal proceedings and before a court of justice, as well as to ensure an acceptable level of efficiency in crime prosecution processes, including the need for accountability and transparency in carrying out these processes.
- **Private-sector Databases.** The increasing use of private-sector databases by law enforcement agencies (both for prosecution and for profiling-based crime prevention) has brought to light the lack of harmonized regulation in Europe regarding the maintenance of these databases, their integrity, accuracy, security and protection.
- **Incentives for the Private Sector.** The business case for the private sector to develop and adopt privacy-compliant and privacy-enhancing as well as security-enhancing products, is not obvious. The reasons include the significant costs involved, a lack of consumer awareness and demand, and the complexity of installation and use. This is an aspect of market failure that could justify regulatory intervention.
- **'Horizontal Effects'.** The current EU privacy regulation lacks *horizontal effect,* meaning that it is impossible for citizens to lodge a complaint against other citizens, their employer or a

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Clara Centeno has degrees in Telecommunication Engineering and Business Administration. After more than ten years working on the electronic payments business and technology fields across Europe, she has been working at the IPTS since May 2001 as a researcher on ICT policy related areas. Her current areas of research are Cybersecurity, Consumer Trust, and Foresight on Information Society Technologies in the Enlarged EU.

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commercial organization (business) based on Article 8 of the European Convention for the Protection of Human Rights and Fundamental Freedoms.

- **Checks and Balances.** There is a need to have mechanisms to "watch the watcher", whether governmental, law enforcement or private organizations, in order to preserve citizens' privacy.
- **Private-public Sphere Indicators.** The lack of private-public sphere indicators in the Information Society and the need to legally define the private digital territory (what has been referred to here as a "virtual residence") in order to facilitate a greater acceptance of the information society technology environment.
- **Technology-specific regulation.** The threats posed by certain new technologies may give rise to specific regulation in cases where the general privacy and/or data protection provisions are deemed insufficient.

Conclusions

The rapid emergence of the information society in Europe and the intensifying use of existing and new technologies calls for the continuous observation and assessment of the balance between privacy and security and the associated risks, as well as a more proactive integration of new technologies under the umbrella of the existing regulatory framework, backed up by an evaluation of the potential need for specific regulatory action. There is also a growing recognition of the need to promote best practices and standards in this area, as well as the continuous assessment of emerging technologies for their security and privacy implications. One way to carry out these functions would be through the creation of a European observatory of identity-related technologies used in different network environments (Internet, mobile, Ambient Intelligence Space).

About the authors

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Yves Punie holds a Ph.D. in Social Sciences from the Free University of Brussels (VUB). His doctoral thesis was on the use and acceptance of ICTs in everyday life, also known as 'domestication of ICTs' (June 2000). Before joining the IPTS as a post-doc researcher in May 2001, he was a senior researcher at SMIT (Studies on Media, Information and Telecommunication, VUB). His main project is on the future of domestic new media technologies.

Keywords

identity, security, privacy, identity technologies, location-based services, ambient intelligence space, virtual residence, policy options

Note

1. A report prepared for the European Parliament by the European Commission's Joint Research Centre (JRC) analysed the security and privacy implications of three emerging technologies: identity management, location-based services and virtual residence in an ambient intelligence environment. A copy of the report may be downloaded from: **http://www.jrc.es/home/publications/publication.cfm?pub=1118**

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New Technologies and New Migrations: strategies to enhance social cohesion in tomorrow's Europe

Antonio López Peláez, *UNED-GETS* and Miguel Krux, *VDI-TZ*

Issue: The organizational, economic and technological changes that have taken place in recent decades have created new challenges for social cohesion in European societies. These challenges are shaping trends in the job market, with the emergence of new opportunities and patterns, and call for a different approach to the integration of the European Union's immigrant populations.

Relevance: The analysis of occupational trends in the short, medium and long term may allow action to be taken regarding the development of permanent training to reduce the mismatch between labour requirements and the skills offered by workers. In addition, were appropriate, strategies to bolster immigrants' ability to integrate with their host societies could be developed.

Introduction

The new opportunities and risks that the European Union needs to confront in its efforts to reconcile economic progress with enhanced social cohesion (given the distinctive features of the welfare state, and in particular, of the European model of development over the last forty years), are defined in part by the phenomenon of migration, a phenomenon that has become more noticeable in the last few decades (SOPEMI, 2002, p. 13). According to Castles and Miller, the principal trends that have characterized migrations during this period are globalization, diversification, acceleration and an increase in the number of female migrants. To these trends should be added a technological and organizational transformation is changing the context of opportunities in the job market (López Peláez, 2003a).

It is important to point out that, contrary to the position held by "technological determinists", the 'new technologies' do not unilaterally determine the society or the economy. Technology is rather a *social product* that simultaneously generates a collection of *limitations* and *possibilities*. "The analysis of its historical evolution, as well as its tendency toward future development, points to the debate regarding the social models from which it is created and applied, and to those models which technology transforms and configures. Technological transformations can fulfil, but can

Recent trends in migration are characterized by globalization, diversification, acceleration and an increase in the number of female migrants

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Technology should be viewed a social product that simultaneously generates a collection of limitations and possibilities, rather than unilaterally determining the path taken by society or the economy

The pattern in northern Europe, where there is already a second generation of immigrants, tends to be to restrict controlled immigration to individuals with specific job skills

In countries where immigration is a relatively recent phenomenon, a large proportion of immigrants work in low-skilled, poorly paid jobs

also damage, our means of subsistence and institutions" (López Peláez, 2003 b: 403). In this regard, some of the characteristics observable in recent changes in Europe's societies, such as the increasingly precarious or temporary nature of work, the widening of income differentials, or the new psycho-social risks within the field of health and safety at work, can be increased or decreased according to the socio-technological model applied (López and Krux, 2002).

This article takes a look at some of the main occupational trends foreseen by experts over the next few years, along with trends in changing working patterns resulting from the implementation of new technologies in all sectors of the economy. The conclusions allow us to sketch out various educational actions that could potentially enable a closer match between the jobs offered and the skills of workers seeking work, thereby enhancing social cohesion, which is one of the main goals of European policy in this field.

Two models for managing migratory flows in the European Union

In the countries of the European Union we currently find two different models of integration of the immigrant population, which are to some extent shaped by the opportunities offered by the job market. In those countries where there is already a second generation of immigrants, such as the countries of northern and central Europe, selective immigration policies are being applied, favouring workers who are qualified in new technologies, public health, and other areas where there is a skills shortage among the native population (as in the case of recruitment of IT professionals in Germany, or of medical personnel in the United Kingdom) (OECD, *International Mobility of the Highly Skilled,* 2002). According to data from the OECD, this phenomenon was accompanied, in the year 2000, by a reduction in the total number of migrants to certain countries such as Germany, Austria, Norway and Sweden (SOPEMI, 2002, p. 17-18).

However, the countries of southern Europe, especially Spain, Portugal and Greece, have witnessed a significant increase in immigration since the late 1990s (SOPEMI, 2002, p. 18). Portugal, Greece and Spain have initiated unprecedented legalization programmes, and in just a few years the total number of legal immigrants has reached 1,500,000. Increasing numbers of migrants have taken up low-skilled jobs in agriculture, construction, the restaurant industry, or domestic services. In Spain, for example, the immigrants primarily work in domestic service, agriculture and the hotel industry. Percentages similar to the average in OECD countries may be observed in construction, commerce or education; and its percentages are clearly lower in the fields of medicine, industry or public administration. Thus, "the profile of the Spanish case resembles something that currently exists in the countries of southern Europe, and differs markedly from the situation that exists in nations located in the central and northern parts of the continent" (Group Ioé, 2002: 105). Resorting to importing low-cost manual labour so as to allow employers to be more competitive by keeping salary costs down goes hand in hand with a job market in which there is an increase in temporary work, irregular employment and a black market (Tezanos, 2001).

In both cases some adverse effects of the strategies adopted can be observed: in the case of countries that only acknowledge a shortage of qualified personnel, by allowing only these qualified people to enter the country they are obliging the remaining low-skilled workers who also need to benefit from the economy to enter by irregular means. In the case of southern European countries (Izquierdo, 2003: 33-39), resorting to low-cost manual labour (in spite of the fact that in many cases these workers possess qualifications obtained

in their country of origin), increases social polarization, diminishes social cohesion, and cannot be sustained in the long term within an economic context characterized by rapid technological change.

Migratory flows in the context of technological change

Both from the viewpoint of the establishment of selective migratory policies in the country of origin, as well as of the establishment of educational policies that make it possible to adapt the population's skills to the new opportunities in the job market, it is necessary to consider trends in the employment structure of the European Union. One important factor in this evolution is the impact of new technologies on work. In this regard, the findings of research into the impact of new technologies on the labour market supports neither the view of optimists who see technology as 'manna from heaven', or the doomsayers who predict the end of work. Instead, it shows us a complex and changing reality in which jobs requiring high, medium and low levels of skills and qualifications co-exist. This reality must be kept in mind when designing programmes for the integration of immigrants to the European Union. The final objective, as highlighted in the European Commission's report "Employment in Europe 2002. Recent trends and prospects" (European Commission, 2002), is that changes in European employment will allow for an increase in social improvement and regional cohesion.

To ensure that the revolution in technology, organization and production can be balanced with maintaining social cohesion it is necessary to evaluate the characteristics of current and future employment. For example, new Information and Communication technologies, together with robotics and advanced automation, imply a redefinition of the tasks and training requirements demanded of workers. It should be borne in mind that the migratory phenomenon in the EU needs to be understood within the context of various factors, such as the much debated "demographic deficit', but we must also be conscious of the fact that the European economy is undergoing rapid and far-reaching automation, to the extent that it has become a world leader in the incorporation of robots and work automation systems in the last few years (IFR, 2002: 27-33). In the next few years, the types of work available will be redefined, not only as a result of the aging of the population, but also according to technological and organizational transformation.

According to the results of a Delphi study by the *Grupo de Estudio sobre Tendencias Sociales* (GETS) entitled *Estudio Delphi sobre Tendencias Científico-Tecnológicas 2002,* the main impacts likely to result from the expansion of the new information and communication technologies over the next few years, and from the systems of automation and robotics, are new demands for technical qualifications and permanent training both within companies (table no. 1) and in society at large (table no. 2). These forecasts agree with those of other research carried out in the EU, stating that: "Globalization, rapid technological progress and the advances of the knowledge economy and society demand increased efforts to raise skill levels for all" (European Commission, *Employment in Europe 2002*: 9).

In the Delphi study the experts distinguished four main dimensions to the societal impacts of technological change over the next ten years: firstly, improvements in working conditions, and the performance of dangerous or heavy tasks by robots; secondly, an overall increase in workers' qualifications, in particular to match the new demands of automated companies; thirdly, improvements in the quality and price of goods and services (reduced costs, optimization of production,

Both models have their drawbacks: limiting legal immigration to skilled workers encourages the unskilled to resort to irregular means of entry, while limiting immigration to the unskilled results in qualified immigrants taking up unskilled jobs

Technological change is transforming the job market in complex ways. Although the types of jobs on offer may change over time, opportunities continue to exist in high-, medium- and low-skilled categories

Increased automation has been identified as one of the main drivers of change in the employment market over the medium term. While this will eliminate many dangerous or laborious tasks, it will require new skills from workers

Table 1. Main impacts of automation on company organization

Impact	Value	Weighted value
Need for personnel with advanced technical qualifications: specialized workers, highly trained in automation and robotics.	17	66
Higher level of importance of permanent training: substantial increase in training activities and in re-training of employees.	16	53
Increase in quality and productivity: greater dedication by all workers to improving quality, reducing costs and boosting profitability.	15	58
A higher level of safety in the workplace: fewer risks and injuries for workers, and a drop in the number of work-related accidents.	12	35
Decrease in direct manual labour, and an increase in indirect manual labour.	10	27

(1) Cited in first place, 5 points; second place, 4 points; third place, 3 points; in fourth place, 2 points; and in fifth place, 1 point.

Source: GETS (2003): Estudio Delphi sobre Tendencias Científico-Tecnológicas 2002, Sistema, Madrid.

greater reliability of industrial processes, and reductions in price, together with increased product quality), i.e. the productivity of the entire economic system will increase substantially; and, finally, inequalities are forecast to increase both within and between continental blocs.

New opportunities for immigrants to the European Union

Extrapolating from the trend seen over the last few years, the forecast work structure for the next few years seems to reveal a polarization between those jobs requiring advanced qualifications and offering substantial financial rewards, and unskilled, low-paid jobs, some of which will tend to be replaced by automated systems in some sectors of the economy. If we analyse projections regarding occupations that will offer a large volume of employment in the United States during the next ten years (table no. 3), we see the polarization just mentioned. Along with systems analysts, the occupations that will offer the greatest number of jobs in the US economy will be salespeople in the retail sector and cashiers.

Forecasts extrapolated from the results of the GETS Delphi study suggest that over the next ten years there will be an increase in employment in information technology, the life sciences, medicine, health, financial services, and management. There will also be increased demand for caregivers for the elderly over the next few years. A reduction is, however, forecast in the volume of jobs for semi-skilled workers and machine operators in the mineral extracting industries and in construction, as

Table 2. Main impact of automation on society as a whole

Impact	Value	Weighted value
Decrease in laborious or dangerous tasks carried out by people	15	54
Increase in the qualification levels of employees	14	53
Substantial improvement in the quality and price of goods and services offered (lowered costs, optimization of production, greater reliability of industrial processes, reduction in price together with greater product quality)	11	52
Substantial increase in production throughout the entire economic system	11	30
Increase in trans-national differences, especially continental (north/south)	10	24

(1) Cited in first place, 5 points; second place, 4 points; in third place, 3 points; in fourth place, 2 points; and in fifth place, 1 point.

Source: GETS (2003): Estudio Delphi sobre Tendencias Científico-Tecnológicas, Sistema, Madrid.

Table 3. Occupations that will provide a high number of jobs in the United States

Projections for 1998-2008	Growth in the number of jobs (thousands)	Growth %	General range of growth percentage
Systems analysts	577	94	Very high
Salespeople (retail)	563	14	Low
Cashiers	556	17	Low
Managers and high-level executives	551	16	Low
Drivers of heavy and lightweight lorries	493	17	Low
Office workers	463	15	Low
Nurses	451	22	Intermediate
Computer support specialists	439	102	Very high
Professional caregivers and domestic help	433	58	High

Source: Douglas Braddock (1999): Occupational employment projections to 2008, Monthly Labor Review, November 1999, p. 73.

well as machinists and assembly workers, office workers, agricultural workers and qualified farm workers, artisans and graphic artists, low-skilled sales and service workers, and unskilled labourers.

Strategies to enhance social cohesion in the European Union

The jobs available for the EU's immigrants will depend on social models from which new technologies are developed and applied. Thus, historical analyses, together with experts' forecasts, allow us to identify a model of the emerging labour market not shaped by 'technological determinism', (which forecasts an increase only in jobs for highly skilled workers, and therefore tends to reinforce migratory policies biased in favour of qualified workers). At the same time it also differs from the model that ignores the expansion of new technologies (and establishes a migratory policy based on the use of unskilled manual labour to enable competition on the basis of low salaries).

From the forecast impact of the new technologies on the work situation over the next few years, appropriate training strategies could be put in place

While opportunities in IT, health, and financial services are expected to increase, fewer jobs are forecast for office workers, and semi-skilled and unskilled manual workers

Table 4. Evolution of occupations around the year 2010

Occupations that will increase in number between years 2000 and 2010	Occupations that will remain the same between years 2000 and 2010	Occupations that will experience a reduction in numbers between years 2000 and 2010
professionals (physics, chemistry, mathematics, and information technology engineers)	Teaching professionals	Office workers
High level professionals in the life sciences, medicine and health	Specialists in business administration and organization, law professionals, file clerks, librarians, documentalists, specialists in social and human sciences	Agricultural workers and qualified farm and fishing industry workers
Professionals in financial services, sales, and administrative services	Teachers (mid-level)	Semi-skilled and other workers in metallurgy, mechanical construction and related fields
Mid-level professionals in biology, medicine and health	Service workers and retail salespeople.	Precision mechanics, artisans, graphic arts workers and similar
Directors and managers	Semi-skilled workers and workers in the mineral extracting and construction industries	Low-skilled sales and service workers
	Installation and machine workers, and assemblers	Unskilled labourers

Source: GETS (2000): Estudio Delphi sobre Tendencias Ocupacionales, Sistema, Madrid.

Offering training to match forecast future demand is one way of enhancing the integration of current and future migrant workers

Table 5. New migrations and education: strategies to integrate migratory flows in the European Union in the 21st century

Strategies to integrate migratory flows in the European Union in the 21st century
Education and the job market
Taking as a reference the *technological and organizational evolution* of the European economy for the development of educational policies, insisting on the highest technical qualifications.
Establishing agreements to *train and select* the workforce in their countries of origin, according to the needs of the job market and its foreseeable development in the near term.
Establishing agreements that will allow for the *recognition* of educational levels acquired in the country of origin, as long as they meet the quality criteria set for the European Union.
Establishing programmes of *continuous training* for workers with low and medium levels of training, with timetables that are compatible with work schedules, both at the company level as well as at educational institutions.
Education and social cohesion
Developing *educational programmes* for children of foreign workers, whether or not they are legal residents.
Establishing educational resources to reduce levels of inequality by increasing the *human capital* of the immigrant population.
Developing programmes of *for training women* so as to allow them to join the job market under more favourable conditions.
Education and social mobility
Undertaking research to determine the *training needs* of the groups of immigrants, establishing specific programmes that will allow them to become better integrated.
Determining available employment and the qualifications needed in order to *avoid* the irregular incorporation of manual labour without standardized qualifications.
Setting up free basic educational programmes through agreements with public educational institutions (and, when possible, running programmes at companies) so as to *prepare* untrained immigrants for the job market.
Promoting legalization of those workers who are illegal residents but who can prove that they have completed educational programmes of the type just mentioned.
Setting up on-going training programmes to equip immigrants with better *technical skills*.

to enhance the integration of migrants to advanced societies over the coming decade. As the ILO puts it: "the greatest risk is perhaps the exclusion of the untrained" (ILO, 2001: 19). The experts' forecasts point to a scenario in which the implementation of new technologies, under present dominant models of understanding and running the economy, may favour the dualist and exclusivist trends, which have already been pointed out by various international organizations (ILO, 2001: 109). From the perspective of this article, a greater degree of work automation, together with some greater educational demands, make it essential to establish appropriate training strategies that will allow for an improved integration of the migrant population to the EU (table no. 5). In our view, training policies need to be developed to help avoid two dangers. The first danger consists of believing that there will only be an increase in demand for highly qualified workers. This could lead to the establishment of selective migratory policies which will not take into account the needs of, or need for, less qualified workers in various sectors of the economy. Selective policies of this kind could have the unintended consequence of leading to a growing number of irregular immigrants taking jobs in some sectors of the economy. The second danger consists of developing a model of importing unskilled manual labour so as to enable industry to compete on the basis of cheap labour, which could produce a higher level of unemployment in the population migrating to the European Union whose level of education is inadequate to enable them to cope in the context of accelerated technological change. In the face of both risks, and in order to increase the social cohesion and welfare of the population as a whole, educational strategies in the country of origin as well as in the European Union could allow for an increase in the qualifications of the workforce, thereby improving individuals chances of entering the job market.

Keywords

Delphi Study, technological trends, migratory flows, social cohesion, educational strategies

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Land Area Requirements to Meet the Targets of the Renewable Energy Policies in the European Union

Boyan Kavalov, *IPTS*

Issue: There are various different renewable energy sources which can play a role in ensuring the security and diversity of the European Union's energy supply in an environmentally-friendly way. Amongst them, biomass is regarded as being particularly promising, since it has significant unexploited potential in Europe.

Relevance: The European Commission (EC) has set three indicative targets for the use of renewable energy sources (RES) in the EU. One of the RES likely to play an important role in achieving these targets is biomass. However, the absolute availability of land sets an objective upper limit on its potential. Since the available land has a number of other important applications, the use of biomass for energy competes with and depends on them.

Increasing the share of energy derived from renewable sources is a key element in Europe's strategy to diversify its energy supply and reduce greenhouse gas emissions

A variety of renewable energy sources could contribute to achieving the EU's targets. In particular, wind-power and biomass are considered to have significant growth potential in the next few years

Introduction

Renewable energy sources have come to be seen as having an important role in enabling the EU to diversify its energy supply while also cutting greenhouse gas (GHG) emissions, given their contribution to global warming. In this context, over the past few years the European Commission (EC) has set three indicative targets for renewable energy in the EU:

- 2% of all petrol and diesel sold for transport uses is to substituted by biofuel by 2005, rising to 5.75% in 2010 (Directive 2003/30/EC). In effect, these targets apply exclusively to road transport, since rail, water and air transport use other fuels and/or sources of power.
- 22.1% of electricity is to be generated using renewable sources by 2010 (Directive 2001/77/EC). If the target includes the 10 New Acceding Countries (NAC), the combined EU target drops to 21%, due to negotiated lower targets for NAC than those for the current 15 EU member states (EU-15).
- 12% of gross inland energy consumption (GIEC) to come from renewable sources by 2010 (EC, 1997).

There are several renewable energy sources which could contribute to these targets, such as hydro and geothermal power, photovoltaic, wind power and biomass. Of these sources, only the last two are expected to have a significant potential for

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further expansion between now and 2010. Wind power is well suited for electricity generation, but its contribution to transport is likely to be modest, being limited mainly to powering grid-dependent vehicles such as electric locomotives, metros, trams, etc. Biomass can be employed as a feedstock for producing transport fuels and as a cofiring fuel for combined heat & power (CHP) generation.

In theory, it is possible to expand wind power capacity yet further by building additional generating capacity, e.g. offshore. However in practice, beyond a given limit, this is no longer economically feasible. In contrast, absolute land availability always places an upper limit on theoretical biomass potential. Unlike wind, however, in practice the economically feasible bio-energy potential is further constrained by competition with other land uses. A secure food supply is a core element in the EU's agricultural policy. Thus, a substantial part of the available land is, by definition, reserved for this purpose. In this context, the CAP regulations are also intended to ensure reasonable incomes for farmers. Non-food and non-energy land uses (flowers, plants used to produce ingredients for the pharmaceuticals industry, timber for construction, etc.) are generally higher value than bio-energy production, thus better positioned to compete for land. Taken together, these reasons mean that the feasibility scenarios about reaching the renewable energy targets are far more constrained by biomass availability than by wind potential.

The potential of the various biomass alternatives

There are several types of biomass feedstock that can be utilized for energy purposes:

- Oilseeds (rapeseed, sunflower, linseed, etc.). The vegetable oils they produce can be converted to biodiesel for transport use. This process also generates large amounts of straw, which can be used as a cofiring fuel for CHP generation.
- Starch crops (wheat, maize, sugar beet, potatoes, etc.) which can be fermented to produce ethanol. This process also creates large quantities of straw and other bio-waste, which can be either employed in CHP generation, or converted to ethanol using other technologies (currently at the experimental stage).
- Ligno-cellulose crops (grasses, fast growing trees, wood and wood residues, etc.), which can be used for ethanol production, synthetic (Fischer-Tropsch, or F-T) biodiesel or as for cofiring in CHP boilers.
- Biodegradable waste from households, animal manure, etc., which can be used to produce biogas. The gas produced is methane and has similar properties to fossil natural gas and can therefore be used for same applications, e.g. transport fuels (directly or converted to F-T biodiesel, bio-methanol, bio-hydrogen, etc.), CHP or electricity generation.

Each type of biomass feedstock has its strong and weak points, which make certain types of feedstock better suited to some applications than others. In practice, however, the energy yield per hectare (Figure 1) is not the only criterion on which to assess the utility of bio-feedstock.

Some plants also yield protein meal, which can be used as animal feed, others fit well into crop rotation schemes, etc. Therefore, the choice of crops is normally set within the broader framework of the agricultural economy and environmental concerns, rather than simply being a matter of selecting the highest yielding crop(s).

Meeting the indicative transport biofuel targets

The 2% indicative target for transport biofuel in 2005 is generally regarded to be relatively easy to meet. However, the 5.75% target for 2010 appears to be much more ambitious, since it will

Expanding wind power capacity further will largely depend on building wind farms offshore

The upper limit on the potential of biomass as a renewable source of energy is competition with other land uses

A number of different biomass feedstocks can be used as a source of energy. These include oilseeds, starch crops, lignocellulose crops and biodegradable household and other wastes

Figure 1. Average energy yield from different bio-feedstock

	Transport fuel	Other energy products
Oilseeds for biodiesel (IPTS, 2002a)		
Rapeseed	45-50 GJ/ha	40 GJ/ha
Sunflower	27-30 GJ/ha	quantity unknown
Starch crops for ethanol (IPTS, 2002b)		
Sugar beet	133-157 GJ/ha	limited
Potato	96 GJ/ha	limited
Wheat	25-62 GJ/ha	50-100 GJ/ha
Ligno-cellulose crops		
Agricultural waste	1 GJ/t (IPTS, 2002b)	9-16 GJ/t (Oak Ridge)
Woody biomass	55-77 GJ/ha[1] (GAC, 2003; IPTS, 2002b)	110-165 GJ/ha[2] (GAC, 2003; Oak Ridge; IPTS, 200b)

Each type of biomass feedstock has its own strengths and weaknesses. How the crop fits into the existing agricultural framework is also an important consideration

Meeting the EC's target of biofuels providing 5.75% of transport fuel by 2010 will require significant land resources

require significant land resources (IPTS, 2002a; IPTS, 2002b). Therefore, the analysis looks at the 5.75% target for 2010 only.

The 5.75% target for transport biofuel by 2010 can be met via different crop compositions. Figure 2 shows the different amounts of land that might be required in the case of the EU-15, EU-25 and EU-28, under different scenarios about the crop composition[3]. The land area requirements are calculated as a percentage of the Utilized Agricultural Area (UAA)[4].

Figure 2 shows that with the most optimistic estimates, the 2010 transport biofuel target can be met with a land area comparable to, or perhaps even less than, the set-aside land in the EU. The lower land area requirements in the NAC and CC are due to their much lower transport fuel consumption compared to that of the EU-15.

In principle, less land is required when biofuel is produced from sugar beet and wood (ethanol), while the land requirements are greater when a larger share of biodiesel comes from oilseeds. Howe-

Figure 2. Land area requirements within different EU scopes to meet the 5.75% indicative target for Transport Biofuel (TB) in 2010, under different crop composition scenarios (% of the UAA)

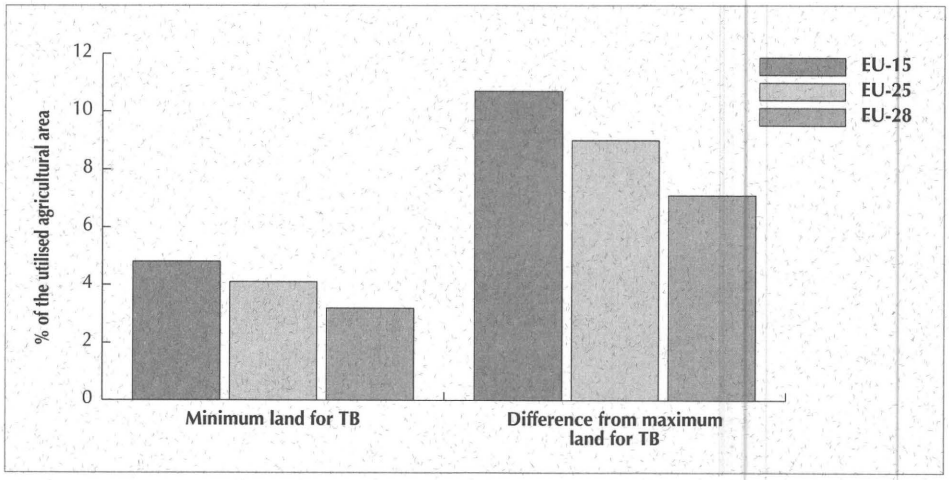


Figure 3. Best estimates of the land area requirements within the EU-15, EU-25 and EU-28 to meet the 5.75% target for Transport Biofuel (TB) and the 22.1% target for Renewable Electricity (RE) in 2010 simultaneously (% of the UAA)

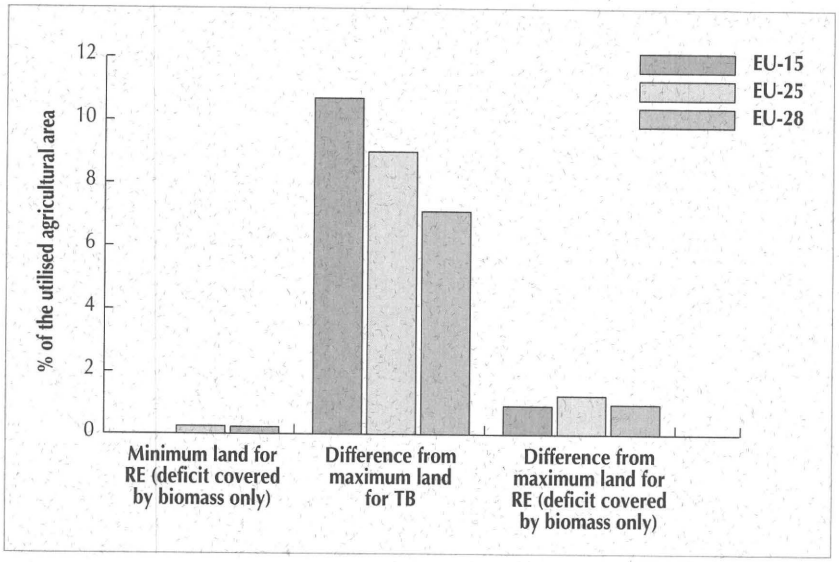
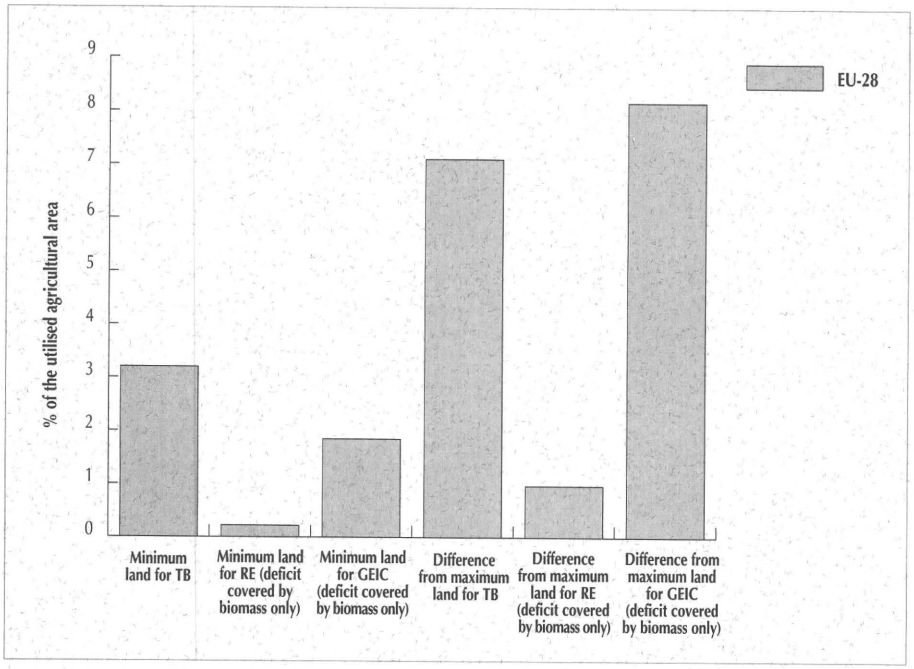


Figure 4. Best estimates of land area requirements within different EU scopes to meet simultaneously the 5.75% target for Transport Biofuel (TB), the 22.1% target for Renewable Electricity (RE) and the 12% target for GIEC in 2010 (% of the UAA)



ver, as already mentioned, the processing of wood to ethanol is still an experimental technology. On the other hand, sugar beet does not produce significant quantities of by-products (Figure 1) available for further energy production. In contrast, other feedstocks with lower yield of transportation biofuel (rapeseed, wheat), generate large amounts of by-products with possible further energy applications (Figure 1), e.g. for CHP generation. All the scenarios considered, however, normally yield significant additional energy benefits, which can be taken into account for other energy applications.

In the most optimistic scenario, it may be possible to meet the 2010 transport biofuel target using a land area comparable to set-aside land in the EU

Meeting the indicative renewable electricity target

As mentioned earlier, the 22.1% indicative target for renewable electricity production in 2010 drops somewhat when the 10 NAC are included. However, for reasons of simplicity, the 22.1% share is used as a common target for the EU (EU-15, EU-25, EU-28) considered in this analysis.

It should be possible to meet the 22.1% target for electricity generation from renewable sources with only a marginal increase in land requirements

Figure 3 presents the aggregated land area requirements to meet the 2010 indicative targets for renewable electricity and transport biofuel simultaneously. It is assumed that the (maximum/minimum) shortfall in reaching the renewable electricity target is covered solely from biomass. It is also assumed that the bio-feedstock with the largest total energy yield (transport biofuel and by-product) – woody biomass (Figure 1) – is employed. The calculations of the land area requirements take into account the projected expansion of hydro, geothermal and wind power[5]. It is also assumed that the by-product left after the production of transport biofuel, will also be utilized for electricity production[6].

Figure 3 indicates that the 22.1% target for renewable electricity can generally be met with the baseline projected expansion of renewable energy sources. Thus, little or no additional input will be needed. If this additional input comes from biomass, the marginal increase in land requirements within the different sizes of EU is modest – up to around 1% in the pessimistic case. This additional increase in land requirements can, however, be substituted for by growth in electricity generation from wind power, for instance. As mentioned earlier, this option is, however, not applicable to transport biofuel, where the potential of renewable sources other than biomass, is negligible. As in the transport biofuel case, the lower land area requirements in the NAC and CC are due to their lower electricity production, compared to that of the EU-15.

Meeting the indicative renewable energy target

Figure 4 shows the aggregated land area requirements to meet the 2010 targets for GIEC, renewable electricity and transport biofuel simultaneously. As in the case of renewable electricity above, it is assumed that the (maximum/minimum) shortfall to be made up before the GIEC target is reached is covered by biomass alone. It is also assumed that only woody biomass – the feedstock with the largest total energy yield (transport biofuel and by-product) – is used. The calculations of the land area requirements take into account the projected expansion of other renewable sources[7].

With the above pre-conditions, Figure 4 shows that in all EU scopes considered, a significant additional land area should be reserved, if the balance deficits up to the 12% target of renewable GIEC by 2010 are covered using bio-energy. While in the optimistic scenario these additional land requirements fall within the 2-5% range; in the pessimistic case they come to 8-13% of total UAA. Again, as in the renewable electricity scenario, the shortfall that needs to be made up in order to reach the target can alternatively be covered using other renewable sources, such as hydro-electric or wind

power. As in the cases of transport biofuel and renewable electricity, the smaller land area requirements in the NAC and CC are due to their lower GIEC, compared to that of EU-15.

Conclusions

A number of conclusions may be drawn from the foregoing analysis:

- In principle, it is not impossible to meet the EC's 3 renewable energy targets simultaneously covering the balance deficits solely from biomass. In such a case, however, a significant land area in the EU would need to be devoted to energy purposes – much larger than the land area employed at present. Since the absolute land area availability is constant, this could be done only at the expenses of other land uses. Considering the full set of policy objectives and market realities, achieving such a substantial increase in the land area for bio-energy purposes looks likely to be difficult in practice.
- Of the 3 renewable targets, the transport biofuel target appears to be the one with the largest absolute land area requirements. The reason is that it is only technically feasible to meet this target from biomass, while the renewable electricity and the GIEC targets can be met using other renewable energy sources as well.
- The renewable electricity target generally can be met with the planned expansion of the wind power capacity and the biomass left after the production of transport biofuel. Thus, no significant additional land area will be needed to reach this target.
- The aggregate GIEC target can be met with the employment of substantial land resource. However, the target can be achieved alternatively with other renewable sources.

These conclusions should not be considered as final, however. There are a number of ways in which it may be possible to reduce the land area requirements, such as utilizing wood waste from forests. However, the technology necessary to do so is not yet commercially available, still being at an experimental stage. An additional, but relatively small growth in hydro-electric, geothermal and photo-voltaic generating capacity could also take place. However, this option is not included in this, kind of abstract, analysis either. And, last but not at the least, biomass availability can be substantially increased via imports, e.g. from the countries of the former Soviet Union (FSU). Such a hypothesis would have a number of positive impacts, e.g. reduced GHG emissions, creating employment both in the FSU and the EU (since bio-energy production is normally more labour-intensive than fossil energy generation, for instance). However, since the indicative renewable targets are set up for the EU member states themselves, this option has not been considered here.

Meeting the target of providing 12% of gross inland energy consumption from biomass alone could prove challenging. Increasing the share of other sources at the same time is likely to be more feasible

Keywords

renewable energies, biomass, land area requirements

Notes

1. The IPTS, *Techno-economic analysis of Bio-ethanol production in the EU* states 5-7 GJ/t as an average ethanol yield from woody biomass. According to GAC (2003), the typical yield from wooded areas (including fast growing trees) is 3-30 t/ha per year, with an average value of 11 t/ha. Thus, 5-7 GJ/t, multiplied by 11 t/ha, gives 55-77 GJ/ha. However, the production of ethanol from woody biomass is still at the experimental stage. Therefore, the energy yield figures per hectare should be considered to be indicative, rather than precise values, due to the relatively high degree of uncertainty.

2. According to data from the Oak Ridge National Laboratory, the total energy content of woody biomass varies between 15 and 22 GJ/t. Thus, 15-22 GJ/t, multiplied by 11 t/ha – the average wood yield – gives 165-242 GJ/ha. Upon deduction of the ethanol yield (55-77GJ/ha), the remaining balance for other energy products varies between 110 and 165 GJ/ha.

3. The configurations of the EU considered here are EU-15, EU-15 plus the 10 NAC (EU-25) and finally – EU-25 plus the current 3 EU candidate countries (CC): Bulgaria, Romania and Turkey (EU-28). The 2010 forecast about the automotive fuel consumption, as well as all other forecasts about the electricity production and GIEC, are taken from the POLES energy model, run by the IPTS. Since the POLES model aggregates the countries differently from here, some approximations have been made. Thus, some figures may not fully correspond to other projections. Totally five crop compositions are considered: 100% rapeseed, 50% rapeseed & 50% wheat, 50% sugar beet & 50% wheat, 50% sugar beet & 50% woody biomass and finally – 100% woody biomass.

4. The utilized agricultural area comprises all land that can potentially be used for biomass production – arable land, permanent grassland, permanent crops, crops under glass and kitchen gardens.

5. From the POLES models results, with corresponding approximations for NAC and CCs. In the case of wind energy, the increase comes from EU-15 only, where the POLES model projects substantial growth. On the other hand, since at present wind power is practically non-existent in most NAC and CC, no wind energy input is assumed from those countries.

6. After corresponding reduction, due to conversion losses (assumed as to be about 60%).

7. From the POLES models results, with corresponding approximations for NAC and CC.

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Spatial Decision Support Systems for Coastal Environmental Planning

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Issue: Coastal areas are extremely important and fragile from an ecological perspective and therefore need to be carefully managed. Among the main limiting factors for the sustainable development of coastal areas are conflicting interests and jurisdictional complexities. One of the main objectives of Integrated Coastal Zone Management (ICZM) is to bring together the concerns of various authorities within a unified management plan.

Relevance: Spatial Decision Support Systems (SDSS) can offer unique support to the ICZM process through their ability to handle the complex patterns of interactions between natural and human ecosystems occurring in coastal areas. Decision makers involved in environmental planning can combine information and procedural knowledge while the artificial intelligence features embedded in SDSSs facilitate the overall process, making these tools increasingly valuable as patterns become more complex.

Coastal zones and ICZM

Coastal zones are particularly valuable as they concentrate a diversity of natural habitats and a variety of resources. They are also extremely significant and delicate from an ecological viewpoint as they act as the boundary between land and sea and therefore need to be managed carefully. The sustainable development of coastal areas is constrained by the divergence of interests and the jurisdictional complications, given the involvement of a variety of authorities in the utilization of coastal resources and the regulation of dissimilar activities.

Coastal zones are particularly valuable as they concentrate a diversity of natural habitats and a variety of resources

Integrated Coastal Zone Management (ICZM) focuses on coordinating these activities and actions together within a combined management plan and involves the preparation of a strategic plan for the coastal area shaping the general objectives and policies to accomplish sustainable development. Furthermore area-specific management plans and actions for both land and sea are decided in accordance with the strategic plan. In most cases the implementation of these plans and actions demands the mobilization of different policy and administrative mechanisms, procedures and controls as well as meeting legal institutional and financial requirements. The long-term management strategy is transformed into concrete actions and projects during the implementation phase and engages regulatory instruments that support the sustainable management of coastal activities. These include land-use planning, building regulations, licensing

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activities based on environmental impact assessment, construction guidelines for the coastline, conservation regulations and directives, etc.

The contemporary requirements of ICZM, as set out in the document "Towards a European ICZM Strategy" and the Communication from the Commission to the Council and the European Parliament on "Integrated Coastal Zone Management: a Strategy for Europe", stress the outstanding importance of the decision-making process. Environmental planning includes all the procedures relating to the framing, evaluation and implementation of environmental policy. In addition, environmental planning procedures in coastal areas take the form of strategic development of environmental policy. This policy is affected by the atypical spatial patterns of the coastal zone.

Environmental planning requires the development, evaluation and implementation of coastal environmental policies to encourage rational management. This is facilitated with the drafting and implementation of a management plan that:

- focuses on the shoreline, in such a way that the degree of control decreases with distance from the shoreline
- targets the implementation of suitable managerial measures according to the different characteristics of each entity of the coastal zone (Environmental Planning Laboratory, 1997).

The steps involved in achieving these goals include (Coccossis & Dimitriou, 1999, 2003; Dimitriou, 2002):

- identification and designation of management zones parallel to the shoreline that satisfy different policy objectives. In this case the SDSS could be used to identify ideal zones in accordance with specific criteria and determine the spatial projection of different alternatives.
- policy differentiation according to different ecological, socioeconomic and other special characteristics of each coastal entity. In this case the SDSS could give unique support to decision makers through its broad range of features. The spatial diversifications and complexities encountered in coastal zone are beyond the ca-

Integrated Coastal Zone Management (ICZM) focuses on coordinating diverse activities within a combined management plan and involves the preparation of a strategic plan for the coastal area

Environmental planning in coastal areas need to take into account the atypical spatial patterns of coastal zones

In the ICZM approach, environmental planning involves identifying management zones parallel to the shoreline and applying different policies according to the special characteristics of each coastal entity

Box 1. ICZM case studies

The Environment and Spatial Planning Laboratory[1] is closely involved with a number coastal zone management projects and research programmes. The Laboratory provided scientific support to the Greek Ministry of Environment, Physical Planning and Public Works during the National Programme for the Sustainable Development of the Greek Coastal Zone. It has also developed an SDSS for the integrated development of the island of Thassos (Greece) with funding from the Greek General Secretariat for Research and Development. One of the objectives was to develop a system tailored to the needs of the local community which could be used from the prefecture of Kavala, which is responsible for the administration of the island. Thassos represents a typical Mediterranean ecosystem under intense human pressure and during the programme it became clear that the principles of ICZM should form the basis for the SDSS.

The implementation of both programmes provided the necessary experience and know-how to identify critical issues and interactions between the decision-making process, coastal environmental planning and information technology. The process of interviews with staff from various administrative departments also helped formulate a picture of their information technology (IT) requirements.

In order to meet these requirements above an SDSS was created. Its specifications cover most ICZM management needs and facilitate environmental planning procedures. Its features include support for the decision-making process (serving administrative decision-making in a user-friendly and interconnected way), handling variable spatial scales, flexible handling of data from a variety of inputs (including spatial and non-spatial databases), and knowledge management (formalism necessary to represent semi-structured problems, reasoning techniques, knowledge acquisition, etc.)

The system is based on an open, modular architecture so it can easily be modified to tackle a variety of problems. Figure 1 describes the rationale underlying the overall planning of the system. The system integrates knowledge and information to support decision making, to provide tailored solutions and to evaluate alternative scenarios in time and space.

pabilities of Geographic Information Systems (GIS) and other conventional information systems. Decision makers could use the SDSS for the choice of the best policy for each coastal entity and could evaluate the consequences in time and space.

- At the same time the SDSS should embody the general principles of environmental planning and ICZM, help decision makers to clarify and achieve their objectives and support spatial planning and policy preparation at national, regional and local levels.

Geographic Information Systems are an essential tool for evaluating the environmental management process, but Spatial Decision-Support Systems are better suited to the analysis needed to find solutions to specific problems

The differentiation and diversification in the scales of the complex patterns of interactions in space make use of GIS highly appropriate for coastal management purposes, while the need for effectiveness and efficiency during the decision-making process calls for the use of Decision-Support Systems (DSS). Although the ability of GIS to store, handle and analyse spatial data (both geographical and attribute data), in conjunction with their real time performance, can be used to support the decision making process, they are primarily data processing systems and as such are not readily able to deal with complex problems. The linkage, combination, intersection etc. of different layers in conjunction with their built-in mathematical capabilities makes a GIS an essential tool for the direct evaluation of the management process. However, their limited analytical power they cannot provide sufficient support alone.

SDSSs are systems that focus on decisions and decision theory focuses on finding the best solution to any given problem. Problems can be classified as being structured, semi-structured (loosely structured) or unstructured. In most cases the ICZM process implies conflicting interests and presents multi-dimensional characteristics. SDSSs can handle the majority of situations through the utilization of spatial information and knowledge. Scenario development, spatial analysis, and advanced modelling require so-called procedural knowledge while so-called declarative knowledge is essential for representing human know-how, knowledge and experience. By incorporating artificial intelligence (AI) methods and techniques an SDSS is able to use declarative and procedural knowledge simultaneously. Moreover it provides decision makers with the ability to control the overall ICZM process intelligently and utilize all the available information, data and knowledge. The leading edge of intelligent SDSS is moving towards intelligent knowledge-based systems and combinations of neural networks, fuzzy logic, genetic algorithms and hybrid systems.

By incorporating artificial intelligence (AI) methods and techniques an SDSS is able to use declarative and procedural knowledge simultaneously, thus enabling decision-makers to control the ICSM process intelligently

Lessons and conclusions

The utilization of the SDSS for the delimitation of the coastal zone and the identification and designation of management zones can improve the effectiveness and the efficiency of the process since it makes even people with no previous GIS experience able to make critical comparisons between multiple alternatives. With the use of SDSS decision makers have a direct display and representation of their verbal decisions.

- To facilitate choices between different policies, SDSS are able to offer decision-makers either neural network or fuzzy logic capabilities. In the first case, neural networks are used for the classification of the different coastal zone entities at national level. Different networks are already trained and built-in to the SDSS to support a variety of managerial situations on user request.
- In the second case, a "fuzzy logic" approach is used in classification systems making them relatively user-friendly since it allows the user to phrase the requested criteria in a less restrictive way.

The use of the SDSS at the local level provides additional functionality and focuses on coastal environmental planning issues. The SDSS uses a mo-

del based on spatial and non-spatial databases. It can be focused on the level of any spatial unit, but requires the availability of equivalent databases. It is useful to view this in a modular way, each module addressing different users and needs.

The first module is suitable for those with no GIS expertise. It gives them the ability to perform various spatial analyses easily. Selected commands, sequences of commands and scripts are executed at the touch of a button. Although the available options are predefined and tailored to the special managerial needs of the local community they could be used in any similar situation.

The second module is able to simultaneously evaluate different spatial information levels (layers). The user selects the layers and then assigns quantitative or qualitative criteria or weights for each layer. This module has also shown itself to be suitable for scenario development.

The third module is based on logical rules. The decision maker gets logical advice, clarifications and explanations about the proposed solution from the SDSS solutions. The process is based on questions from the system and answers from the user. The main difference of this AI module from the modules described above is the presence of a knowledge base. The knowledge base contains ICZM related rules and may be dynamically updated.

In summary, The use of the SDSS can improve the overall effectiveness and efficiency of the ICZM related decision process. The time required to run even the most demanding spatial processes and analysis is significantly reduced, compared with the time that would be needed using classical approaches. It is easy for users to become familiar with the SDSS and in most case they do not require any prior training in GIS or modelling. Moreover, the hardware requirements are reasonable, and the use of a single uniform managerial tool for all administrative levels that deal with the ICZM process facilitates the overall decision-making process and enables effective management. Finally, the open architecture and modularity of the SDSS guaranties the ease of any future expansion and modification.

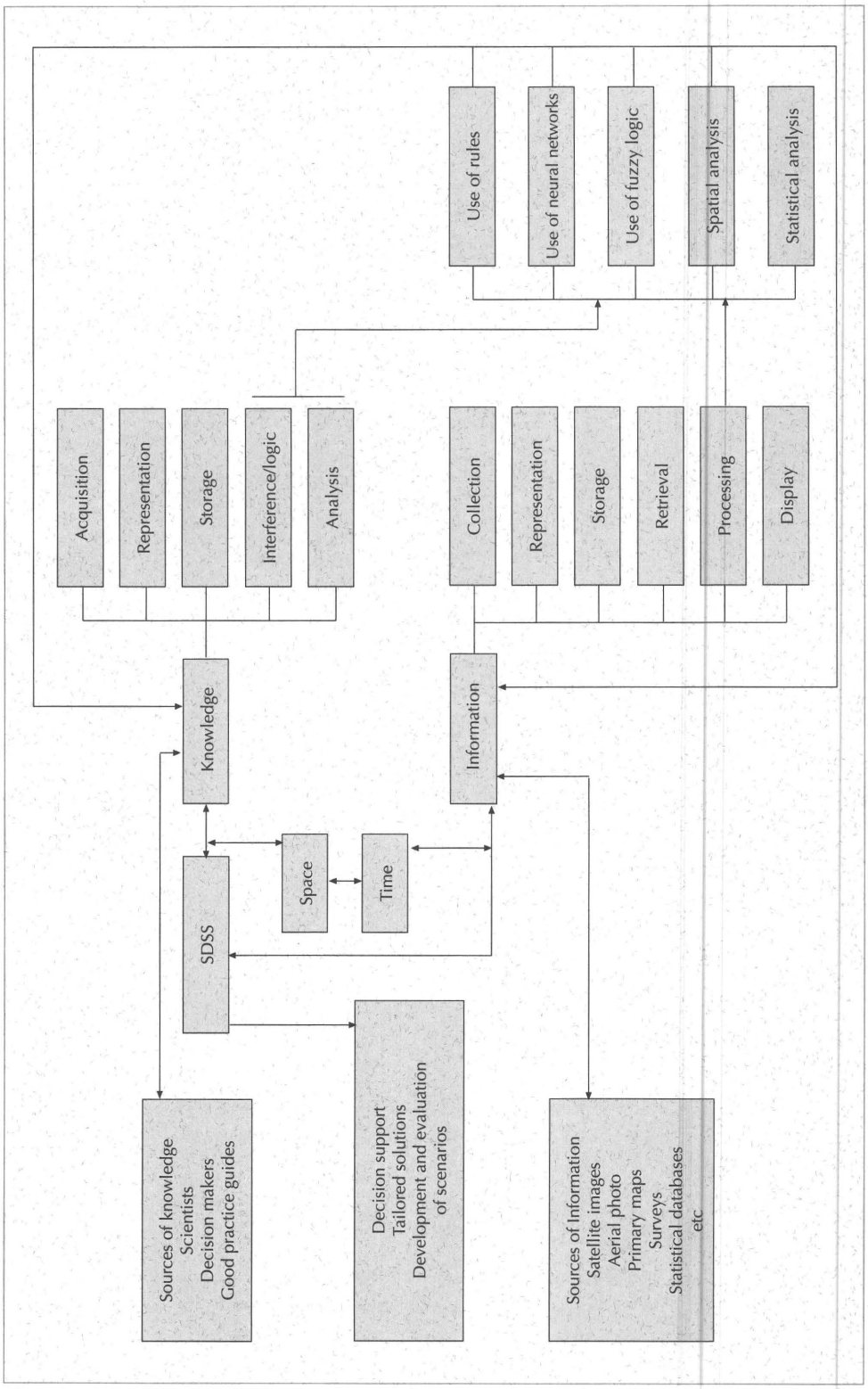
Judging from experience, although decision makers involved in coastal environmental planning could benefit a lot from modern information systems they have tended to be slow to adopt innovative tools. Indeed, the higher up the administrative hierarchy individuals are, the lower their willingness to use pioneering tools. Their past experience, time limitations and personal considerations perhaps make the use of IT somewhat unappealing. On the other hand it is important to mention that they generally have positive attitudes to IT and agree that they at least need composite maps, statistical data, and graphs to form their decisions. In most cases they use hard copies (printed) to support their effort. However, printed material of this kind is static and time consuming to produce or modify. This process is therefore cumbersome and not conducive to efficient decision making.

Everybody involved in ICZM agrees that the overall process needs to be enhanced by continuous monitoring and information feedback. At this phase the use of information systems and technology could prove indispensable. Electronic Data Processing, Transaction Processing Systems, Management Information Systems, Office Automation Systems, Decision Support Systems, Expert Systems (ES) as well as Geographic Information Systems (GIS) and SDSS are all Computer Based Information Systems and support the overall ICZM process in different ways. Although a fundamental feature of any information system for successful management is precision and simplicity, the complex patterns of interactions between natural ecosystems and human actions taking place on the coastal zone, call for complex and integrated approaches.

SDSS incorporate a set of pre-trained neural networks to support a variety of managerial situations. Fuzzy logic can also be used to enable free-format queries, thus making SDSS more user-friendly

The use of the SDSS can improve the overall effectiveness and efficiency of the ICZM related decision process, significantly reducing the time needed to run even the most demanding spatial processes

Figure 1. Overall operation of the system (Dimitriou 2002, p.153)



Keywords

Spatial decision support systems, artificial intelligence, ICZM, environmental planning

Note

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Genetic Testing: Quality Assurance issues in Research, Development and Regulation

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Issue: Genetic testing is used to identify varations in the DNA sequence that correlate with a disease or higher risk of developing a disease. Genetic tests differ from many other medical tests in that they can predict the future onset of (often severe) disorders and that the results can also be relevant for the patient's relatives. The far reaching effects a test result can have on an individual and his/her family makes the quality assurance of genetic testing services an issue of the utmost importance. Thus, as well as being a challenging research issue which is generating breakthroughs and turning points in predictive and preventive medicine, genetic testing is also a topic of considerable public concern.

Relevance: Genetic testing is something of a model case in illustrating the complexity of the issues associated with cutting-edge research and technology, and the need to create close links early on between this type of research and broad policy developments. An active international "arena" recently saw coordinated initiatives by bodies such as the EP[1], EC, EGE, OECD, the Council of Europe and UNESCO. All pinpointed the need to guarantee quality assurance of genetic tests, in an internationally compatible framework.

Rapid progress in the identification of genes and mutations has enabled the incorporation of an ever expanding range of genetic tests in clinical practice

Although genetic testing has enormous potential for preventive and predictive medicine, it also has serious implications for society given the impact test results may have on the lives of individuals and their families

Introduction

The rapidly growing identification of genes and mutations causing a variety of inherited disorders has resulted in the proliferation and rapid integration of a vast array of molecular genetic tests into clinical practice. Genetic testing is used to identify variations in the DNA sequence that correlate with increased risk of developing a particular disease. This type of test can be used for diagnosis in asymptomatic individuals so as to determine their risk of going on to develop certain multi-factorial diseases. Thus, the results of genetic testing can have far-reaching effects on an individual's life. These evolving diagnostics and predictive techniques, which are the outcome of continuous new discoveries by genetic research, bear an enormous potential for preventive and predictive medicine, but bring with them serious implications for society.

In view of the potentially far-reaching medical, psychological, social, legal and ethical consequences of a genetic test result, the question of how to ensure the quality and safety of genetic testing inevitably arises. Highest quality assurance standards and reference practices for genetic testing need to be carefully considered, and developed further,

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from the perspective of at least three different but strongly interconnected aspects: the sophisticated and delicate technical parameters, the sensitive social and ethical issues, and the complex international regulatory context.

Genetic testing is, above all, not only produced by, but also continuously dependent on leading edge scientific research. Genetic tests involve complex and rapidly evolving molecular techniques, which - by their nature - require direct inputs and continuous monitoring and guidance by rigorous state-of-the-art research. Indeed, a considerable proportion of genetic testing is currently carried out as a part of research programmes rather than in routine clinical laboratories.

Furthermore, genetic tests pose specific ethical questions and may imply serious consequences for people's physical, psychological and social welfare. They can in some circumstances reveal important information, including predictive data, not only about the tested individuals, but also about members of their families; they may ultimately have a great impact on individual lives and lifestyles, not least as regards reproductive choices. For these reasons, genetic testing should be offered only in association with appropriate counselling so as to ensure all the medical, ethical, social, psychological and legal aspects are properly covered. Careful genetic counselling needs to be considered an integral part of the tests and not as something separate from sampling and testing.

A further degree of complication is added by the rapidly expanding range of genetic testing services: a growing number of laboratories in Europe and elsewhere are offering a broad and heterogeneous array of genetic testing and analysis services. These practices are becoming increasingly more frequent, highly variable in quality, and available across national boundaries. Not only are genetic samples and data being transmitted across frontiers, but also some genetic tests are becoming the object of uncontrolled "mass marketing", including via the Internet. The combination of such conditions and market trends is raising serious concerns about the reliability and quality assurance of the tests provided as well as to their compliance with social, ethical and legal norms. Altogether, this underscores the importance of adopting appropriate regulatory policies in order to allow the development of a significant, reliable and competitive global market for high quality genetic testing materials and services.

Although genetics specialists and professional organizations have made many moves to promote quality assessment, genetic testing services are provided under widely varying conditions and regulatory frameworks in different countries, including in the EU.

There are at present no common European regulations to guarantee that genetic testing and analysis services will conform to minimum standards; these services lie outside the scope of Council Regulation (EEC) No 2309/93 which lays down Community procedures for the authorization and supervision of medicinal products for human and veterinary use and Directive 98/79/EC on in vitro diagnostic medical devices, which apply only to products.

The legal environment in relation to genetic testing is complicated by its connection to the issue of the protection of genetic data. This includes aspects such as confidentiality, privacy protection, commercialization, access to information, insurance and employment. EU directive 95/46/EC on the protection of individuals with regard to the processing of personal data and on the free movement of such data addresses such issues.

In sum, all these arguments tend to highlight genetic testing as an example of complex systems

The far-reaching medical, psychological, social, legal and ethical consequences of a genetic test result make it necessary to ensure the quality and safety of genetic testing

Given the potential impact on individuals and their families, genetic testing should be offered only in association with appropriate counselling so as to ensure all the medical, ethical, social, psychological and legal aspects are properly covered

There are at present no common European regulations to guarantee that genetic testing and analysis services will conform to minimum standards

of leading-edge research and development - yielding promising outcomes and offering huge potential benefits for society- while at the same time requiring a early framework of coherent and internationally compatible policies, spanning diverse - but interconnected - aspects such as technical standards for research and development, ethical and social requirements, legal and regulatory issues.

Recent policy initiatives

Since 2000, a number of forums and international bodies have addressed the issue of genetic testing from various different angles, and have formulated similar and complementary recommendations on the need to develop internationally recognized best practice policies for genetic testing, including quality assurance. At the international level there have been coordinated initiatives the European Parliament, the European Commission (including the active collaboration of DG RTD and DG JRC) the European Group on Ethics, the Organization for Economic Cooperation and Development (OECD), the Council of Europe, UNESCO, articulated with further initiatives by national governments and by research networks (see boxes 2, 3 and 4).

More specifically, in 2000, the European Parliament (EP) established a Temporary Committee on Human Genetics and New technologies in modern medicine to assess the ethical, legal, economic and social implications of human genetics.

Over the last few years a number of forums and international bodies have addressed the issue of genetic testing and have formulated recommendations on the need to develop internationally recognized best practice policies for genetic testing

Box 1. European Parliament Report on the Commission communication on Life Sciences and Biotechnology

The European Parliament Report on the Commission communication Life Sciences and Biotechnology- A Strategy for Europe[3] - produced in October 2002 and adopted by a large majority of the EP - concludes the following in its motion for a resolution on health and reproductive medicine:

1. Calls on the Commission to draft a legislative regulation for the introduction of a standard for genetic tests, since these services lie outside the scope of Council Regulation (EEC) N° 2309/93 laying down Community procedures for the authorization and supervision of medicinal products for human and veterinary use and Directive 98/79/EC on in-vitro diagnostic medical devices, which applies only to products to be marketed;
2. States that genetic testing and analysis must be conducted under clear rules within the frame of competent, independent and personal counselling which must cover medical, ethical, social, psychological and legal aspects;
3. Solemnly reaffirms that the life and dignity of all human beings, whatever their stage of development and state of health, must be respected and is opposed to any form of research or use of life sciences and biotechnology that runs counter to this fundamental principle;
4. Notes that genetic testing analysis and diagnosis data must remain confidential and should be used only for the benefit of the person requiring such tests, with the exception of tests undertaken for clearly defined scientific or criminal investigation purposes, therefore such tests should be inadmissible for social or recruitment purposes, and should not jeopardize personal privacy and dignity;
5. Calls on the Commission to take the necessary steps for an EU-wide regulation on DNA-testing, choosing, if possible, a legal basis (e.g. Article 152 (health) or Article 153 (consumer protection)) which leaves Member States free to introduce more stringent protection measures and asks its competent Committee, subject to prior authorization by the Conference of Presidents, to consider drafting an own-initiative report on the legal aspects of DNA testing;
6. Considers it particularly important to ensure that no woman is compelled to have prenatal diagnosis carried out and that any decision not to resort to such diagnosis is respected and supported;
7. Takes the view that determination of sex in connection with prenatal diagnosis should be permitted only - if at all - if there is a risk of serious gender specific hereditary diseases;
8. Instructs its President to forward this resolution to the Council and the Commission and the parliaments of the Member States.

Box 2. Examples of on-going actions by the EC: DG Research activities

The European Commission (through its Directorate-General for Research) has supported, throughout successive Framework programmes since 1996, a series of nearly 30 research projects, networks and studies tackling different aspects of genetic testing, involving hundreds of laboratories throughout Europe[4]. These activities contributed to i) developing novel or improved genetic tests, ii) improving the quality of genetic services, iii) analysing the ethical, legal and social aspects of genetic testing and iv) providing support for the development of related policies. Within the Fifth Framework Programme (1998-2002) alone, the EC contribution to research in this area was of 17 million Euros. Most relevant examples include the European Molecular Genetics Quality Network - for the development of External Quality Assessment schemes and best practice protocols for molecular diagnostic genetic tests, with the participation of 15 EU and 14 non-EU countries – and the European Thematic Network for Cystic Fibrosis - a platform gathering no fewer than 160 diagnostic laboratories, fundamental research groups, patients and family associations, clinicians, and ethical, legal and IPR experts for the development, control and management of highest standard diagnostic procedures. Other projects address various aspects of genetic testing, ranging from the production of reference materials, to the international quality assurance and regulation systems, the education of non-geneticist health professionals to other ethical issues. A survey addressing the regulatory framework for genetic testing in the EU has been also recently published[5]. Initiatives addressing genetic testing have also been included in the recently launched FP6 programme.

In 2002, the Science and Society directorate of DG-Research established a high level expert group "ETAN-STRATA" (Strategic Analysis of Specific Political Issues) dealing with the ethical implications of genetic testing[6]. This STRATA group has been given the mandate to create a dialogue platform in which key industrial stakeholders, representatives of civil society and scientific experts from various backgrounds will have the possibility to discuss the ethical implications of genetic testing and then prepare a report on the ethical implications of genetic testing. The report will refer to discussions taken between the group members, different stakeholders (industry, patients and civil society organizations, experts of the fields) and relevant International Organizations (OECD, WHO, the Council of Europe, EMEA, etc.). The report will contain a detailed analysis not only of the issues involved in genetic testing, from an ethical viewpoint, but also best options to have a person in charge of the ethical issues of genetic testing. This initiative implements Action 30 of the "Science and society action plan" and Action 16 of the Communication "Life Sciences and Biotechnology: a strategy for Europe"; and reflects the recommendations of the draft report of the "EP Temporary Commission on Human Genetics". The STRATA group has held a series of hearings to date and is expected to produce a report on Genetic Testing, social and ethical issues by end of 2003[7]. This report may contribute to creating the environment for the development of European guidelines concerning the ethical aspects of genetic testing.

In its final report, this EP Temporary committee on Human Genetics considered it essential to lay down a harmonized regulatory framework, recognized right across Europe, providing clear-cut rules to guarantee the quality of genetic testing in Europe. Such a quality assurance scheme would encompass not only development, but also scientific and technological procedures, including guidelines on good laboratory, clinical and industrial practice, with a view to ethical issues such as genetic counselling.

Additionally, in response to the requests by several EU Summits, in January 2002 the European Commission proposed the Life Sciences and Biotechnology Strategy for Europe and Action Plan[2], which received broad political support from the European Parliament (see Box 1) and Council of Ministers. Under this strategy, Europe has contributed to the international agenda through a raft of actions; the objectives include playing a leading role in the development of international guidelines, standards and recommendations in relevant sectors, based on international scientific consensus (action 24). Also relevant in this context are the proposed action 5 on intellectual property protection (in terms of sequence patenting and its impact on the price of genetic tests and availability of certified reference materials), action 16 on ethical values (achieving consensus), and action 18 on science based regulatory oversight (authorization procedure for products of public health interest). The strategy also calls for strengthening policy coherence, through co-ordination, foresight and review functions. In

Box 3. Examples of on-going actions by the EC: DG Joint Research Centre

In parallel, the EC's Joint Research Centre, through the Institute for Prospective Technological Studies, in collaboration with the EC Research Directorate –which is supporting a large portfolio of EU projects on genetic testing quality assurance– launched a prospective study on the technical needs and options for quality assurance and harmonization of genetic testing services in Europe. The main goal of the study was to assess the current situation of genetic testing (a review of the state-of-the-art, including all existing networks and referral systems to European centres providing genetic testing in the EU –public or private, clinical or research– and current accreditation systems) and to present alternatives to improve it. In addition, the study presents a foresight exercise with scenarios for the future of genetic testing services in Europe.

An initial, more detailed, insight into the problem was achieved by analysing the situation in depth in one EU Member State, chosen as a case study. Spain, because of its large population and complex decentralized public health system was deemed a good illustrative example. The results of this pilot study have recently been published[8]. The second step was a wider overview of the situation in the EU, assessing potential solutions at European level. The outcomes of this study were presented for the first time at an EC-OECD International Colloquium on Genetic Testing Quality Assurance in October 2003, which is further described below.

particular action 29 calls for the JRC/IPTS to enhance technology foresight in biotechnology for early identification of newly emerging issues and elements of a policy response. Genetic testing is a model case for the application of such actions.

Conclusions

To conclude, there seems to be broad agreement that initiatives at European and international level are necessary for quality assurance systems to have a permanent and recognized place in the practice of genetics laboratories.

The European Commission has played an active role in this field, in connection with several other international bodies, by supporting various initiatives affecting different aspects of genetic testing. In order to further contribute to the shaping of an international policy coherence towards quality assurance of genetic testing, the Commission could continue to sustain a coordinated effort, in line with the Life Sciences and Biotechnology Strategy for Europe and the Science and Society Action Plan. In parallel, the OECD has also been committed to the question of how to ensure the quality and safety of genetic testing, in OECD countries and beyond (see Box 5).

In the context of increasing international trade in genetic tests and services, and in consideration of the policy issues this raises, the EC (DG RTD and DG JRC) and the OECD jointly organized an *EC-OECD Colloquium on Genetic Testing Quality Assurance*, held in Brussels on 6 October 2003. The Colloquium gathered nearly 100 delegates from 20 different countries as well as representatives from major international bodies that have been shaping, or involved in this field, during the past few years (Council of Europe, EGE, EMEA, EP, WHO, OECD and various EC services) together with leaders in this research field networks (including scientific, ethical, social, legal aspects).

The **EC-OECD Colloquium on Genetic Testing Quality Assurance** served as a preliminary example of a consultation forum for international coopertion leading to genetic testing quality assurance and as a launch platform for further initiatives to be developed towards the possible harmonization of quality assurance of genetic testing, including the elaboration of guidelines, standards and recommendations, in this field.

An important goal would be to create the space for an international platform, inclusive of all major stakeholders (scientific, technical and other experts as well as policy makers and national government representatives, interest groups, civil society), with the intent of discussing a roadmap to achieve some level of harmonization in quality assurance of gene-

Box 4. Examples of on-going actions by the EC: Other European Commission services

Other Commission Directorates-General are also active in the field: DG Enterprise is responsible for Directive 98/79/EC on in vitro diagnostic medical devices, DG Internal Market is responsible for the Data Protection Directive (95/46/CEE), DG Employment and Social Affairs is responsible for Directive 2000/78/EC on equal treatment in employment and occupation and DG Health and Consumer Protection has responsibilities including the work on Health Determinants in the Public Health Community Action Programme, which focuses on analysing the situation and exchange of information on genetic determinants and the use of genetic screening in recognition of the associated risks of genetic testing. Although these activities are particularly important and relevant for genetic testing quality assurance, they cannot be covered here for reasons of space.

The European Group on Ethics

The European Group on Ethics in Science and New Technologies[9], appointed by the European Commission and supported by the Group of Policy Advisers (GOPA), which acts as its secretariat, held a series of activities concerning ethical aspects of genetic testing. In 1996, it published its Opinion n°6, on ethical aspects of prenatal diagnosis. In 2000, it held a Round Table Debate on Genetic Testing in the Workplace. In a recent statement, the EGE warned against the risks of advertising genetic testing via the Internet. An EGE opinion on the ethical aspects of genetic testing in the workplace has been published[10].

tic testing, throughout Europe and world-wide. In closing, a number of significant observations can be made regarding not only the promises but also the current and potential weaknesses in genetic testing services world-wide. In a "greying society" such as that of the EU, judicious use of genetic testing could be one of the tools to shift our health services to focus on disease prevention and on healthy lifestyles, to reduce the cost burden and improve the health of an ageing population. Most of the EU population has a very positive view of the potential of medical genetics (Eurobarometer 55.2). To help maintain it, action is required to ensure the highest quality of tests and testing centres, to harmonize procedures, including consent, and to make best use of EU expertise to widen coverage at the lowest cost possible. In a world where individual citizens are being offered "mass marketing" of genetic tests via Internet, and where 60 % of laboratories performing genetic tests exchange samples across national borders, the development of a responsible international agenda is therefore becoming an urgent need.

Box 5. OECD and genetic testing

In the year 2000, nineteen OECD countries formulated the recommendation on developing internationally recognized and mutually compatible best practice policies for analytical and clinical validation of genetic tests, including quality assurance and accreditation of genetic services (OECD workshop on "Genetic Testing: Policy Issues for the New Millennium" (2000)). The OECD Working Party on Biotechnology (WPB) set up a Steering Committee on Quality Assurance in Genetic Testing with running a survey of laboratory practices in molecular genetic testing across OECD countries. This survey has been run with the support of the EC – DG RTD, as an accompanying measure of the FP5- Quality of Life Programme. Preliminary survey results offer the first indications regarding the practice of referring genetic testing specimens across national boundaries (approximately 60% of responding laboratories receive specimens from outside their country)[11]. They also provide some evidence of the current variability in the policies of laboratories with regard to the requirement for written informed consent, reporting practices, and the development of a confidentiality policy for genetic test results. Altogether this confirms that further international discussion and exchange in these areas could be useful.

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Keywords

Genetic testing, harmonization, quality

Notes

1. Abbreviations used: EC: European Commission, EGE: European Group on Ethics in Science and New Technologies; EMEA: European Agency for the Evaluation of Medicinal Products; EP: European Parliament, JRC: Joint Research Center; DG: Directorate General; IPTS: Institute for Prospective Technological Studies; OECD: Organization for Economic Cooperation and Development, WHO: World Health Organization.
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