Scientific Survey (WP8)

ICT for Environmental Sustainability

Concerning Key Area: “ICT for Sustainable Use of Natural Resources”

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April 2009

This survey was conducted in the course of the ICT-ENSURE project. ICT-ENSURE is financed under the grant agreement number 224017 of the European Commission’s seventh framework programme, Theme 3, Information and Communication Technologies.

1) Scope: Definition and Analysis of Key Area ICT for Sustainable Use of Natural Resources

a) Introduction

According to Reding (2009), European Commissioner for Information Society and Media, we live today in a constantly changing world where the pace of change continues to accelerate. In our daily and professional lives we are confronted with increasingly complex tasks and situations, requiring us to be alert, and to learn and adapt our knowledge as things change. The need to learn arises in all kinds of situations and settings, be it at the workplace, in an educational institution or during leisure activities. The question is how do we cope with this, both on an individual and organisational level?

In the information society, developing and maintaining know-how in organisations is crucial to becoming and staying competitive. Today it is no longer enough to simply acquire knowledge: we need to transform, enrich and structure it; and then to share and re-use it.

Equally important for knowledge organisations are skilled employees, who can handle and manage a constant inflow of information, make sense of it and turn it into knowledge and skills. With constantly changing environments, the competences needed to carry out a specific task are also in permanent change. For many organisations, 'time to competence' is becoming more important than 'time to market'.

The public sector is not exempt from these fundamental changes. To be able to respond quickly, flexibly and efficiently to provide services, public sector administration also has to become knowledge-driven, adopting a culture that encourages change and innovation, where people are continually learning to learn together.

Permanent learning is a key asset in this climate of rapid technological change. But learning in an organisational context is more than just training, which itself is not restricted to step-by-step, repeatable instructions. Rather, it comprises training of soft skills like empathy, awareness of needs and reflecting on one's own behaviour. On the 13th March 2009, the European Commission called for doubling funding for ICT research and innovation since Europe represents 34% of the global information and communication technologies (ICT) market.

At present, the German Deutsche Bundesstiftung Umwelt (German Federal Environmental Foundation) runs one of the most active programmes in ICT for sustainable development of natural resources. These include the following categories:

<u>Communication of Environmental Information</u>

The effectiveness of those environmental and communication measures initiated is dependant on the choice and application of suitable methods and instruments. Projects are funded that are characterised by a combination of different environmental communication forms (e.g. film and media projects, print material, information and dialogue events, cultural actions, electronic media etc). In particular the present-day environmental and natural resource protection themes are to be emphasised and accompanied scientifically in the form of interactive exhibitions. Contribution to specific focal group educational activities for the qualification of journalists in environmental sectors and for environmental cooperation through media corporations. For the environmentally friendly development of products and procedures it is important to enable an open communication on the basis of suitable methods and media together with the stakeholders along the product-line. Projects can be funded that develop and apply innovative methods and instruments for environmental communication within, to and from enterprises and that develop environmental communication between enterprises, users and other actors and contribute to the reduction of obstacles in co-operation.

Electronic Media

The application of electronic media enables a new and fast possibility of access to environmentally relevant Information. The main advantages lie in the manipulation and search of Information and the possibility to interact with electronic media.

- mobile information systems, especially for the improvement of transfer of environmental information in the field (e.g. protected areas)
- internet-based information transfer to improve the objectiveness of environmental communication processes as well as interaction and organisation between communication partners
- multi-media application (e.g. CD-ROM, DVD) of transfer of small and large data volumes

Experimentation and application of new media

Media instruments that cover direct or indirect changes in environmental behaviour, play an important role in the transfer of the necessary competence to act through environmental communication. Research is funded on:

- innovative use of press, radio, TV, film and exhibitions that promote and strengthen the possibility of interaction strategies
- embed playful and creative forms of environmental information transferral, in concrete environmental and natural protection schemes.
- A broad exchange and spread of environmental knowledge promoted through competition and actions and the identification of new focus groups

Definition of ICT

According to Tongia et al (2005), ICT is mainly built around 4Cs: Computing, Communication, Content and human Capacity. The ICT research area is best

summarized as treating the processing, transmission, storage, retrieval, management, usage, and exchange of information and knowledge, with emphasis on fundamental aspects and pre-competitive technology development (COST 2009). ICT for sustainable development of natural resources is a necessary and rapidly expanding area but with some given limitations. In this study, emphasis will be put on areas such as water resources, biodiversity and natural resources exploited for tourism, mainly in mountain regions. Information is taken from literature, studies and ongoing or finished European projects. The following points are derived from the open call of the COST programme (COST 2009).

Information science and technologies: the area covers all the aspects related with the foundations, design, analysis, development, and application of hardware and software systems. Related areas are foundations of computer science, software development technologies, software engineering, intelligent systems, advanced interfaces, user aspects, information management, high performance computing, and open, embedded, and distributed systems.

Communication technologies: research in this area concentrates on the transfer of information from source to sink. Fundamental aspects cover physical, electromagnetic and functional modelling of all elements of information and communication systems such as terminals, antennas, transmission channels, networks, devices, components and materials.

Societal aspects of ICT: research in this area covers both the influence of ICT on society and the requirements imposed by society on the ICT infrastructure. interdisciplinary cooperation with disciplines dealing with societal needs is essential for the development of this research area. An important area for this domain is **multidisciplinary research** – with an ICT core – in fields like sustainable development, health, attention to the elderly and the disabled, culture, learning, bioinformatics, and many others, performed in cooperation with the corresponding COST domains.

b) Overview of sub-categories included in the observed key area.

Within the main scope of sustainable development of natural resources, the observed key areas are focussed on Water Resources for drinking water, household consumption, tourism, artificial snow making, agriculture, hydropower, cooling water

The main sub-categories of water resources include:

- water quantity (depending on glaciers, snow, ice, lakes, springs, torrents, rivers, wetlands)
- water quality (depending on geology, geomorphology, soils, pollutants, mineral concentration by artificial snow making etc)
- water management
- water prediction
- aquatic biodiversity

c) Analysis of key area concerning:

Main problems, Key tasks, priorities

At present there is a worldwide crisis of natural resources (Tongia et al 2005). If the consumption of primary materials and the deterioration of natural resources continues at the same rate, mankind will be faced with serious problems. Mankind is overusing limited and non-renewable resources. The consumption of natural resources should be limited in future to avoid ecological disaster. In a world with limited natural resources, the growth model of industrialised countries cannot be used as a future reference for developing countries. Intact ecosystems offer invaluable services, they supply us with clean water, air and regenerate soils.

Most conflicts (both armed and non-armed) take place in environmental hotspots. Already in the second half of the last century many conflicts were waged in biologically diverse, fragile places, with many negative consequences and a few surprising positive ones. A team of international conservation scientists found that 81 percent of conflicts fought between 1950 and 2000 in which at least 1,000 people died played out in "biodiversity hotspots" from the Himalayas in Asia to the coastal forests of east Africa (Hanson et al 2009).

The hotspots contain the entire populations of more than half of all plant species and at least 42 percent of all vertebrates, and are highly threatened (Hanson et al 2009).

Different fields of research

For Water Resources, ICT can help in assessing supply adequacy, modelling different supply and technology alternatives and factor in different usage technologies (Tongia et al 2005). This can include:

1. The development of dynamic Geographic Information Systems (GIS) for identifying water availability, storage, transmission and distribution.
2. Monitoring of water quality, especially through low-cost sensors of for example agriculture and industry.
3. Optimize the allocation between different water uses (e.g. treated drinking water, agriculture etc
4. Water use management at a societal level including distribution systems (loss reduction) and utilisation efficiency

For ICT to be applied successfully, stakeholders must have access to information for informed decision-making and they must have open access to a range of different models and solutions. ICT can also help with education regarding efficiency, loss reduction and new technologies. Required research includes low-cost approaches to quality assessment and modelling such as sensors, data collection, analysis and dissemination and system analysis of supply which demands adequate data (GIS) and flexible and robust models.

The sustainable development of water requires particular attention in the context of tourism, both directly related to snow making as an economical source (depending

on amount of water available, amount stored and amount used) and water as a source of well-being and recreation (depending on availability and discharge of springs, lakes, torrents, waterfalls). Artificial snow making is nowadays computer-controlled according to meteorological conditions such as relative humidity, wind speed and temperature. There is however an imbalance in the degree to which ICT is applied in water resources with comparison to meteorology for snow-making. Whereas weather conditions are measured according to fixed parameters and are therefore relatively easy to obtain in a systematic manner, the availability of water resources are subject to human decisions that can be highly erratic and market-oriented and are often only roughly quantifiable or nor quantifiable at all at the same temporal scale. Citing a stakeholder in the commune of Gets, Upper Savoy, French Alps, during the warm and largely snow-free winter 2006/2007, “the decision to use water for snow-making with relation to what is left for drinking water is taken nearly from minute to minute.” (Perret 2007) The decisions are often based on observations and not on high precision, quantitative measurements that could form the base for a decision-support system. The lack of ICT in this domain not only endangers water availability for human consumption but more so the minimal amount of residual water left for the environment. This is mainly due to a lack of data, lack of easily classifiable data and lack of data transfer systems. It is also due to the difference between transferring data from measuring equipment to storage and processing tools (i.e. from machine to machine and back again) against transferring data from qualitative questionnaires to interfaces and then to storage and processing tools (from humans to interfaces to machines to interface to humans).

In terms of minimizing energy requirements, new developments are under way. The need for snow infrastructure for artificial snow making has significantly increased worldwide. Unfortunately snow production is very energy intensive. The main aim of the project NESSY run by the SLF Davos (see references) is to develop an innovative high pressure snow gun system following scientific methods for artificial snow making on ski runs under improved energy and ecological balance by combining the HD and ND combined snow systems. Amongst other, a water-driven ventilator should ensure air exchange in the nozzle so that even with little wind the system can function. Compared to the actual state of technology, an energy economy of 30% is aimed at. In addition, the possible climatological span of functioning should be increased. With the much lower operational costs and without the use of additional chemical or biological additives, this will give an important sale argument so that the new snow gun systems can be used worldwide on the market.

Other technologies involving ICT is the redistribution of artificial snow over ski runs by piste grooming machines. In Switzerland, these machines have special sensors inserted that measure snow height under high precision. This allows snow to be distributed optimally and only minimal amounts to be used. This in turn prevents overuse of natural resources such as water for snow making. Thus in terms of sustainable development the technique aims at minimising the use of water.

For basin-wide use of water resources, the problem is even more complex, since ICT considers river basins or catchments as closed systems, whereas they are in reality

open systems, subject to variable environmental conditions, e.g. choices and decisions of inhabitants that can either be local or external.

For the protection and development of the cryosphere, which involves water in a frozen state, as snow and ice ICT is essential. In general, the trend in the cryosphere is to build information into prediction. According to Carlson (2009), the full success of the International Polar Year (IPY) requires that discoveries and data are converted as rapidly as possible into predictive skill. The breadth of IPY science, and the well-recognized unpredictability of biological or geophysical systems during periods of extreme stress or rapid change, make the prediction process more challenging, but the requirements of a prediction process will advance communication and impact of Cryospheric science like no other activity. Producing a useful Cryosphere prediction entails substantial risk (and requires changes in thinking and funding), but prediction focus and frameworks help to think operationally, assess the timeliness and quality of observations, develop and use assimilation schemes, and identify and meet user needs (Carlson 2009 EGU).

2) Relevance

a) General importance of sustainability research in this key area

Sustainability research can be considered as “very important” in the key areas, even if it is not yet well developed. The concept is treated on a daily basis but there may a gap between research demand and actual research carried out. For the key water quantity and quality, sustainability research depends to a large degree on the energy market, costs and weather conditions and therefore requires an interdisciplinary research approach. For the key areas water management and prediction, tools and water laws are more important Climate change is a major element in sustainable development in all the key areas and therefore needs to be considered. This requires developing appropriate research on the interfaces between climate change scenarios and the local scale issues.

b) Scientific interest of ICT in the analysed key area

There has been growing scientific interest in ICT over the last decade, in particular since 2004.

VIRTU@LIS, a project funded under the IST Programme of the 7th Framework programme, explored the potential of new digital and multimedia technologies to increase awareness of environmental management and risks in four domains - agricultural pollution, climate change, freshwater resources and fisheries (O’Conner 2004). In addition to scientists, stakeholders can inform themselves about sustainability of natural resources by exploring the VIRTU@LIS project's computer-based virtual reality learning tools on ecosystems and natural resources.

In terms of the 6th and 7th framework programme, ICT is considered to play an important part in the management of natural resources, such as water, wildlife and

landscape associated with agricultural practises (Ubieta 2006). Since currently broadband infrastructure is often too expensive, or simply unavailable, in rural regions, it can hamper efforts to modernise different types of resource management.

Some examples of programmes and networks that fund ICT research in sustainable development include:

- ICT in 7th Framework programme http://cordis.europa.eu/fp7/ict/
- ICT in 6th framework programme http://www.ideal-ist.net/ict-programme
- Leader+ NTIC (new knowledge to improve our understanding, to put into value and improve the protection of our natural and cultural heritage). http://www.leader-plus.com/index.php?rubrique_id=1&menu_id=4&ssmenu_id=24
- STREP (Specific Targeted Research Project) http://cordis.europa.eu/fp6/instr_strp.htm, http://cordis.europa.eu/fp7/dc/index.cfm?fuseaction=usersite.cooperationdetailscallpage&call_id=12
- Ideal – is a worldwide ICT support network http://www.ideal-ist.net/
- ESF (European Science Foundation) and COST (European Cooperation in Science and Technology). One of nine scientific domains is ICT: http://www.cost.esf.org/opencall. http://www.cost.esf.org/domains_actions/ic
- ERC (European Research Council) http://erc.europa.eu/index.cfm?fuseaction=page.display&topicID=46
- Alcotra Transboundary Programmes http://www.interreg-alcotra.org/project.asp?itemid=45&lang=fr
- Swiss National Research Programme (www.snf.ch)
- BMBF (Federal Ministry of Education and Research) http://www.bmbf.de/de/9069.php
- DBU (German Environmental Foundation) e.g. application of ICT in environmental projects http://www.dbu.de/phpTemplates/publikationen/pdf/0801070933078839.pdf or Ch@t der Welten (world chat, a platform for environmental and political development in schools), http://www.nibis.de/nli1/ikb/chat/cdwinfo1-Dateien/chatnds1204.pdf

c) Economic importance of ICT in the analysed key area

The economic importance of ICT in water resources is multiple. Domains that are most advanced include hydro-electric production, flood control, irrigation and cooling water supply. Less developed domains include fishery, tourism, etc. The economic importance of ICT in natural resources for tourism is also potentially large. Again, it is applied mostly in technically dominated areas such as snow-making or discharge release for rafting, but less so in the qualitative data domains.

Unfortunately, ICT is often trapped in a viscous cycle in economical terms. Thus, as the examples above demonstrate, ICT is often only applied in domains that are already economically important in order to increase their economical potential. On the other hand, in economically poorly developed issues, the interest for ICT is often

not high. Thus ICT research needs to identify areas that have potential and evaluate the potential impact that ICT can make.

According to Ubieta (2006), external costs related to the environment are not sufficiently taken into account nowadays. One has to internalise them if one would like to orientate towards sustainable development. The economy and the political world have to question the practice of investment – often this is too short-cited because to solve environmental problems one has to apply a long term strategy and perseverance. Large enterprises have to develop signs of re-orientation. Those planning at the long term have to permanently adjust their commercial models for the future and therefore have a primary interest to preserve the natural resources (Hartmann 2009). The aim of ICT in the management of natural resources linked to farming is to revitalise rural economies and societies by ensuring the appropriate use of technology, ultimately aiming to allow rural citizens to stay in their area if they want to.

The most recent strategies in ICT and economical development were presented at the conference on “European Regions for better ICT connections” in Turin in April 2009. The exchange of information, knowledge and research was seen as an important counteraction to the present economic crisis. ICT was seen as a means for overcoming the disadvantage of distance, in particular at the local and regional scale. Specific examples were presented for mountainous regions. Two ICT projects at universities were introduced, one at the University of Crete, the “Smart village project” which aims at linking disadvantaged mountainous areas, and one at the University of Catalonia, which seeks to develop infrastructure in the Pyrenees. The Piedmont region, of which 74% is mountainous, consists of 1200 municipalities. Up to 2008, broadband connections consisted mainly in the urban areas but ICT was developed in the remote areas, in particular as an enabler of social exchange. Now there is not only a regional multi-service backbone of more than 1000 km but also more then 650 km connections in the underserved areas. This covers E-health, E-learning, E-security and E-assistance. Many of the mountain huts are covered by internet access which is an important means of boosting their economy. ICT in the 21st century was compared to railway communication in the 19th century. The predictions by the DG Information Society and Media of the European Commission are that in Europe, ICT should create 1 million new jobs and create an extra growth of Euros 850 billion in the coming years. ICT was described as creating new empowerment of individuals into new roles, i.e. from individuals to potential public figures. This is seen as a powerful engine of innovation and social networks with relatively little investment. The technological convergence is seen as an important means for public entities, i.e. water and energy companies and authorities to gage the welfare of territories. The “high-speed” and “low-carbon” strategy was emphasised for restructuring Europe’s economy. However, a 25% gaps still exists between rural and urban communities.

d) Political relevance of ICT in the analysed key area

ICT is of high relevance to public service, decision makers; politicians and other stakeholders since it is a means of monitoring, classifying, analysing and diffusing information according to the most modern technological standards. This is particularly important for mountainous areas with reduced accessibility. Communication networks help professionals in mountain regions to counter natural obstacles inherent to mountain territories. These tools have considerable potential in the field of general services and yet it is in mountain areas that these networks are the least developed and the least effective. Profitability and feasibility are often mentioned by the private operators to explain this situation. To overcome this problem of governance and political resolve, service for everyone, everywhere should be an obligation at the national and European level.

3) State of the Art - Detailed Analysis

The sustainable use and management of natural resources demands an interdisciplinary approach and sound knowledge on each specific resource, as well as on the ecological, economic, and social perspectives related to their use. It also calls for greater coordination at the global level. Natural resources management is one of the applications of ecology that looks into the sustainable management of not just individual ecosystems but entire landscape systems and functions. It identifies and highlights the prospects for institutional, technological, and policy innovations for community-based management of resources to reduce poverty, enhance food security, and ensure biodiversity and watershed management. It helps in answering some of the questions as to how the current natural resources can be managed in a way that will ensure they remain accessible for future generations; how the increasing energy demand can be met in a sustainable way or what technological innovations would enhance their sustainability; and what type of institutions and regulations are needed to prevent the over-utilisation and exploitation of land-based biological resource.

a) Relevance of ICT in sub-categories of Key Area

In which sub categories are ICTs of relevance

ICT is relevant in all the main sub-categories of water resources including water quantity, water quality, water predictions, water management, and aquatic biodiversity. However, whilst it is well developed for the first four, there are still very few readily applicable products available for the last category. This is due to the complexness of the topic and the socio-economic dimension involved. With respect to all categories, information and knowledge management is often well advanced yet information transfer to the end-user still requires improvement. Also, where information is numerical and measured quantitatively, information communication is straightforward. However, where data is qualitative and subjective yet still of major importance for the system, ICT is still poorly developed. This is due to the difficulties and incompatibilities encountered at the interfaces between different information and

data systems. Also, ICT will be better developed for sustainable use of natural resources in National Parks who are often more acquainted with the use of technology such as GIS and public bodies and less at the local scale. .

Some of the ICT-relevant systems available on the market include in the domain of water resources include for example WISKI (Water Information System of Kisters). It deals with hydrological measuring networks, groundwater monitoring, meteorology, flood forecasting and alarming, water quality control, urban hydrology and dam reservoir operation. WISKI promises that in every field of application, unique WISKI water software technology converts the complexity of hydrological data and tasks into pure efficiency: reducing workload and raising its quality.

The competences of WISKI include:

- Measuring network management
- Data and time series
- Calculations and evaluations
- User management
- The WISKI Explorer
- Reporting
- Data transfer and telemetry
- Data Quality Code System
- Flow measurement/rating curves
- WISKI Web

Two examples are particularly relevant, the WISKI Explorer that facilitates simple navigation through individual data structures and definitions of own data trees. Graphs, tables, reports and evaluations can be accessed directly, key lists and meta data management are completely integrated, and external data sources such as websites can be tied in directly. The other example is the Data transfer and telemetry. WISKI provides comprehensive import and export functionality for time series/ recorded value data and meta data. All time series data imports can take place on a continuous and automatic basis or also manually. The SODA telemetry system, consisting of special hardware and software for communication tasks, offers an ideal platform for remote data transfer.

In some fields ICT has progressed more due to more data availability or because of the need for data management. This can be partly due to a high demand or large amounts of routinely available data.

What kind of relevance do they have (e.g. collection of data, processing of data, generation of knowledge, distribution of knowledge …)

ICT is relevant in all the problem fields but often there is an exponential decrease in the in their relevance according to the parameters listed. ICT is usually most intensively developed around collection of data, then considerable less well developed are all aspects considering processing of data and those most weakly

developed include generation and distribution of knowledge. Thus most emphasis is put on collection of information and least on its distribution and dissemination. Thus in the domain of tourism, for example, most emphasis is put on snow height measurements for skiing, which are then displayed in the internet, or discharge heights in rivers for rafting. The foremost intention is the use of ICT for economical development or for scientific interest and not for the sustainable development of natural resources. For example, lacking snow heights are not used to raise awareness amongst skiers about climate change and the need for adaptation as well as the protection of water resources to prevent overuse for artificial snowmaking. The information is rather used to guarantee conditions suitable for the consumer, even this goes inversely to sustainable development of natural resources.

Overview of existing methods and tools and Extent of application of discussed methods and tools

ViViANE (Virtual Visit to our Environment) is a virtual community within the FP6 framework VIRTU@LIS project where visitors assume the roles of various stakeholder groups - consumers, agriculturalists, associations, industry, institutions or scientific researchers - to learn how their individual behaviour and interaction affects the environment (O'Connor 2004). The prototype is a multimedia interactive framework that facilitates an interface between science and stakeholders and is developed for use in a variety of institutional and educational settings. For example, at the Université de Versailles-St Quentin en Yvelines, it is being used in a new Masters level programme being developed as a tool for European harmonisation. The UK Environment Agency is considering using the water resources prototype developed by project partner Cranfield University for stakeholder discussions around implementing the EU's Water Framework Directive. And the European Environment Agency is assessing the prototypes with a view to adapting them as an interface to display environmental statistics

The extent of applicability in terms of natural resource management related to e.g. agriculture is high in terms of collaboration. This includes developing means for farmers to get the best from ICT by, for example, developing community websites or tracking crop prices live, or working in local forums to maximise local efficiency. Here the problem is developing business models that could make such local collaboration initiatives self-supporting, and developing local expertise to run and maintain collaboration platforms (Ubieta 2006).

The following section is supported by the results and experience of a study by Papa et al (2006) on sustainable development of natural resources in the French Alps based on ICT. Although the case studies are specific for more isolated regions with their particular governance and infrastructure, the essence can be applied in other alpine regions. Few comparable studies exist in the literature on the topic. However, there is an emergence of "green ICT" and the analysis of ICT and sustainable development in terms of opportunity as opposed to menace (Ullmann 2008).

They discuss how ICT and their associated uses can tie in with the notion of sustainable development. Interestingly, the research was funded by France Telecom Recherche et Developpement (French Telecommunications Research and Development). Sustainable development was subdivided into 3 different categories, 1) environmental, 2) heritage and 3) economical. According to the authors, sustainable development appears less as a scientific model and more like a framework of action mobilising social actors. ICT is a support for the representation of the territories, useful during different stages of development. ICT can be consulted via three paths, in terms of infrastructure, in terms of a method transporting content but also as a relational vector between agents implied in the process of rebuilding of territories and the mobilisation of resources. ICT constitutes a territorial resource that can allow the detection, mutualisation and putting into value of specific resources within the territories. ICT are often perceived as being able to reduce or even eliminate geographical constraints of access to resources. On the other hand, sustainable development attempts to achieve a solution between the contradiction between different types of development and the preservation of ecological equilibrium. In mountain territories ICT can be useful for solving problems of interaction and exchange. Since mountain territories are strongly heterogeneous, they allow the development of different scenarios of evolution around specific resources (natural, cultural) and modes of organisation around these resources such as pluriactivity. In the valley of Maurienne (Savoy, France), for example, there is an emerging dynamism concerning the development of ICT. This includes putting into place procedures for participation in management projects and the development of public spaces linked to ICT. There is a common positioning of public politics towards ICT to assume equality between territories, equality of access for a balanced development of territories. Unfortunately, the results show that ICT does not always create a balance but in the contrary can accentuate differences, asymmetries between territories and the associated development paths. One has to take advantage of the regional differences created by the unequal distribution of ICT and know how to capture the marginal advantages and to capture and mobilise niches of innovation that are not present in other territories. Thus ICT does not enable a unique development model. The most important role that ICT plays in mountain territories is the development of internet. This is not understood or seen as a perspective for sustainable development at the local level but simply as a means of reducing gaps and handicaps. Therefore the link between ICT and sustainable development is only rarely achieved. Since so much effort is put into reducing inequalities at the economical level, the actual aim of improving environmental conditions is not the priority. Therefore, ICT often does not function as a tool for accompanying activities organised in a perspective of sustainable development nor as a generator of dynamical sustainable development.

French mountain territories often see their development in terms of tourism, even if their history, their resources and their values are very heterogeneous. Since there is no common tourist development model, ICT on line contributes to the organisation of tourist consumption in the context of competition between territories in the context of the global market. The websites of the territories are seen as an essential element for

the putting into value of the territories, often initiated by public actors. They bring together networks of stakeholders with tourist offers. Seen within the perspective of controlling the process of development of a territory, they are the levers for a better territorial autonomy. The image of the territory is largely created by the tour operators within their online offers of tourist consumption. The inhabitants often do not control what is put into place on their behalf. In Vesubie for example, the putting into value of the return of the wolf in the massif of Mercantour, which is at the heart of the communication strategy in the upper valley, is based essentially on a web site initiated by the commune of Saint Martin Vesubie. In Maurienne, internet sites have enabled cooperation between actors in the framework of intercommunes. However tin Vesubie they are much weaker. They traverse the existing administrative and geographic boundaries in a global context of the redefinition of missions in national parks.

ICT is identified by all actors together as a necessary condition for the development of their territories but they are also seen under an infrastructural angle that destroys an approach cantered on the users. The question of the applicability of ICT is in fact most frequently understood via the putting into place of numerical public sites that promise to regulate in one go the question of access (to a network) and the education of inhabitants for using the internet.

The analysis of the practise of the users of public sites show that they are mainly centres on the regulatory framework. This framework fixes practical conditions such as access, opening hours, entry prices in the field of tourism etc.

Internet sites are places of cooperation between actors since the successful development of a project depends on cooperation between actors. This cooperation is developed on the base of professional networks and existing associations representing the local development councils. In this case ICT constitutes a n essential intermediary tool in a system marked by multiple sources, a federation of users. The internet sites allow to pass to the level of global public space instead of just a single local action. Beyond the disparities in equipment and the logic shared in terms of handicaps, the question of territorial governance is central for understanding the mechanisms of adopting ICT with regard to development. Thus ICT is not justifiable as specific forms or modalities of deliberation or concentration of resources to equip a territory. But, internet sites do demonstrate that ICT in terms of a relational and media vectors in a territorial project, strongly engages actors. However in terms of public participation in large debates, ICT has not yet found a footing in mountain territories. However ICT enables local action to become global information that circulates in a network. ICT also enables awareness raising of actions which is a way of constructing common references. Thus ICT enables the development of tools allowing actors to access contents and information of several knowledge sectors. ICT may provide society with targeted tools for sustainable development. Accessibility to ICT does not guarantee cooperation between actors but it does allow diagnostics and sharing of information. In terms of operators of territorial resources, ICT can be mobilised for all strategies. Beyond the technical modalities for sustainable development, they remain fundamentally political.

They argue that although the most common approach consists in examining the possible impacts of ICT development in economic, social and environmental terms, the ability of information processing and communication technologies to be integrated within these three dimensions has still to be explored. A comparative analysis was made of the logic behind the installation of networks and the development of uses in the Maurienne and Vésubie valleys, France taking into account the characteristics of the geographic area. The results underline the importance of meshing given the smaller level of investment in the area of ICT uses. However, specific uses do emerge in certain conditions, which lead to the offering and possible mobilisation of resources specific to the territories. The ability of territories to break free from the control and influence of external actors would explain the emergence of such uses. From being seen as generic resources needed to develop territories, ICT's have acquired the status of resource operators. This status has yet to be characterised.

There are several examples of sustainable development in the field of tourism, one is the "Guide Vert" or green guide of the Mountain Riders. This guide classifies ski resorts internationally according to environmental and sustainability indicators. It is an electronic data base that has been classified into systematic and user-friendly tables that can be consulted online or via a widely distributed handbook. The guide is quite comprehensive but has potential in developing hydrological and landscape aspects of sustainable development. Another example are the "Alpine Pearls", an eco-tourist cooperation. These are 21 tourist sites in the Alps that have obtained this label due to their exemplary way of sustainable use of natural resources. This includes reduction in CO2 emissions, giving the possibility of hotel and restaurants to adhere to "green label" with financial incentives, the possibility of online calculations of CO2 emissions per tourist, the sharing of ski lift between communes etc. Another example is the ClimAlpTour project (www.climaptour.eu). In the frame of this Alpine Space Interreg, concepts for environmentally friendly and sustainable tourism are developed. The ICT include an e-tourism tool that enables clients to choose amongst destinations according to different criteria of adaptation and vulnerability to climate change. In addition, a book has been published on snow sports and education for sustainable development (Luther 2008), that gives ski clientele the option of deciding for environmentally friendly and sustainable ski destinations. For example, a choice can be made between sites that produce artificial snow or not, those that allow free-riding or not, that are in natural resorts or not, that can be accessed by train or by car. In this way, the clientele themselves can contribute directly to the sustainable development of natural resources.

Many mountain people have better access to the wider world through information and communications technologies (ICT), such as mobile telephones and internet connections,

than through traditional means, such as roads and railways (Kohler et al xxx). Modern communication technologies have shown great potential in marketing (tourism, sale of mountain products), telemedicine and distant education. He states that amongst access and energy, communications are key issues in sustainable development of mountain areas. They state that these are powerful agents of

change, providing vital linkages between these regions adjacent lowlands. Despite their relative isolation, mountains have always depended on exchange and trade with surrounding areas. The appearance of modern communication technologies (internet, e-mail) is mountain areas is a much discussed issue in development circles. Modern communication technologies such as internet have been increasingly important to link institutions and individuals interested in mountain development on global, regional and national level. However, linkage and exchange are still effected by the “digital divide”: people and institutions in mountains are still largely excluded from access to and use of these technologies. This is due to lack of the requisite infrastructure (telephone connections) and the high initial cost for the purchase of equipment such as personal computers. Simple telephone access has the most impact, for users that do not have to be literate and no specific language skills (such as English) are required. In terms of accessibility, telephones are often the first means of access via radio or satellite, followed by electricity and lastly roads which are most costly.

Key actions for local communities in the ICT sector include the participation of mountain populations in the development of communication facilities. This may require the (re)establishment of local institutions to shape local opinion. Improvements of this can allow mountain communities to benefit between themselves and creating regional institutions to enhance their political position and to promote tourism of marketing.

Who is Who of Mountain Institutes Worldwide and in Europe in Cooperation with European Mountain Forum (EMF)

The Mountain Forum (MF) set out mid 2008 to optimize, with partners, the systems and tools for information and knowledge (as part of ICT) sharing on Sustainable Mountain Development. It is part of the Mountain Forum strategic plan 2008-2011 and aimed at optimizing use of resources and providing efficient services to the 5.000 members of the Mountain Forum regional networks in Asia-Pacific, L. America, N. America, Europe and MF partners. It includes a review of existing MF systems and tools as on-line libraries, membership-, expert- and organizational Who=Who systems, e-dialogue and e-conference tools, calendar of events. Defining user needs is central and features that will be addressed are integration of tools and content, common processes, decentralization of management and enhanced user-customization of services.

Several partners engaged in information sharing for sustainable mountain development have expressed interest to participate in the process. This includes global networks and organizations such as the ILEIA-LEISA network for sustainable agriculture, the Mountain Research Initiative, GMBA, Mountain Research and Development, SDC-C. Asia networks, EU-CTA for agricultural information in ACP countries, Institute de la Montagne and departments of international agencies such as FAO, UNEP dealing with mountain related information as well as the Mountain Partnership Secretariat with its 3 decentralized hubs.

The process is carried out in 2008/2009 and entails

1. a review of existing systems and tools of the Mountain Forum,
2. a survey of information needs of MF and partners and
3. an overview of potential new tools. This was followed by
4. a workshop 27- 30 January 2009 in Kathmandu to outline the way-forward, based on common principles of work. Implementation will take place during the rest of 2009 and thereafter.

The Mountain Forum carried out an ICT scan in February 2009 in the frame of a "Mountain Forum Systems and Tools" electronic conference with several hundred participants. Regional networks and partners will be structured as an input for the joint tool development, lead by InfoAndina and coordinated by Mountain Forum Secretariat.

Within ICIMOD (International Centre for Integrated Mountain Development) ICT plays an important role in sustainable development of natural resources in cooperation with the Mountain Partnership and Mountain Forum. In terms of information resources, ICIMOD collates, shares and links information on a different topics relevant to mountain development, especially in the Hindu Kush-Himalayan region. Some of the tools available include the ICIMOD bi-monthly e-Newsletter, e-discussions and a website with boos online. One of their programmes is Integrated Knowledge Management, with a sub-division on Mountain Environment and Natural Resources Information Systems.

Rural people in the mountainous areas of the HKH region have lived traditionally in much lower levels of economic incomes and general well being than their counterparts, are more marginalized from digital opportunities despite ICT as an effective tool to address these longstanding problems of inequality. In addition, negative perceptions on rural ICT use are prevalent: rural people are considered to have little demand for so-called e-services maybe partly infused by the notion of higher illiteracy, absence of electricity to feed electronic equipment and the returns on investment are low because rural people are not productive but consumptive users of ICT. Reducing the information cost and building ICT capacity are of central importance for the rural and mountain poor and most RMC's have developed frameworks to improve accessibility. It is however extremely important that after the provision of infrastructure, connectivity, complemented by capacity building, providing useful content is crucial to people living in rural areas and often in the form they can absorb or understand (local language. Access to education and training through e-learning, will be important in most sectors, particularly to improve the participation of woman in development and bridge the gender gap. Appropriate ICT solutions for improving the efficiency of health service, governance, disaster preparedness, market information services enables rural poor to meet basic needs and encourages greater public voice in decision making and above all, empowers rural people.

<u>The following list set out to explore some examples of tools</u>

- Webpage: www.mtnforum.org

- Online Videos e.g. Greenland: http://www.telegraph.co.uk/earth/environment/climatechange/4734859/Scientists-capture-dramatic-footage-of--Arctic-glaciers-melting-in-hours.html
- structured e-conferences
- tools for e-dialogues
- facebook
- online library
- online newspapers
- e-Learning has emerged during the last decade as a promising new approach to education, training and personal development. It has the potential to create a knowledge society for everyone
- who is who system on organisations active in sustainable mountain development
- membership registration and communication system
- calendar of events
- electronic newsletters (in several languages)
- MF Global website and regional networks (EMF) www.mtnforum.org/europe/
- Kompass Kompetenzzentrum Klimafolgen und Anpassung (competence centre for climate change impacts and adaptation) (http://www.anpassung.net). This is a project catalogue www.anpassung.net/projektkatalog. The complete listing of project information follows via the Umweltdatenkatalog or the environmental data catalogue of the federal state of Germany (PortalU).
- International Programme on Research and Training on Sustainable Management of Mountain Areas, Snow and Alpine Soils Lab, University of Turin, Italy. Course objectives: Summer School “Developing economic opportunities for mountain areas. The aim is to give post-graduate students a broad view and essential skills in relation to the economic roles of mountain resources, taking into account the important values recognised to the several environmental and social services provided by mountain landscapes including the wood and non wood forest products, the ecotourism enterprises, the protected areas and the mountain agriculture

Organisations

- OWSA (One World South Asia)
- InfoAndina
- InfoBridge Foundation
- EEA (Environmental Technology Atlas)
- EGU (European Geosciences Union)
- NSCE

Networks

ICT

- The i2010 initiative, was launched in 2005, promotes convergence in information and communication technologies, a strategy that is vital to reach the overall

objectives of boosting innovation and jobs set out by the Lisbon Strategy. (Redding 2009)

Mountains

- MRI http://mri.scnatweb.ch/ (Mountain Research Initiative)
- Mountain Forum http://www.mtnforum.org/
- www.institut-montagne.org (French only) Electronic Resource Centre of the Mountain Institute
- http://www.uibk.ac.at/igf/index.html.en The Mountain Research: Man and Environment in Innsbruck.

Ecology

- LTER http://www.lter-europe.net/
- GTOS www.fao.org/gtos
- GMBA http://gmba.unibas.ch/index/index.htm

Hydrology

- IWRA (http://196.36.166.88/iwra)
- IAHS (http://iahs.info/)
- Mountain Water Network http://www.netzwerkwasser.ch/ Water Network of Switzerland. Research objectives: enhance transregional and transdisciplinary knowledge transfer. Funding possibilities at national and international level (e.g. Swiss Mountain Water Award) Developing innovative and practical solutions for the upcoming challenges. Strengthening the international competiveness of the networks partners.
- World Water Council http://www.worldwatercouncil.org/
- World Water Forum (www.worldwaterforum5.org)

Newsletters

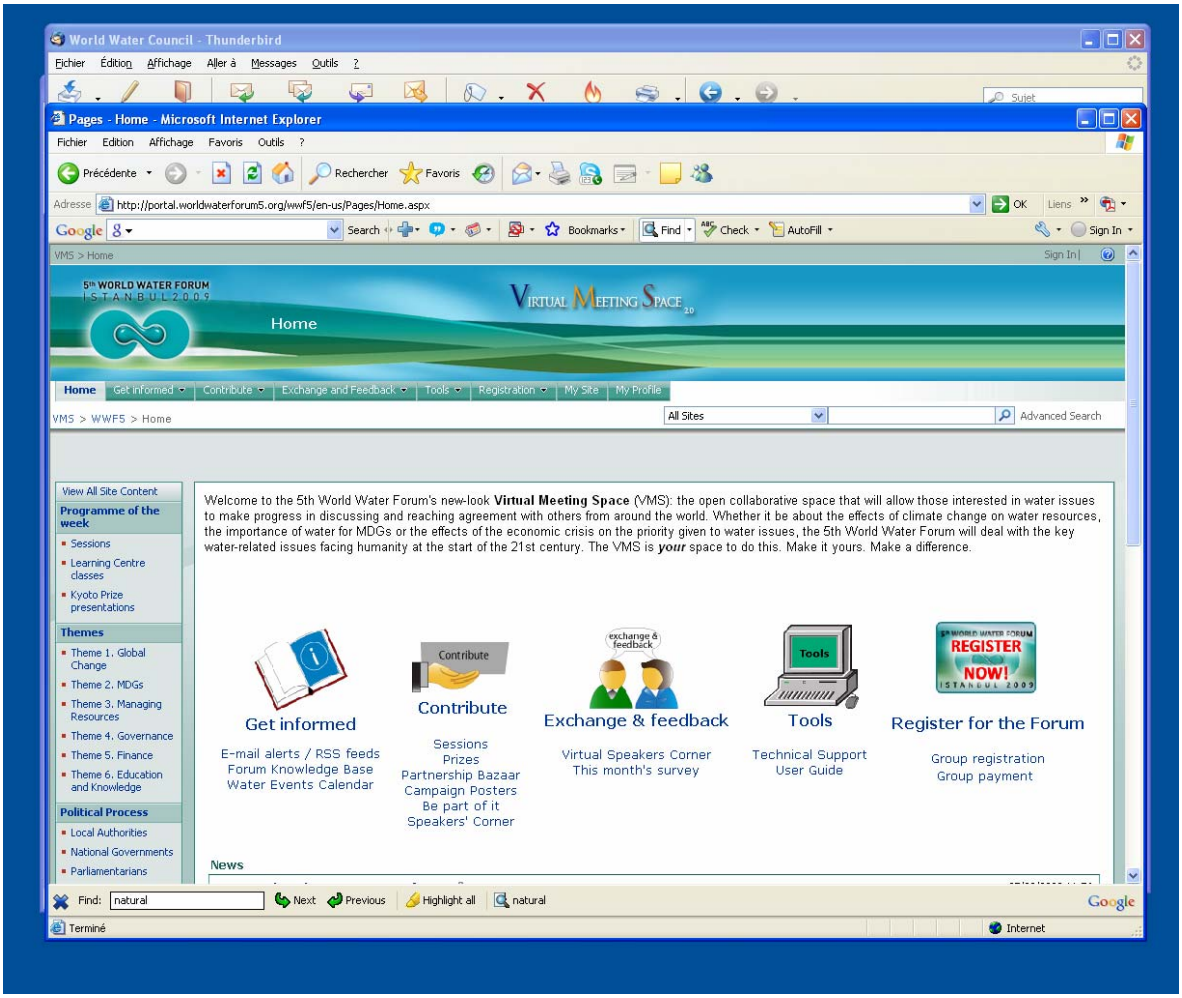
- Earth Portal (Environment in Focus)
- Umweltdachverband (http://www.umweltdachverband.at/)
- Waterportal UNESCO Waterportal@unesco.org, http://www.unesco.org/water/news/newsletter/EnvironmentalResearchWeb
- World Water Council (http://www.worldwatercouncil.org/index.php?id=760)
- Public Service (Science, Technology and Research Overview) (http://www.publicservice.co.uk/topic_section.asp?topic=Science and technology)
- Water Bridges of the 5th World Water Forum newsletter@worldwaterforum5.org
- DurAlpes Attitude contact@duralpes.com (http://www.duralpes.com/34/)
- environmentalresearchweb newswire info@environmentalresearchweb.org
- EMWIS Flash N°67, February 2009 Euro-Mediterranean Information System on the know-how in the Water SectorEMWIS is a program of the Union for the Mediterranean. http://www.emwis.net
- ILEIA e-bulletin www.leisa.info.

Projects

- Alp-Water-Scarce. The project is putting into place a Stakeholder Interaction Forum. Part of this is based on the internet (web based questionnaires, questions and answers, contacts see www.alpwaterscarce.eu/stakeholders) and part is based on questionnaires in the field. An electronic forum on its own is not sufficient to enable smooth communication between the different stakeholder groups and project manager or project partners, since not all mountain communities have internet access or take the time to answer the questions. Face-to-face interviews and telephone calls are much more binding. ICT in this context is seen as a tool or guidance for a participative process, but can only be used in conjunction with public meetings. In the absence of proper coordination, and personal engagement (such as meetings), this process cannot contribute to sustainable development of natural resources.
- ClimAlpTour (www.climalptour.eu)
- Alplakes (www.alpinespace.org/alplakes.html)
- AWARE (www.aware-eu.info/de/home.htm)
- ACQWA (http://www.acqwa.ch/)
- Envirogrids http://www.envirogrids.net/
- GLORIA http://www.gloria.ac.at/?a=2

Conferences

- A new trend in the application of ICT to conferences dealing with sustainable development is conference preparation via these tools. This has to be well organised and requires an own secretariat to deal with requests and sorting of information. Here are a few examples.
- The International Conference on Biodiversity Informatics (E-Biosphere 2009) is interactive and includes tools such as an Online Conference Community (OCC) that supports electronic discussion forums. These enable researchers and users to interact. Position papers will be prepared on the future of biodiversity Informatics in the next 5-10 years. One of the themes is ecology and ecosystems, environmental sustainability and climate change.
- 5th World Water Forum. One of the mottos of this conference is “Managing and protecting water resources and their supply systems to meet human and environmental needs”. Prior to the meeting a monthly newsletter was released called “Water bridges”. Within it is a link to the Virtual Meeting Space (VMS), an open collaborative space that allows all interested in water issues to discuss with each other. It is divided into 5 sub-categories: “Get informed”, “Contribute”, “Exchange and feedback”, “Tools” and “Registration”. Within the Virtual Speaker Corner, a rich palette of themes and discussion forums can be found, including PowerPoint presentations and documents. One of them concerns Topic 3.3 Preserving Natural Ecosystems and discusses the changing paradigm of “Water for Nature” to “Nature for Water”. IWRM (Integrated Water Resources Management) plans are discussed next to national forest programmes, biodiversity strategies and land-use planning to ensure sustainable water management.



- Biodiversity in a rapidly changing world, NCSE (National Council for Science and the Environment), Washington DC, December 2008. This conference aims to bridge the gap between scientists, policy makers and politicians on biodiversity and sustainable development of natural resources. There were several special sessions, electronic discussion and preparatory sessions.
- Impact of ICT on the principle planning of rural territories in mountains Gap, 25 October 2007. Organised by RIA Leader+ South-east, the GAL including the sites "Gapençais-Buëch-Durance", "Pays du Grand Briançonnais" and "Vallées du Mercantour".
- The environmental eScience revolution" – a symposium in London held to mark the end of the UK's Natural Environmental Research Council (NERC)'s eScience programme. This investigated using the internet and other information technologies to transform the way environmental researchers work.

b) Analysis of framework conditions

Use of ICT discussed in other sustainability research areas Apart from its use in water resources management, ICT is applicable in other areas such as:

- protection of natural resources related to natural parks and Natura 2000 areas including biodiversity, forests, meadows, soils, lakes and rivers
- protection of natural resources related to tourism, such as snow, ice, glaciers and water bodies, in particular canyons, waterfalls, streams and lakes and biodiversity as well as geology (rock faces, scree slopes) and geomorphology (moraines, fans and cones). It should also include the protection of air quality and lowering of CO2 levels, by allowing only the use of electrical cars and boats
- prevention of infrastructural developments (such as dams, reservoirs, electricity lines and motorways) in natural reserves
- protection and development of “green cities”.
- development of environmental education schemes related to development of green technology and protection of natural resources for school children, students, journalists and museums

Efficiency information flow in this area, open access to technologies, acceptance of technologies:

The main obstacle encountered with the efficiency of information flow in this area is the recognition, knowledge, accessibility and applicability of ICT-related information. Often, the connection is not made between the existence of work tools related to ICT for sustainable development of natural resources. This is mainly related to a lack of awareness raising in this area. Also, there is a certain exclusiveness of ICT application s to those already working or trained in this area, as opposed to those users that should benefit from it but are not yet connected to the ICT-market. The lack of access to technologies is closely related to the efficiency of information flow, since ICT is a special electronically-related technology field, it presumes the existence of hardware and software and an elevated level of training in that field, basically requiring a first-level degree. Thus, a basic cost of investment is a pre-requisite. Also, most ICT tools related to natural resources have a high level of sophistication and are not necessarily freely available on the market, but require purchase of commercially developed software that is unique and tailored to special users. The acceptance of technologies may be less of an obstacle, since most users would be willing to apply a fast and cheap tool for development of natural resources.

Geographic, country-specific differences in Europe

There are considerable differences in the application of ICT in the field of sustainable development and use of natural resources within the Alps as related to the rest of Europe and within east and west European countries. Thus, within the alpine countries there are considerable differences. Countries such as Switzerland, Austria, S. Germany and the eastern parts of the Italian Alps are well interconnected via ICT for the development of water resources and natural reserves, whereas western and eastern alpine countries have a low level of ICT application. This is mainly due to the sequence and systematic development of natural resources via monitoring, modelling and predication. Those countries that have not yet developed a sound monitoring system for natural resources threatened by extinction or depletion, do not yet have the basis for modelling and prediction and can therefore not yet feed the ICT-based

systems and data bases. Those countries that have large quantities of data available electronically necessarily have to apply ICT to manage them and further process them. On the whole, geographical and topographical differences have a strong influence on the intensity of use of ICT, thus the Netherlands has a high level of ICT interconnectivity whereas France has a lower one.

c) Short overview of relevant sustainability indicators and policy background

Overview of used Indicator Systems

It is very difficult to define sustainability indicators since at a large scale, this is virtually not possible. For small, partial systems, e.g. wetlands or small mountain communities, certain indicators that involve mostly an indicator of an equilibrium in factors (e.g. water consumed < or = than water available,). The problem apart from quantifiable environmental indicators such as water amounts is the problem of finding indictors for economic, social and cultural parameters, or those that come in unexpectedly and are external to the system such as disease.

The lost commonly used indicators directly related to ICT include the Digital Access Indicator (DAI). They include internet connections per 100 inhabitants, mobile internet. per 100 inhabitants, internet tariff as % of GNI, international internet bandwidth, broad bad subscribers, internet users per 100 inhabitants, knowledge, quality, usage.

EU legislation (concerning environmental key area and ICT):

There are a number of dynamical developments concerning the environmental key area and ICT. EU legislation such as the water framework directive or the soils directive, or that related to the lowering of CO2 emissions, require precise monitoring and development of different resources. This implies the application of ICT as all different levels, whether via monitoring or awareness raising. The EU commissariat for ICT, Reding, has also dedicated the debate to this field of development.

EU politics, relevant policies:

The EU relevant policies include, as mentioned above different framework directives that for purpose of monitoring and control require ICT technologies. The climate impulse has considerably advanced European Policy on the use of ICT for energy efficiency (European Commission, DG INFSO (2005) and climate change, but less directly related to natural resources. Another EU relevant policy that is in development is the idea of a European “clearing house” on climate change and sustainable development related projects.

4) Future Potential

a) Characterisation of potential and limitations of discussed ICT concerning the relevant key-area

The future potential of ICT in sustainable development is judged highly (Forum for the Future 2004), Monteiro (2007), Ruddy (2008) since they are seen as a method of parameterization, monitoring , protection and development.

The main limitations of ICT in the key areas of sustainable use of natural resources, such as water, snow, ice, air, topography are often technological in nature. Thus mobile phones are often without network in mountain valleys and internet infrastructure is often not available in remote mountain valleys and on slopes in the Alps. This considerably restricts modern communication techniques, such as e-mail and questionnaires. Other disadvantages include the time required to learn new software programmes, getting accustomed to different interfaces and time lost registering for different programmes in the internet.

Sustainability, is about people and social issues as much as technology and natural resources. Modern ICT markets have a tipping equilibrium and may not always be beneficial for sustainable development. If a lot of ICT equipment is used and it saves on energy-then energy becomes cheap, inducing more to be used (Cave 2004). In some mountain communities (such as Quincy, Upper Savoy, see Perret 2007), the transition to ICT is not seen favourably since the new possibilities offered by internet increase the purchasing interest and choice and therefore cause more time spent searching for products by car, in turn augmenting CO2 emissions. The GLOCHAMORE project (Global Change in Mountain Regions) identified the need to protect natural resources in Mountain Biosphere Reserves by carefully monitoring land use change. While excellent land use change models exist, few of the Mountain Biosphere Reserves have the GIS technology needed to run them. A minimum strategy would consist of implementing GIS, obtaining basic spatial data, and assessing current land cover condition and trends (MRI 2005).

b) Research demand concerning ICT in the relevant key area

The main research demand in both key area domains includes:

- improving the incompatibilities encountered at the interfaces between qualitative and quantitative information and data systems.
- developing methods of overcoming the problem of integrating “routine” data versus “non-routine” data. This is closely connected to the problems of how to cope with non-uniform qualitative data discussed above. Improvements could be made in finding simplifications and shortcuts for converting qualitative data in an objective way to quantitative data.
- solving the language problem at the local scale (many stakeholders do not master English and are therefore exempt from using ICT)

- dealing with sustainable development as an “open system” rather than a neatly defined “closed system”.
- bridging the gap between the existence of information and communication technology and its application
- applying ICT actively rather than passively. This requires permanent personnel responsible for the sustainability of- and trouble-shooting within the system
- accustoming all sectors of society to use ICT and not just top level managers and planners
- enabling the transition from traditional concerted efforts in groups to electronic means
- developing methods of homogenisation of ICT
- integration of socio-economic experts and stakeholders confronted with every day problems for the development and application of ICT
- developing eco-technologies (with reference to the key area treated in this report: e.g. environmentally friendly methods of water purification i.e. non-chemical or environmentally friendly methods of using natural resources for alpine tourism e.g. alternatives to artificial snow production).

c) Importance of relevant research fields for future research programmes

Future research programmes in the field of ICT for sustainable development could focus on the regional (geographical and topographical) disparities of ICT application in Europe. In particular, peripheral areas that are less accessible both physically and electronically (mountains, wetlands etc) should be strengthened. Future programmes should also focus on a clearer systematic approach, developing ICT-specific tools (such as databases and atlases) at the beginning of the set-up of environmental monitoring programmes, supply them with structured data during monitoring phases and link them to models and future predictions related to climate and global change. Particular emphasis should be placed on the set-up of ICT for qualitative data, so that natural resources can be monitored and action taken based on tools such as lime surveys and choice experiments via internet surveys.

Some future developments include a conference on “Sustainable Development: a challenge for European Research” organised by the European Commission Research DG. In preparation for the conference, a RD4SD exercise – a web-based consultation is carried out. In this context the European Commission Research DG invites scientists to express their view. http://ec.europa.eu/yourvoice/ipm/forms/dispatch?form=RD4SD. The RD4SD exercise is launching a structured dialogue on how European research should evolve to best respond to sustainable development challenges in terms of research implementation, research policy, and indicators. More information on this exercise is available on http://ec.europa.eu/research/sd/index_en.cfm?pg=rd4sd.

5) Networking Activities

Remark of the ICT-ENSURE Project Consortium: Information about national research programmes, organisations, research institutions and experts contacts has been collected, but will not be displayed in this public website-version of the survey. Some of the information will be available on the research programmes information system.

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ANNEX I - Examples for ICT-fields relevant for ICT-ENSURE

Short name	Additional Info
Information management	Incl. Information systems, data bases, metadata catalogues …
Artificial intelligence, knowledge management	Incl. decision support systems, expert systems, planning systems, cognitive systems, agent systems…
Human-computer-interaction	Incl. Human-computer-interface, visualisation, computer graphics, ergonomics, multimedia, barrier-free access, rich Internet applications …
Personalised information, eLearning	Incl. generation of personalised information, knowledge transfer …
Communication, networks, Internet	Incl. Web-based systems, portals, wireless telecommunication …
Integration, inter-operability, services	Incl. services concepts, SOA, service infrastructures, distributed systems, GRID, ubiquitous computing, pervasive computing …
Cooperative systems	Incl. CSCW, Web 2.0, social Web …
Modelling and simulation	Incl. methods and tools, applications …
Monitoring & control, sensors	Incl. monitoring networks, sensor webs, remote sensing, measurements …
Geographical information, GIS	Incl. location-based information, visualisation of geogr. Info …
Mobile systems	Incl. mobile phone and PDA based systems …
Other ICT methods, tools and techniques	Other ICT methods than the above listed methods …
ICT in general	General and overall questions of ICT …

ANNEX II - Environmental Sustainability Fields relevant for ICT-ENSURE

- Energy consumption/efficiency
- Sustainable Use of natural resources
- Climate Change
- Industrial Ecology
- Agriculture
- Biodiversity
- Landscape planning
- Personalised Information Systems and Quality of Life
- Sustainable Urban Development
- Health
- Environmental Risk Management