ITU Symposium on

ICTs and Climate Change

Hosted by CITIC

Quito, Ecuador, 8-10 July 2009

ITU background report

1. INTRODUCTION

Over the past few years, the issue of climate change has become a main item on the global agenda. The UN Secretary-General, in his visit to the International Telecommunication Union (ITU), observed that *"Climate change is the moral challenge of our generation"* and that *"ITU is one of the most important stakeholders in terms of climate change."*

Dr. Hamadoun I. Touré, the ITU Secretary-General, has stated that *"Climate Change is a global challenge that the world cannot lose"* and that *"ITU is committed to achieving climate neutrality and to working with our membership to promote the use of ICTs as an effective tool to combat climate change."*

The impact of ICTs on the environment has been a longstanding concern at the ITU, dating back to the International Radio Conference of Atlantic City, 1947, where ITU Member States included Meteorological Aids Service (MetAids) in Radio Regulations and allocated radio frequency spectrum for MetAids applications employed for environment and climate monitoring.

At the Plenipotentiary Conference 1994 in Kyoto (Japan), ITU Member States adopted Resolution 35 *"Telecommunication support for the protection of the environment"* that resolves *"that the Union shall give every possible encouragement to an increasing role being played by telecommunication and information technologies in promoting environmental protection and sustainable development [...]."*[1]

The World Telecommunication Development Conferences, in 1998 (Resolution 8, Valletta[2]), in 2002 (Recommendation 7, Istanbul[3]) and in 2006 (Resolution 54, Doha[4]) invited the Telecommunication Development Sector, in general, and the Telecommunication Development Bureau in particular, to assist developing countries in the use of telecommunications for the protection of the environment.

The last Radiocommunication Assembly 2007 (RA-07) and the World Radiocommunication Conference 2007 (WRC-07) approved several resolutions (such as Resolution[5]) requesting Radiocommunication Study Groups to carry out studies and develop the relevant international standards (ITU-R Recommendations) for further development and the use of radiocommunication systems and radio-based applications for climate monitoring.

In 2007, ITU and its membership and partners launched a major programme to investigate the specific relationship between ICTs and climate change. At the meeting of the Telecommunication Standardization Advisory Group (TSAG) in December 2007, a Technology Watch Briefing Report on this topic was reviewed[6]. Two international Symposia on ICTs and Climate Change were held in 2008[7]. They took place in Kyoto, Japan, in April 2008, hosted by the Ministry of Internal Affairs and Communications (MIC), and in London, UK, in June 2008, hosted by BT. Now in 2009, as part of its major initiative on ICTs and climate change, ITU is organizing the third Symposium on ICTs and Climate Change in Quito, Ecuador on 8-10 July 2009, hosted by Centro Internacional de Investigación Científica en Telecomunicaciones, Tecnologías de la Información y las Comunicaciones (CITIC) Ecuador.

The Kyoto and London events led to the establishment of an ITU-T Focus Group on ICTs & Climate Change by TSAG in July 2008. The Focus Group analyzed and identified gaps in the areas of definitions and developed agreed methodologies and appropriate tools to measure the impact of ICTs on climate change and to support the development of appropriate international standards[8]. The Focus Group successfully completed its work in March, and TSAG, at its meeting in April 2009, established ITU-T Study Group 5 as the lead Study Group on ICTs and climate change, changing the Study Group's name to *"Environment and Climate Change"*[9]. A main task of the Study Group will be to convert the output of the Focus Group into ITU-T standards. Further, all ITU-T Study Groups are committed to taking into account the environmental impact of all new standards.

The ITU membership endorsed a major statement on the issue in Resolution 73 on Climate Change, adopted at the World Telecommunication Standardization Assembly, Johannesburg, South Africa, in October 2008 (WTSA-08)[10]. The Resolution recognizes the crucial role of ICTs in addressing climate change and resolves to continue and further develop the ITU-T work program in this area as a high priority and in close collaboration with the other two ITU Sectors. In addition, Resolution 73 instructs the Director of the Telecommunication Standardization Bureau to organize related events in developing countries, to raise awareness and identify their needs in this domain, as they are the most vulnerable countries affected by climate change.

More recently, the ITU World Telecommunication Policy Forum met in Lisbon and agreed to Opinion 3 on *"ICT and the Environment"*[11].

This revised background report has been prepared by the ITU secretariat for the Symposium on ICT and Climate Change in Quito, Ecuador. New sections highlight the key issues in the region, including deforestation and financing. In addition, the Annex to this report provides an inventory of work underway in ITU on climate change.

The Perspective from Latin America

This is the first ITU Symposium on Climate Change to take place in a developing country and the first in Latin America.

Thus, this Symposium presents an occasion to focus on issues with respect to climate change that are most relevant to developing countries as well as to the Americas.

Although developing countries are not the major contributors to GHG emissions that lie at the heart of global warming, the impact of climate change falls heavily upon them. Once released in the atmosphere, GHG emissions do not observe geographical boundaries, and their effects on climate can be global and pervasive. The rise in the number of extreme weather events, such as hurricanes in the Caribbean, glacial melting and threats to low-lying areas from rising oceans are evidence of these impacts on developing countries and in the Americas.

For developing countries, implementing climate change solutions raises questions of funding, financing and access to technology, and thus this Report and the programme of the Symposium address these issues. In addition, ICTs can only play a role in combating climate change in countries that have affordable, widespread and accessible ICT infrastructure. The Report touches on that topic as well.

There are also issues that are unique to the Americas. It is estimated that deforestation contributes nearly one-fifth of total global GHG emissions. This figure dwarfs the emissions from aviation, shipping and ICT sectors. As home to the Amazon rainforest, Latin America is particularly impacted by deforestation.

In addition, Latin America is one of the most biodiverse regions in the world, with five of the world's ten most biodiverse countries: Brazil, Colombia, Ecuador, Mexico, and Peru, as well as, five of the 15 countries whose fauna is nowadays most threatened with extinction.

In a 2008 Report, the World Bank listed some of the critical impacts of climate change in the region[12]:

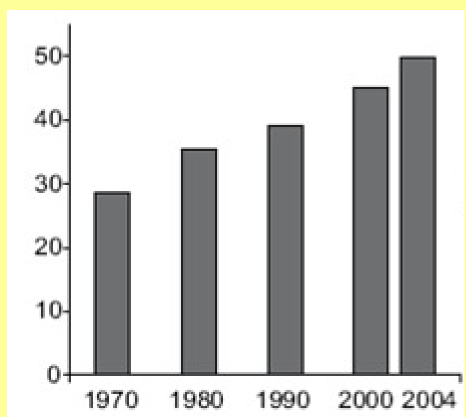
- By 2100, agricultural productivity in South America could fall by 12 to 50 per cent.
- In Mexico, 30 to 85 per cent of farms could face a total loss of economic productivity by 2100.
- Climate-related natural disasters (storms, droughts and floods) cost, on average, 0.6 per cent of GDP in affected countries.
- Hurricane damages will increase by 10 to 26 per cent for each 1°F warming of the sea.
- Many Andean glaciers will disappear within the next 20 years placing 77 million people under severe water stress by 2020.
- Caribbean corals will bleach and eventually die. Since the 1980s, 30 per cent of corals already have died, and all could be dead by 2060.
- Increase in risk of dengue, malaria and other infectious diseases in some areas.
- The Amazon rainforest could shrink by 20 to 80 per cent if temperatures increase by 2 to 3°C.
- Large biodiversity losses are expected in Mexico, Argentina, Bolivia, Chile and Brazil.

Even though, the Region is not one of the main sources of global GHG emissions that are driving global warming, the above list shows that the impact of climate change on Latin America is and will be dramatic and costly and highlights the urgency of actions to address this problem.

2. CLIMATE CHANGE AND THE IMPACT OF ICTS

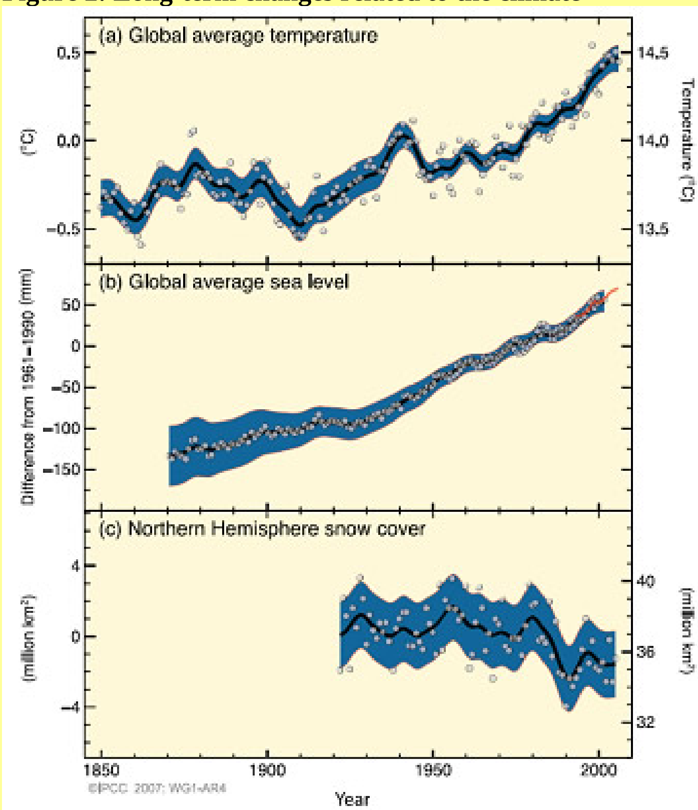
There are a number of different causes of climate change, many of which are naturally generated (e.g., variations in solar radiation, volcanic activity, etc). However, it is man-made climate change that is of major concern because it appears to be leading to a progressive and accelerated warming of the planet, as a result of the release of greenhouse gases, primarily carbon-based emissions, including carbon dioxide and methane. As shown in Figure 1, taken from the work of the UN Intergovernmental Panel on Climate Change (IPCC), global GHG emissions have risen by 70 per cent since 1970[13]. As a consequence, global average temperatures have risen by around half a degree centigrade (from 14° to 14.5°C) since 1950, and there has been a rise in sea level of around 10 cm and a reduction of Northern hemisphere snow cover of around 2 million km^2 over the same period (see Figure 2)[14]. Since measurements began, eleven of the warmest annual average temperatures recorded have been in the thirteen years up to 2007[15].

Figure 1: Total Greenhouse Gases (in Gt CO_2eq)



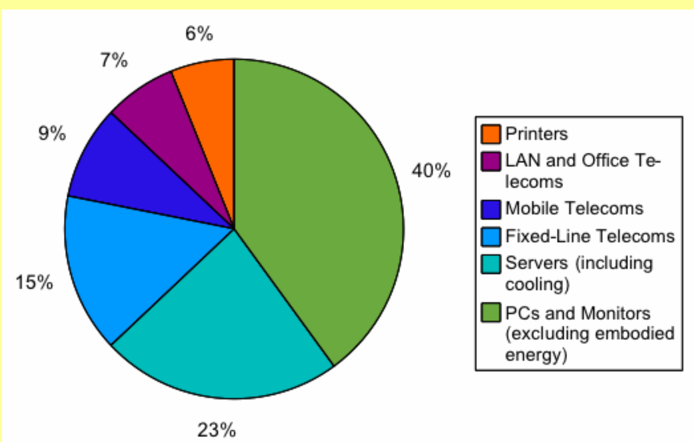
Source: IPCC (WG 3 contribution to 4th assessment report)

Figure 2: Long-term changes related to the climate



Source: IPCC (WG1 contribution to 4th assessment report)

Figure 3: Estimated distribution of global CO_2 emissions from ICTs



Note: This analysis does not include radio-broadcasting equipment or TV sets. It is based on a global estimate of 0.9 Gt CO_2eq.

Source: R. Kumar and L. Mieritz, "Conceptualizing 'Green IT' and data centre power and cooling issues," Gartner Research Paper No. G00150322, Sep. 2007.

At a scientific conference on climate change in Copenhagen in March 2009, Lord Nicholas Stern, author of the Stern Review on the Economics of Climate Change [16], predicted that average temperatures could rise by as much as 6 degrees by the end of this century[17].

The primary sources of GHG emissions are energy production and consumption, transport, buildings, land-use change, agricultural byproducts, waste management etc. Other industries, including the ICT sector, generate around 4 per cent of total GHG, but this is much higher—around 14 per cent—if indirect energy use is included. According to a report prepared by McKinsey for the Climate Group and the Global eSustainability Initiative (GeSI), the ICT sector itself (excluding the radiocommunication sector) contributes between 2-2.5 per cent of GHG, at just under 1 Gigatonne of carbon dioxide equivalent (CO_2eq)[18].

The main constituent (40 per cent) of this is the energy requirements of PCs and data monitors, with data centres contributing a further 23 per cent (Figure 3). Fixed and mobile telecommunications contribute an estimated 24 per cent of the total. As the ICT industry is growing faster than the rest of the economy, this share will likely increase over time. ICT's share of global GHG emissions (2.5 per cent) is much smaller than its share of gross domestic product (GDP; which is around 8 per cent of US GDP, for instance).

The main output of the ICT sector is information rather than physical goods (*"bits"*, not *"atoms"*), a concept sometimes referred to as *"dematerialization"*. Thus, ICTs can contribute greatly to finding a solution to reducing the GHG emissions from other sectors of the economy, perhaps by five times as much as the carbon footprint of the sector[19].

However, some experts consider that the carbon footprint from ICT equipment, including radio applications (TV and radio set, video and DVD players and recorders, terrestrial and satellite set-top boxes, etc.) and systems is significantly higher than 2-2.5 per cent. For example, the European Commission in its report to the European Parliament stated[20]: *"ICTs are now embedded in almost all parts of the European economy. As a result of its own success, use of ICT products and services represents about 7.8% of electricity consumption in the EU and may grow to 10.5% by 2018."*

ICTs are a contributor to global emissions and this comes from a number of sources:

- The major contribution of ICTs to climate change comes from the proliferation of user devices, all of which need power and radiate heat.
- For instance, in the decade between 1996 and 2008, the number of mobile phones rose from 145 million to more than 4 billion. Over the same period, estimated Internet users grew from 50 million to more than 1.5 billion. In 1996, virtually all residential Internet users were using dial-up whereas by 2008 a majority had always-on broadband connections, further increasing power use.
- In addition to the proliferation of users, each individual user may now own multiple devices. For instance, whereas twenty years ago a single television might have provided entertainment for a household, now a typical family in a developed country might own multiple radio receivers, television sets, as well as a digital cinema, video-recorder, a DVD recorder, one or more set- top box decoders, satellite dish, etc, many of which are routinely left on standby overnight or during absences for work, vacation etc.
- As these ICT devices acquire more processing power, their requirements for power and for cooling, also rise. For instance, third generation (3G) mobile phones operate at higher frequencies and need more power than 2G ones (for instance, for Internet access, digital signal processing, polyphonic ringtones, etc.). Therefore more power is required to keep them charged.

ICT use will continue to grow, and as the deployment of ICT continues, the sector faces the challenge to limit and reduce its own carbon emissions. New technologies, such as Next Generation Networks (NGN), promise greater energy efficiency than existing systems[21].

3. CLIMATE MONITORING

A key element in addressing climate change and the impact of natural disasters are efforts to improve global climate monitoring. The use of accurate climate change indicators increases the possibilities of mitigating climate change and helping countries to adapt to extreme weather events. ICT is a key to monitoring systems for weather forecasting, climate monitoring, and predicting, detecting and mitigating the effects of natural disasters. Adapting to extreme weather events, such as hurricanes, is a critical issue in many developing countries, particularly those in the Caribbean.

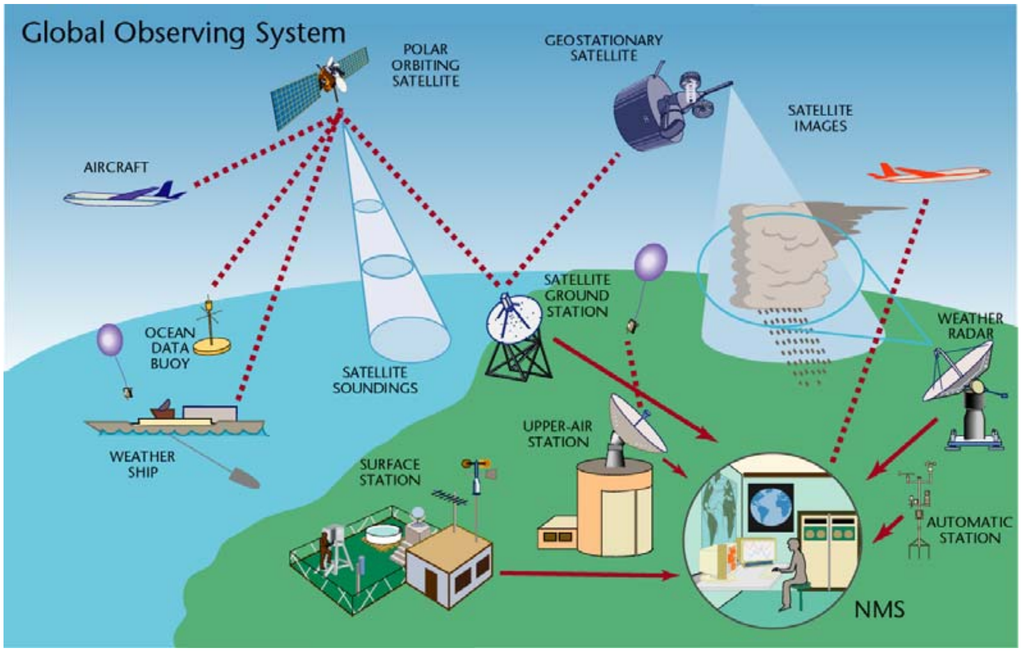
ITU work in this area focuses on the use of ICTs (including radio and telecommunication technologies, standards and equipment) for weather and climate change monitoring, for instance in predicting, detecting and mitigating the effects of typhoons, thunderstorms, earthquakes, tsunamis, man-made disasters, etc. The role of ICTs in weather and climate monitoring is clearly shown in the structure of the World Meteorological Organization's (WMO) World Weather Watch (WWW; see Box 1).

All ITU Sectors are very active in developing ITU standards and other publications devoted to the use of telecommunications and radio technologies for climate, weather monitoring and forecasts, as well as Earth observation activities, and organizing different forums (symposia,

Box 1: WMO's World Weather Watch (WWW)

The WWW is composed of three integrated core system components. All three layers are based on the use of different ICT components and applications:

- The **Global Observing System** (GOS) provides observations of the atmosphere and the earth's surface (including the surface of the oceans) from all parts of the globe and from outer space (see below). The GOS mainly acts as relay for remote sensing equipment placed on satellites, aircrafts, radiosondes (a type of weather probe), as well as meteorological radars on the earth and at sea.
- The **Global Telecommunication System** (GTS) combines radio and telecommunication equipment capable of providing real time exchange of a huge volume of meteorological data and related information between international and national meteorological and hydrological centres.
- The **Global Data Processing System** (GDPS), based on thousands of linked mini, micro and supercomputers, processes an enormous volume of meteorological observational data and generates meteorological products such as analysis, warnings and forecasts.



Note: NMS = National Meteorological Service.

Source: World Meteorological Organization.

seminars, workshops, etc.) relevant to climate and weather monitoring systems and equipment.

However, taking into account the importance of the radio frequency spectrum, the ITU Radiocommunication Sector's (ITU-R [22]) contribution is especially valuable for the development and functioning of the Global Observing System (GOS). ITU-R Study Group 7 (*"Science services"* [23]) has developed the RS (*"Remote Sensing"*) Series of ITU-R Recommendations[24] and Reports[25] for the implementation of radiocommunication systems for monitoring climate change.

Other studies carried out by the ITU-R Study Groups provide necessary support for the development and utilization of different ICT systems such as:

- Weather satellites that track the progress of hurricanes and typhoons;

- Weather radars that track the progress of tornadoes, thunderstorms, and the effluent from volcanoes and major forest fires;
- Radio-based meteorological aid systems that collect and process weather data, without which the current and planned accuracy of weather predictions would be seriously compromised;
- Broadcast sound and television systems and different mobile radiocommunication systems that warn the public of dangerous weather events, and aircraft pilots of storms and turbulence; and
- Satellite systems that are also used for dissemination of information concerning different natural and man-made disasters.

All these systems are part of the GOS, employed by the majority of countries. These systems save thousands of lives each year and the WMO and ITU, together with other UN Agencies, Administrations and organizations contribute to further develop such systems.

Recognizing that the radio frequency spectrum is a critical resource for remote sensing employed in the GOS (see Resolution 673 (WRC-07) *"Radiocommunications use for Earth observation applications"*) and in order to provide necessary spectrum / satellite orbit resources, ITU-R adopts the Radio Regulations (treaty status) and voluntary international standards (ITU-R Recommendations) that are employed for the development and operation of different radio applications for climate monitoring. The last World Radiocommunication Conference (WRC-07, Geneva):

- Considered (with positive results) four main issues directly related to remote sensing (including extension of bands for some active sensors);
- Approved five new Resolutions concerning new studies relevant to remote sensing;
- Included four items in the draft agenda of WRC-11 on the use and further development of remote sensing systems;
- Requested ITU-R Study Groups to carry out studies and develop Recommendations related to the further development of remote sensing applications that would improve precision of climate monitoring and prediction of climate change.

For more than 50 years, ITU has enjoyed excellent cooperation with the WMO, with national and international meteorological organizations and subsequently, with space agencies in providing radio-frequency spectrum and satellite orbit resources for radio-based remote sensing that is the main tool for global monitoring of the environment and climate on a permanent and long-term basis.

A recent example of this cooperation is the ITU/WMO Handbook *"Use of Radio Spectrum for Meteorology: Weather, Water and Climate Monitoring and Prediction"* [26]. This Handbook provides comprehensive technical and operational information on current observation applications and systems to the meteorological and radiocommunication communities, as well as to the general public.

In addition to monitoring the effects of climate change, ICTs have also proved invaluable in computer modeling of the Earth's atmosphere, beginning with the work of computer pioneer von Neumann in the late 1940s. Meteorological services are among the most demanding users of the world's fastest supercomputers, and produce progressively more sophisticated general circulation models of climate. For instance, the Hadley Centre for Climate Change in the United Kingdom runs a variety of climate models on a suite of NEC SX-6 supercomputers which have processing power equivalent to 1,000 times that of a top-of-the-range desktop PC. The numerical climate models are linked via Bracknell, one of 15 regional and three global telecommunication hubs of the GOS. In addition, by using the unused processing

Figure 4: Retreat of the Trift Glacier, Switzerland

Note: The glacier retreated by around 200m between 2004 and 2005.

Source: Swiss Academy of Sciences.

cycles of thousands of linked computers, it is possible for scientists, and even amateurs, to conduct climate modeling experiments[27]. Sophisticated computer systems also help run the system of tradable permits for carbon emissions which are one of the main implementation tools of the Kyoto Protocol.

The typical locations for climate research—such as the polar ice caps, deserts, rainforest, glaciers, volcanoes, the ocean bed or the upper layers of the atmosphere—are inhospitable, and remote monitoring and data collection using ICT-equipped sensors (telemetry) is essential for research. Even more useful has been the development of aerial photography, satellite imagery, grid technology and in particular the use of global positioning by satellite (GPS) for tracking slow, long-term movement, for instance of glaciers or ice floes (see Figure 4). The World Glacier Monitoring Service[28] uses an integrative multi-level approach to document glacier changes that links satellite remote sensing and GPS data with aerial photography, in-situ measurements and computer modeling of glacial mass balance, with research spread over many decades.

The technology of Ubiquitous Sensor Networks (USN) is also proving useful in the field of environmental monitoring[29]. USNs combine a network of sensors with computer processing power for data collection and analysis. Standardization work for USNs is currently being undertaken by a number of bodies, including ITU-T. Applications of USNs for environmental monitoring include SEAMONSTER (the South East Alaska Monitoring Network for Science, Telecommunications, Education and Research[30]), a NASA-sponsored smart sensor web project with near real-time recovery of environmental data, initially focusing on the Lemon Creek watershed in Juneau, Alaska.

4. MITIGATING THE IMPACT OF ICTS ON CLIMATE CHANGE

The key to combating climate change is to stabilize and eventually reduce the emission of GHG. Global success has been achieved in the past with a reduction in ozone depleting substances (such as chlorofluorocarbon (CFC) gases) to 20 per cent of their 1990 levels by 2004, due to the 1987 Montreal Protocol[31].

However, emissions of carbon dioxide have grown by around 80 per cent since 1970 and, despite the 1997 Kyoto Protocol[32], which set aggregate targets for a limitation/reduction by 5 per cent of 1990 levels by 2008-2012 for the so-called *"Annex 1 countries"* (developed countries and economies in transition), there seems little sign of this rate of growth slowing. Furthermore, CO_2 emissions outside the Annex 1 countries have grown enormously, as countries like China and India industrialize their economies rapidly.

The fourth IPCC assessment report proposed a reduction of GHG emissions of 25-40 per cent below 1990 levels by the year 2020 for Annex 1 countries. At the UN Climate Change Conference (COP 13), held in Bali in December 2007[33], the assessment report was formally adopted as the scientific basis for further work within the UN Framework Convention on Climate Change (UNFCCC). Furthermore, a schedule of future meetings was adopted with a view to adopting a successor agreement to the Kyoto Protocol by 2012 in Copenhagen in December 2009 (COP 15). The negotiations process took place in a subsidiary body of the

UNFCCC called the Ad-hoc Working Group on Long-term Cooperative Action (AWG-LCA[34]) and in COP 14, which met in Poznan, Poland in December 2008[35].

Reducing carbon emissions will require changes in lifestyle and behavior, but changes in management practices can also have a positive impact. New energy infrastructure investments are required to move towards cleaner energy production, and more use of renewable sources, but there is also much that can be done in reducing energy consumption, in changing agricultural practices and through land-use change. Other longer-term, more high-tech solutions include ocean fertilization, creating a global sunshade and carbon sequestration. It is clear that any mitigation strategy must have multiple elements and ICTs can help with this, either:

- **Directly**, by reducing the ICT sector's own energy requirements. For instance:
  - One of the major focuses of ITU's work in recent years has been on Next-Generation Networks (NGN[36]), which are expected by some commentators to reduce energy consumption by 40 per cent compared to today's PSTN (see Box 2);
  - Another major ITU activity is the development and introduction of modern radio technologies such as digital modulation in combination with the digital video broadcasting standards and effective compression algorithms that reduce energy consumption by powerful broadcasting transmitters ~10 times (see Box 2).
- **Indirectly,** using ICTs for carbon abatement/displacement. It is estimated that ICTs can play a significant role to limit and reduce GHG emissions, e.g., by promoting video conferences instead of travelling, through telecommuting, nomadic working, etc.

Box 2: Directly mitigating the impact of ICTs on climate change

i) Next-generation energy consumption for next-generation networks

The telecommunications industry is currently undergoing a major revolution as it migrates from today's separate networks (for voice, mobile, data etc) to a single, unified IP-based next-generation network (NGN). The savings will be achieved in a number of ways:

- A significant decrease in the number of switching centres required. Use of routers with higher capacity and higher transmission rates;
- More tolerant climatic range specifications for NGN equipment. As a result, the switching sites can be fresh-air cooled in most countries rather than requiring special air conditioning;
- NGNs may make use of more recent standards, such as VDSL2 (ITU-T G.993.2), which specifies three power modes (full, low-power and sleep), whereas VDSL has only a single power mode (full power).

However, a particular concern relates to computer data centres, which have very demanding requirements for air-conditioning, electricity supply back-up, etc. Projects to reduce power consumption by data centres include the "Green grid" consortium involving AMD, Intel, Dell, Sun HP, IBM and others.

Source: ITU-T Technology Watch Report: "NGNs and Energy Efficiency." August 2008. http://www.itu.int/oth/T2301000007/en. Also see http://www.thegreengrid.org/.

ii) Reduction of transmission power envisaged in Digital Broadcasting Plan GE06

The Regional Radiocommunication Conference 2006 (RRC-06), which involved 120 countries, developed a new digital broadcasting Plan GE06 that envisages significant reduction (~7 dB) of transmitter power due to the use of digital modulation. Moreover the number of transmitters (there are tens of thousands of transmitters around the world with power of up to 100-150 kW each) may be reduced due to the possibility of transmitting several TV and sound programmes in one channel (instead of 1 TV programme per channel). ITU-R BT and ITU-T H series Recommendations are used as the technical bases for switching from analogue to digital broadcasting.

- **In a systemic way**, by using ICTs in other sectors of the economy. This includes the use of *“smart”* ICTs in transportation systems, logistics, buildings or the energy grid to increase energy efficiency (see Box 3 on ICTs and intelligent transport systems).

The credibility of the ICT industry in offering solutions to reduce the carbon footprint of other sectors will be much greater if the industry shows that it is taking steps to put its own house in order. Some examples below show how this is already taking place:

- **BT plc**, the incumbent telecommunications provider in the UK and the host of the second ITU Symposium on ICTs and Climate Change, started measuring its carbon footprint in the UK in 1996 and has reduced it by 58 per cent since then. Its new commitment is to achieve an 80 per cent reduction in CO_2 intensity world-wide by 2020[37].

- **Telefónica** is a leading integrated operator in the telecommunication sector, with presence in Europe, Africa and Latin America. It believes that the fight against climate change is not just another part of its environmental or Corporate Responsibility policies, rather is a challenge that must be met for reasons of finance and efficiency and as a new source of business opportunities, which may contribute to its competitive position in a global economy.

  In 2008, Telefónica created a Climate Change Office, responsible for ensuring that the Company saves energy and reduces its GHG emissions. Telefónica committed to reducing its consumption of network electricity by 30 per cent and its office electricity consumption by 10 per cent by 2015. Telefónica is trying to maximise the renewable energy use in their operations. This will considerably reduce the Company's direct and indirect emissions on a global level. In addition, Telefónica Climate Change Office has an objective to identify a business line on products and services that could allow its costumers to reduce their carbon footprint and improve their energy efficiency. One example of this process is “inmotics service[I]”, presented at the third ITU Symposium on ICTs and Climate Change. This service has a direct incidence in energy efficiency of companies when introducing it into their buildings energy systems, with around 27 per cent reduction of the energy consumption.

- The Japanese incumbent operator, **NTT** has taken a number of similar measures as part of its *“Total Power Revolution”* (TPR) campaign, promoting energy management schemes for the 4,000 buildings that their various companies occupy throughout Japan. In addition to deploying energy efficient electrical devices and air conditioning equipment and switching to the use of energy-saving DC power supply for broadband equipment such as servers and routers, the TPR campaign also calls for the use of clean energy systems such as solar and wind power. These various initiatives resulted in a saving of 133 million kWh of electricity throughout the entire NTT Group in fiscal 2008 compared with fiscal 2007. NTT also launched an initiative for promoting the use of renewable energy such as solar power, and plans to deploy the equivalent of 5 megawatts of solar power systems by fiscal 2013 under a limited liability partnership called NTT-Green LLP[38].

- **Vodafone Group** announced that by 2020 it will reduce its CO_2 emissions by 50 per cent against its 2006/07 baseline of 1.23 million tonnes. This target will be achieved principally by improvements in energy efficiency and increased use of renewable energy. In addition, Vodafone will be focusing on developing products and services

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[I] The term INMOTICS, or Building Technical Management, could be defined as "the domotic technology applied to community facilities liable to be managed in an efficient manner in tertiary buildings". DOMOTICS. The term DOMOTICS comes from French "domotique", which is a contraction of the Latin word "Domus" (house in Latin) and "automatique". Its literal definition would be "automatic or automated house".

Box 3: ICTs and intelligent transport systems (ITS)

The potential systemic impact of ICTs is particularly promising in the transport sector which, according to the Stern report, accounts for 14 per cent of total GHG emissions.

ICTs can be applied to transport through the deployment of ITS. Although the main focus of ITS is on the safety, management and efficiency of transport systems, ITS can also be used to reduce their environmental impact. For example:

- Parking guidance systems can lead motorists to the most appropriate parking space, and thereby reduce engine time;
- Similarly, GPS use for navigation or vehicle dispatch can reduce journey time;
- Road pricing schemes, such as the congestion charge in London, can encourage greater use of public transport and reduce congestion, thereby reducing journey times;
- Using cars as an environment monitoring tool. For instance, by feeding real-time data collected from vehicle on average speed, climatic conditions, hold ups etc into satellite navigation systems, it is possible to give other vehicles an updated picture of road conditions and to suggest alternative routings where appropriate.

Sources: ITU-T Technology Watch Reports 1 and 8, at http://www.itu.int/ITU-T/techwatch/reports.html. Also see ITU-R Land Mobile Handbook (including Wireless Access) - Volume 4: Intelligent Transport Systems, at http://www.itu.int/publ/R-HDB/publications.aspx?lang=en&parent=R-HDB-49.

which will help its customers limit their own emissions[39].

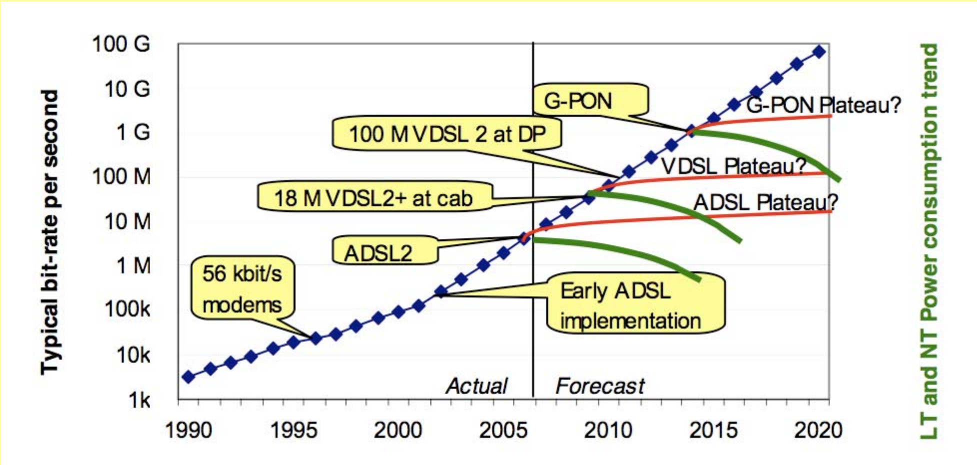
- **Cisco Systems** aims at reducing its absolute GHG emissions 25 per cent by 2012 based on 2007 baseline emissions. Among the actions to reach this goal are a reduction of energy consumption across the company and using power generated from renewable resources, as well as the use of network-based collaboration products to cut down on business travel[40].

The SMART 2020 Report posits that there is scope for reducing the carbon footprint of the ICT sector by some 36 per cent by 2020 (equivalent to 770 Mt CO_2eq) using existing technologies, with the greatest cuts being possible in data centres. For example, Google's data centre at The Dalles, consumes enough electricity to power a town of 200,000 inhabitants. Google chose to locate this data centre next to the Columbia River, in Oregon USA, to make use of cheaper and less polluting hydro-electricity. Other savings can be made in the way that data centres are structured, by using fewer, more powerful processors, and by changing the way that servers are cooled and networked together[41].

The application of ITU Recommendations, especially those that relate to energy-saving in ICT equipment, can go a long way to generate savings of GHG emissions in the ICT sector. At its December 2007 meeting, TSAG invited all ITU-T Study Groups to conduct a systematic investigation of their existing and future Recommendations in the light of climate change. Part of the concern over the global warming effect of ICTs is coming from the continued rise in the power requirements of ICT devices. As shown in Figure 5, the transmission capacity of different generations of access network technology is doubling approximately every year. The speed plateau of Asymmetric Digital Subscriber Line (ADSL) technology is likely to be reached at around 10 Mbit/s, but Very high-speed Digital Subscriber Line (VDSL) technology will raise this to 100 Mbit/s and Gigabit Passive Optical Networks (G-PON) will extend it above 1 Gbit/s. All things being equal, as transmission capacity rises, so too will power consumption, for both devices and networks. The challenge is to achieve continually rising transmission capacity while stabilizing, or reducing, the power requirements.

There are technical solutions to this problem. For instance, continuing with the example of broadband access technologies, the following options offer solutions to reducing power requirements in VDSL:

Figure 5: Relationship between bit rate and power consumption over time



Note: LT=line termination; NT=network termination; cab=cabinet; DP=distribution point.

Source: ITU-T SG 15 Power Saving Tutorials, February 2008. *http://www.itu.int/ITUT/studygroups/com15/tutorials/power.html*.

- Adaptive start-up: reduce power requirements when data rate and margin requirements are met;
- Offer low-power and low-transmission rate options in the standards for VDSL2/2+;
- Offer a sleep state (hibernation) in the standards;
- Adapt VDSL profiles to different markets and applications so as to optimise them for spectrum management and loop-length requirements in different domains[42].

An energy-saving checklist for standards development was elaborated and approved by ITU-T Study Group 15 at its February 2008 meeting[43]. The document presents a questionnaire that enables standards-developers to carry out a systematic check of the implications for global warming. This was further discussed in a series of tutorials on power-saving held 13-15 February 2008.

A further example of reductions in CO_2 emissions are provided by fibre-to-the-home (FTTH) technologies. A study conducted by FTTH Council Europe and Price Waterhouse Coopers, published in February 2008, finds that the net environmental impact of an investment in fibre can be positive over a 15 year period, with a reduction in CO_2 emissions equivalent to 330kg per user; the equivalent to a car travelling 2,000 km. In the next 15 years, these savings would be approximately doubled as the main environmental impact is in the production and deployment phase[44].

However, in order to be effective, it might be necessary to back up technical solutions with regulatory pressure or incentives. Within the European Union, codes of conduct for power saving have been developed for digital TV set-top boxes, external power supplies, uninterruptible power supplies (UPS) and broadband equipment and a further code of conduct is under development for data centres.

A final example from the ICT sector is provided by the introduction of new radio technologies—such as digital modulation for broadcasting, ultra-wideband (UWB) technology employing extremely low power, smart antennas, etc.—which is reducing power requirements (see Box 2). All ITU-R Study Groups are concentrating their studies not only on increasing service quality and the efficient use of the radio spectrum, but also on energy saving and reduction of power consumption.

Another important focus is on promoting greater use of recycling and the safe disposal of waste, which can assist in reducing global warming and the release of GHG. Environmental protection procedures now in place in many countries will affect the selection of materials and mode of installation in outside plant. Study items in ITU-T SG 5 include environmental aspects resulting from outside plant material recycling. Recommendations are being developed to implement these considerations while recycling copper and optical cable materials.

The Telecommunication Development Sector (ITU-D) is contributing to this effort by providing Member States with information and guidance on available energy-efficient ICTs and their use. To this end, ITU-D conducted in 2008 a scoping study entitled *"ICTs for e-Environment – Guidelines for Developing Countries, with a Focus on Climate Change"*[45], to provide developing countries with guidelines on the use of ICTs for better management and protection of the environment, as a crucial part of their development process. The report includes information on key technologies and applications used in this area and names key organizations involved. Finally, it examines issues of relevance to developing countries on six environmental areas: environmental observation, analysis, planning, management and protection, mitigation and capacity building.

Moreover, following its mandate to develop practical tools for Member States, ITU-D is currently developing an *"e-Environment Implementation Toolkit"* that will provide policymakers with principles and guidelines for the development and deployment of electronic applications and services in the environmental area. To support countries in assessing their level of e-environment readiness, the Toolkit will include an e-Environment Readiness Index (EERI).

Overall, while the main potential contribution of the ICT sector to combating climate change is likely to be in the application of ICTs in other sectors of the economy (the topic of the next section) and changing behavior of end-users; it is vital that the ICT sector put its own house in order.

5. USING ICTS TO REDUCE GREENHOUSE GAS EMISSIONS IN OTHER SECTORS

Although ICTs account for only around 2.5 per cent of total greenhouse gas emissions, they can be an enabling technology to reduce emissions in other sectors, notably in smart buildings, smart grids, reduced travel, improved energy efficiency etc. They can do this primarily by creating opportunities for the abatement (or displacement) of existing applications that generate CO_2 and by metering and monitoring energy consumption.

One obvious area for carbon abatement opportunities offered by ICTs is in reducing, or substituting, travel requirements of people and goods. The ICT industry offers a number of different tools and services which can replace travel, especially business travel, which range from the mundane (e.g., email, phone calls, text messaging) to the sophisticated (high-performance video-conferencing). Figure 6 presents a segmentation of the market opportunities provided by ICTs and a selection of the tools available. Supply chain, production and transportation efficiency can also be enhanced by using the full potential offered by ICTs. ITU-T has produced reports on both the low-end of this market (remote collaboration tools[46]) and the high-end (telepresence[47]), to examine the potential of using these tools for carbon abatement through travel avoidance. ITU is making extensive use of remote collaboration tools. For instance, the work of the ITU-T Focus Group on ICTs and Climate Change was mainly conducted online (28 web conferences).

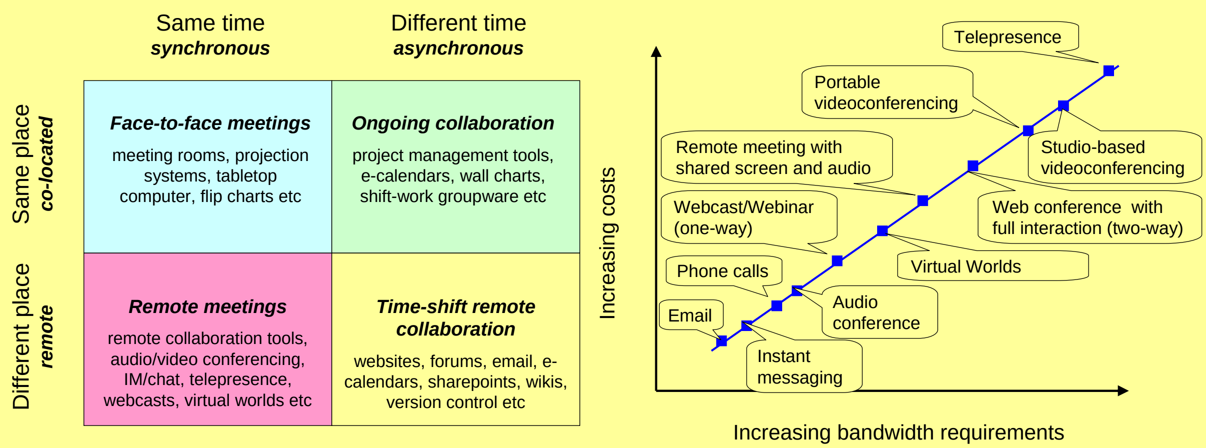
A second area where ICTs have been extensively used for reducing CO_2 emissions caused by transport is in the use of intelligent transport systems (ITS), which is explored in more detail in Box 3. The three main elements of green ITS are the car, the infrastructure and the driver. Over time, considerable progress has been made in improving the fuel- efficiency of cars but relatively little progress has been made in infrastructure, and there has been little change in driver behavior. If nothing changes, the usage of petroleum will double between 2007 and 2030 and this could be multiplied by three if all the world's citizens are to enjoy the same level of mobility currently experienced in the developed world. Ultimately, therefore, telematics and the application of ITS offer the best solution for improved fuel efficiency. A reasonable target would be to reach a level where all cars are using less than 130g of CO_2 per km traveled by 2012. ITU's main efforts in this field are geared towards the annual "Fully Networked Car" workshops, organized jointly with ISO and IEC; the most recent was held in Geneva, 4-5 March 2009, with a particular focus on ICTs and climate change[48].

A third way in which ICTs can assist other sectors of the economy in reducing GHG emissions is through so-called *"dematerialization"*, or the replacement of *"atoms"* with *"bits"*. An example of this is the current shift underway in the market for pre-recorded movies and music away from physical distribution (e.g., DVDs, CDs) to online delivery[49]. ITU-T standards for digital compression (such as the H-series for multimedia, including MP3 and MPEG4) and ITU-T and ITU-R Recommendations for broadband access networks (such as the ITU-T G-series, including DSL standards, the ITU-R BO, M, S series for radio broadcasting and wireless access) greatly assist with this process. ITU is also making its own modest contribution to dematerialization through the long-term shift away from paper-based to online publishing, which reached its culmination in 2007 with the decision of ITU Council to make all ITU-T Recommendations permanently free-of-charge online and the 2008 Council decision to make (provisionally) ITU-R Recommendations free-of-charge online. ITU-D's work relating to ICTs and environmental protection (including waste management and environmentally-friendly supply chain management), provides information and guidance in these areas through its cooperation assistance to Member States and training materials[50].

6. ICTS FOR ADAPTING TO THE EFFECTS OF CLIMATE CHANGE

Adaptation refers to measures to address change that is already occurring as a result of global warming. These changes have a negative impact on ecosystems and on human habitat affecting access to natural resources such as drinking water and land for farming. Moreover, it is expected that the global effects of climate change, including deforestation, could increase the likelihood of floods and droughts caused by severe atmospheric and oceanic disturbances. The effects and the ability to deal with these issues vary from one country to another, in particular the most vulnerable developing countries often do not have

Figure 6: Remote collaboration tools and other groupware



Note: Segmented by time and place (left chart) and by bandwidth / cost (right chart).

Source: ITU-T Technology Watch Report: "Remote Collaboration Tools." March 2008. http://www.itu.int/oth/T2301000005/en.

the necessary technological, human, financial and governance resources to adapt to climate change.

The impact of rising temperatures is likely to be uneven, with low-lying coastal areas (e.g., small island developing states, Bangladesh delta, Netherlands) at risk because of rising sea levels; sub-Saharan Africa at risk due to desertification; and Latin America at risk due to deforestation, glacier melt and hurricanes.

Adaptation to climate change requires action at the national level, in which ICTs can be critical, for instance, in predicting, identifying and measuring the extent of climate change; as well as in the development of effective response strategies to adapt to negative effects of climate change, in such sectors as agriculture, employment, technology transfer and energy.

Adaptation is one of the main issues in the UN-led negotiations on a new global agreement, and UNFCCC already has in place a number of bodies helping developing countries to adapt to climate change[51].

7. EMERGENCY COMMUNICATIONS

The use of ICTs to provide emergency communications to detect and mitigate natural disaster events is an important component in adaptation to climate change. Telecommunication networks are absolutely necessary in the most difficult and dangerous situations. Telecommunications (wired and wireless) are used for early warning, damage assessment and planning relief operations including the vital relief assistance such as food aid convoys, aircraft and medical teams to reach those who need them the most. A good implementation of telecommunications during emergencies means a faster and more efficient response and saving many lives. ITU efforts focus on the planning, development and standardization of ICT solutions used in these situations.

Latin America is especially vulnerable to extreme weather events, in which emergency telecommunication systems are vital. The Caribbean is annually impacted by hurricanes and tropical storms, which lead to loss of life and costly damage. Earthquakes and volcanic activity are also a problem in some countries.

ITU's mission, from the very earliest days, has included telecommunications and radiocommunications for disaster relief and for emergency services, which are particularly important in mitigating the effects of climate change, for instance from flooding due to rising sea levels, or increased incidence of violent storms and hurricanes.

At the ITU Plenipotentiary Conference in 2006, ITU Member States adopted Resolution 136 on the *"Use of telecommunications/ICTs for monitoring and management in emergency and disaster situations for early warning, prevention, mitigation and relief,"* which, *inter alia*, calls upon the Directors of the Bureaux to continue their technical studies and to support the development of early-warning, mitigation and relief systems[52].

ITU-T's work in this field includes standardization of call priority in emergency situations (ITU-T E.106[53]). ITU-T also leads the Partnership Coordination Panel on Telecommunications for Disaster Relief (PCP-TDR[54]), which falls under the responsibility of ITU-T Study Group 2. Its terms of reference include monitoring and promoting technical standardization work in this area.

Another outcome of ITU-T Study Group 2's work is the assignment of a special country code (888) to the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) for the purpose of facilitating the provision of an international system of naming and addressing for terminals involved in disaster relief activities (ITU-T E.164[55]). This might be used in an area of a country that has been cut off from the national telecommunications, or for natural disasters covering many countries, such as a tsunami (see Box 4). A number of regional and

Box 4: Tsunami early warning systems: Message sent, but was it received?

A good example of the use of ICTs for disaster relief is the establishment of a tsunami early-warning and mitigation system for the Indian Ocean, following the tsunami of 26 December 2004, operating under the aegis of UNESCO's International Oceanographic Commission. A similar system has existed in the Pacific Ocean since 1965 and the Indian Ocean system is based on 25 seismic stations, 26 national tsunami centres and three deep ocean sensors, with messages sent by satellite phone. It became operational in June 2006. However, when it was needed for real the following month (see map), as a result of the Java earthquake, no message was relayed to coastal areas of Indonesia and hundreds of people were killed by the ensuing tidal wave. In a test conducted on 24 January 2007, the average delay between a message being sent (by SMS and email) and a response received back ranged between a minimum of two minutes (seven countries) and 31 hours (Indonesia), with three countries failing to respond at all. UNESCO has admitted that more coordination among governments is needed.

Sources: Adapted from IOC/UNESCO, http://ioc3.unesco.org/indotsunami/, *and BBC,* http://news.bbc.co.uk/2/hi/asia-pacific/5191190.stm .

sub-regional workshops have been held on telecommunications/ICTs for disaster relief, and a Global Forum in December 2007 in Geneva[56].

In many cases, when disaster strikes the *"wired"* telecommunication infrastructure is significantly or completely destroyed and only radiocommunication services can be employed for disaster relief operation. ITU-R Study Groups carry out studies and develop ITU-R Recommendation/ Reports/ Handbooks on the use of different radiocommunication services for early warning to the public of impending disasters, for planning and relief operations and for emergency situations (see also Section 3 above).

The 2003 World Radiocommunication Conference, in Resolution 646 (WRC-03) strongly recommends use of the following regionally harmonized bands for public protection and disaster relief in emergency situations for different ITU Regions (Latin America is Region 2):

- **Region 1**: 380-470 MHz as the frequency range within which the band 380-385/390-395 MHz is a preferred core harmonized band for permanent public protection activities within certain countries of Region 1;
- **Region 2**: 746-806 MHz, 806-869 MHz, 4,940-4,990 MHz;
- **Region 3**: 406.1-430 MHz, 440-470 MHz, 806-824/851-869 MHz, 4,940-4,990 MHz and 5,850-5,925 MHz.

The Radiocommunication Assembly 2007 (RA-07) approved Resolutions ITU-R 53 and 55 instructing all ITU-R Study Groups to carry out studies on the use of radiocommunication in disaster prediction, detection, response, mitigation and relief. WRC-07 further advocated the development of spectrum management guidelines for radiocommunication in emergency and disaster relief, as well as the identification and maintenance of available frequencies for use in the very early stages of humanitarian assistance intervention in the aftermath of disaster.

ITU is developing a database for frequency management in disaster situations (Resolution 647 (WRC-07)).

In 2008, ITU produced publications and standards on the use of Common Alerting Protocol (CAP), wired networks and terrestrial and satellite radiocommunication systems for early warning, the mitigation of negative effects of disasters, as well as the use of telecommunications for saving lives.

The development arm of the ITU considers emergency telecommunications an integral part of its development agenda. For this reason, a lot of effort is directed at mainstreaming disaster management in telecommunications/information and communication technology projects and activities as part of disaster preparedness. This includes infrastructure development, and the establishment of enabling policy, legal and regulatory frameworks. In the immediate aftermath of disasters, ITU deploys temporary telecommunications/ICT solutions to assist countries affected by disasters. This includes the provision of basic telecommunications and telemedicine applications via satellites. Reconstruction and rehabilitation of telecommunications/ICT networks is an important part of disaster management (see Box 5). After providing assistance for disaster relief and response, ITU undertakes assessment missions to affected countries aimed at determining the magnitude of damages to the network through the use of geographical information systems. On the basis of its findings, ITU and the host country embark on the resuscitation of the infrastructure while ensuring that disaster resilient features are integrated to reduce network vulnerability in the event of disasters striking in the future.

Box 5: Vital communication links restored after Peru Earthquake

Following the devastating earthquake measuring 7.9 on the Richter scale that struck Southern Peru on 15 August 2007, killing more than 500 people and injuring as well as displacing thousands more, ITU deployed 50 satellite terminals to help restore vital communication links in remote and underserved areas. These links are critical in coordinating rescue and relief operations.

The equipment is being deployed in areas where telecommunications are not available. But these are most needed to facilitate emergency teams as well as government organizations in establishing communications to coordinate their work.

Emergency telecommunication is the key for government and humanitarian aid agencies involved in rescue operations, medical assistance and rehabilitation. Mountainous terrain in Peru has severely hampered access and the coordination of rescue operations. The restoration of telecommunication resources have helped bridge these gaps and provided the much needed link for the transmission and reception of high speed data for e-applications and for voice communications. This has provided succor to both government authorities and relief agencies as well as to the affected population.

Source: ReliefWeb, http://www.reliefweb.int/rw/rwb.nsf/db900sid/EDIS-76SMXM?OpenDocument .

ITU cooperates and coordinates its activities with other relevant UN agencies such as ICAO, IMO and the UN OCHA and its Working Group on Emergency Telecommunications (WGET).

8. DEFORESTATION

The impact of climate change on the rainforest is considered of such magnitude that the issue of deforestation was added as one of the 5 main topics in the UN negotiations towards a new global agreement. Land use and tropical deforestation release annually 1.5 billion tonnes of carbon into the atmosphere, which represents more than 17 per cent of the total of GHG emissions. For this reason, the protection of forests can be a major element to mitigate climate change.

A recent study by British researchers presented at the Copenhagen Conference estimates that a temperature rise of 4 degrees by 2100 would destroy up to 85 per cent of the rainforest. A more modest temperature increase of 2 degrees could kill one-third of the trees

Figure 7: Tropical forests acting as carbon sinks

Source: Nature Magazine, 19 February 2009. Photo: A. Canela/Photolibrary. http://www.nature.com/nature/journal/v457/n7232/full/457969a.html.

over the next 100 years[57]. Since the Amazon is a driver of the world's weather systems, the impact on extreme weather events would be felt world-wide. Higher temperatures can also lessen rainfall in the forest and increase the risk of drought.

Other scientists have noted that *"conserving Amazonian forests both reduces the carbon dioxide flux from deforestation, which contributes up to a fifth of global emissions and also increases the resilience of the forest to climate change."*[58]

Another study reported in *"Carbon Cycle: Sink in the African jungle"* published in Nature in February 2009[59], shows that *"the lush vegetation of tropical forests is a large and globally significant store of carbon, because, tropical forests contain more carbon per unit area than any alternative land cover, cutting them down releases carbon into the atmosphere. For the same reason, growing forests take up carbon from the atmosphere."*

Using data collected in Africa between 1968 and 2007, the authors found that trees have added an average of 0.63 tonnes of carbon per hectare each year. That means that the average rate of carbon accumulation in tropical forests around the globe was 0.49 tonnes of carbon per hectare per year, and estimate that 'old-growth' tropical forests are taking up $1.3x10^9$ tonnes of carbon per year worldwide (see Figure 7).

It is estimated that reducing tropical deforestation by 50 per cent over the next century would help prevent 500 billion tonnes of carbon from going into the atmosphere per year. This reduction in emissions would account for 12 per cent of the total reductions targeted by the IPCC.

Several countries have announced projects to channel millions in funding to tropical countries such as Brazil, to help in the protection of vulnerable forests. Tropical countries also have access to funding under a UN plan of extending carbon trading to forests, the Reducing Emissions from Deforestation (RED) initiative.

This initiative is expected to form part of the treaty to be agreed in December 2009 in Copenhagen. It will allow rich nations, which need to meet targets on cuts in emissions, to buy lucrative carbon credits for projects in countries affected by deforestation.

ICTs can contribute to this issue, for instance by developing technological paths to sustainability and protection of tropical forest, as well as to enhance data collection on the condition of the forests. Satellites that are now able to take images through clouds and at night and remote sensing application are critical for monitoring the health of the world's tropical forests trees and deforestation of these vast forests (see Box 6).

9. ICT POLICIES AND CLIMATE CHANGE

In addition to global agreements on climate change, regional and national ICT polices could play a key role in efforts to combat climate change. Toward that end, ICT policymakers and regulators increasingly need to consider environmental impacts in developing new ICT laws, strategies and development plans.

The ITU maintains a comprehensive database on ICT regulation and policy in its Member States and regularly reports on developments in each region. The 2008 High Level Segment of the ITU Council held 2 sessions on ICT and Climate Change, during which ICT Ministers discussed efforts underway in their sector to address climate change in their countries.

Box 6: Monitoring deforestation from space

Dense green vegetation gives way to pale fields in these satellite images of deforestation in Brazil's Amazon rainforest. The first image, from the Landsat Thematic Mapper in 1992, shows the beginning of agricultural development in a region of the southwestern state of Mato Grosso.

It dissolves into a released image of the same area in 2006 from the Advanced Spaceborne Thermal Emission Radiometer (ASTER) instrument flying on NASA's Terra satellite.

Source: NASA, http://climate.jpl.nasa.gov/news/index.cfm?FuseAction=ShowNews&NewsID=30.

Countries in Latin America have been developing national plans and innovations in technologies to reduce emissions. Some examples are:

- **Mexico:** National Strategy on Climate Change (2007). This strategy identifies a total mitigation potential of 107 million tons of greenhouse gasses by 2014, a 21 percent reduction from business as usual over the next six years in the energy sector.
- **Brazil:** Energy Independence through alternative energy sources (hydroelectricity, ethanol, and biodiesel). Brazil's sugar-based ethanol production is financially and environmentally sustainable without diverting land from food crops. Public and environmentally friendly public transport policies demonstrated by Curitiba (Brazil) and expanded in Bogota (Colombia) are now underway in dozens of cities in the region.
- **Argentina:** Renewable Energy. Argentina is moving forward with this initiative in rural areas, which provides affordable and reliable electricity to different communities and has an impact on productivity and work opportunities.
- **Costa Rica:** *"Payment for Ecosystems Services"*. This Country has received international recognition for its efforts to preserve ecosystems.
- **Ecuador**: Ecuador is committed to leave underground 20 per cent of it's proven oil reserves (850 million barrels), located on the ITT (Ishpingo-Tambococha-Tiputini) oil fields, within the Yasuní National Park. This will prevent the emission of 410 million tonnes of CO_2 into the atmosphere. Yasuní was named a UNESCO biosphere reserve in 1989 and scientists have called it *"one of the most biodiverse places on earth."* At least two indigenous tribes, the Tagaeri and Taromenane, maintain their traditional lifestyles in voluntary isolation in Yasuní.[60]

Despite this, *"Latin America has been moving to a higher carbon growth path. Based on current trends, from 2005-2030 the projected growth of per capita CO_2 energy emissions in the region is 33 per cent (above the world average of 24 per cent). Keeping the Region on a* *high-growth and low-carbon path will require a coherent policy framework on three levels"* (see Box 7)[61].

10. FINANCING SOLUTIONS TO CLIMATE CHANGE

For developing countries, obtaining adequate financing and investment to address climate change is a fundamental aspect of national planning. This issue is also one of the central points of the ongoing UN negotiations towards a new global agreement.

Under the current Kyoto Protocol, there is a mechanism for carbon trading by which projects in developing countries can be used to offset emissions in the developed countries. These projects may focus on adaptation; technology transfer and capacity building; energy, transport, industry, agriculture, forestry, waste management; and economic diversification.

Financing activities to combat climate change is a global concern. Developing countries often lack the financial resources necessary to face the effects of climate change, and require assistance from international agencies and funding programs, as well as from developed countries.

There is international concern that the current financial crisis may worsen this situation by limiting even more the available financial resources. To address this issue, heads of international organizations, including the UN Secretary General Ban Ki-moon, have highlighted the importance that climate change has for humanity and indicated that economic trouble is no excuse for inaction. During his address to the Climate Change Conference in Poznan, Poland, in December 2008, Ban Ki-moon urged world and business leaders to launch a global *"Green New Deal"* that focuses on investing in renewable energy and technological development. *"Managing the global financial crisis requires massive global stimulus. A big part of that spending should be an investment in a green future. An investment that fights climate change, creates millions of green jobs and spurs green growth"*, he noted[62].

Recognizing the challenge of financing solutions to climate change, several UN organizations and the World Bank entrusted in 1994 the Global Environment Facility (GEF) as the financial mechanism of the UNFCCC and other multilateral environmental conventions[63], with the goal

Box 7: Policy Framework Levels to Keep the Region on a high-growth and low-carbon Path

1. An international climate change architecture that creates enough momentum and is friendly to Latin America's specific features, including: clear financial incentives to reduce deforestation; the expansion of carbon trading mechanisms to sectors; mobilization of financial flows to Latin America to facilitate deployment of "green technologies;" and the creation of a global market for sustainable bio-fuels, removing tariffs and other barriers.
2. Domestic policies to adapt to the inevitable climate change impacts on the region's ecosystems and societies, incorporating climate-related threats into the design of long-term infrastructure investments, improving weather monitoring and forecasting, enhancing social safety nets so as to allow households to better cope with climate shocks, and improving the functioning of land, water and financial markets.
3. Domestic policies to exploit mitigation opportunities to make Latin America part of the global climate change solution. Many of the actions needed for mitigation are also good development policies. For example, increasing energy efficiency often can save money; reducing deforestation has social and environmental benefits; improving public transport can reduce congestion and local pollution with impacts on health, productivity and welfare; and expanding off-grid renewable energy can help reach rural populations without access to electricity.

Source: The World Bank, http://go.worldbank.org/5CS0AN9F40.

of assisting countries in meeting their obligations under the conventions. Today, the GEF is a global partnership among 178 countries, international institutions, non-governmental organizations (NGOs), and the private sector addressing global environmental issues.

The GEF provides grants for projects related to six focal areas: biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants. It allocates and disburses about $250 million dollars per year in projects focused on climate change mitigation and adaptation. As part of its mitigation efforts, the GEF aims to reduce GHG emissions by financing projects that promote energy efficiency, renewable energies, and sustainable transportation. In the area of adaptation, GEF has given priority to financing pilot and demonstration projects that support an operational approach to adaptation. The goal in this area is to identify feasible projects that may be integrated into national policies and sustainable development planning. GEF supports adaptation activities through the Least Developed Country Fund and the Special Climate Change Fund.

UNFCCC's discussions on a future financial architecture and funding strategy for climate change have promoted the creation of other funds. For instance, the Multilateral Development Banks (MDBs) created the Climate Investment Funds (CIF) in July 2008, as a source of interim funding to assist developing countries in addressing urgent climate change challenges and to strengthen the knowledge base in the development community. In the Americas, the Inter-American Development Bank (IDB) has established a Sustainable Energy and Climate Change Initiative to finance projects on economically and environmentally sound energy options in the Latin American and Caribbean region.

The private sector is also contributing financial resources to combat climate change. The Rockefeller Foundation in the United States has developed a Climate Change Initiative to *"build climate change resilience for poor and vulnerable people globally"*[64]. The focus of this initiative is to create and disseminate robust action models to improve the resilience of poor and vulnerable populations to climate change. The Rockefeller Foundation has committed $70 million dollars to support this initiative for the 2007-2012 period. Similarly, the Ford Foundation has made grants and loans to support natural resource management projects that deal with environmental and development challenges of poor communities in Mexico and Central America.

To better target the limited financial resources available, the donor community is conducting studies on the costs of adapting to climate change. The World Bank has selected six pilot countries—Bangladesh, Bolivia, Ethiopia, Ghana, Mozambique and Vietnam—to study strategies and practices that would allow decision makers in developing countries better cost, prioritize, sequence and integrate robust adaptation strategies into their development plans and budgets. The study, funded by the Governments of the United Kingdom, Netherlands, and Switzerland, will also help decision makers better understand and assess the risks posed by climate change.

As described above, ICTs can make a substantial contribution and be a major factor in adapting to and mitigating the effects of climate change. However, the implementation of mitigation and adaptation strategies and technologies has a high cost, which countries with low and middle income economies often cannot afford. Consequently, finding funds to finance solutions to climate change is a key concern.

11. CONCLUSIONS

This updated report was prepared specially for the ITU Symposium on ICTs and Climate Change, in Quito, Ecuador, 8-10 July 2009. It examines the ways in which ICTs contribute to global warming, but also how they can be used to monitor, mitigate and adapt to climate change. As with other sectors of the economy, the ICT sector faces a moral challenge to change the way it does business in order to contribute to the wider global struggle to assure our future environment. Although the humanitarian imperative is the primary driving factor, it is clear that there are also important commercial incentives to support such a change of behavior: energy efficiency reduces costs; improved traffic management reduces delays; corporate social responsibility improves brand image; carbon abatement creates new market opportunities; sustainable development creates jobs etc.

In short, the world's looming climate crisis represents a major opportunity for the ICT industry, and one in which international leadership, and the application of global standards will be paramount. This report has presented some of the ways in which ITU and its membership and partners are already responding to this challenge (more details of ITU activities are presented in the annex). But the actions of the ICT industry have to be a coordinated part of a wider, global initiative, and that is why the outcomes of the ITU symposia will contribute to ongoing work in the ITU and elsewhere. Technology-based solutions have to be backed up by political will and a genuine desire to change the direction in which humanity is heading, in order to avoid a planetary crisis caused by climate change.

ANNEX: AN INVENTORY OF ITU ACTIVITIES RELATED TO ICTS AND CLIMATE CHANGE

Activities relevant to combating climate change are already taking place throughout ITU, both in the regular work programmes and in special initiatives. These activities respond to many of the issues discussed in the main report. The following inventory includes current and planned climate change-activities and is intended to be indicative, not exhaustive.

Telecommunication Development Sector

- The World Telecommunication Development Conference 2006 (WTDC-06) reviewed key technological developments in the information and communication technology (ICT) sector and adopted, *inter alia*, Resolution 54 on ICT applications, including e-environment[II]. In this regard, activities of Programme 3 of the Doha Action Plan include providing technical cooperation assistance to ITU member states, developing tools and training material, and collaborating with partners.
- Programme 3 published the scoping study "ICTs for e-Environment" in 2008 to identify key technologies and ICT applications that developing countries could employ in combating climate change. The report includes recommendations to help countries build their capacity for managing and protecting the environment.
- Based on the recommendations provided in the scoping study and other work on ICT applications, ITU-D is elaborating an "e-Environment Implementation Toolkit" that will assist decision-makers in ITU Members States in assessing their needs and establishing strategies for the implementation of national e-environmental strategies. The Toolkit is conceived as part of a comprehensive e-sustainability strategy to reduce GHG emissions and energy consumption across all sectors of the economy at all levels of society across a given country. The e-Environment Toolkit is designed to be a practical and easy to use tool for decision makers to quickly assess their country's potential for using ICTs to help mitigate and adapt to environmental and climate change and then designing the blueprint for e-sustainability.
- As part of its e-Environment Implementation Toolkit, ITU is preparing an e-Environment Readiness Index (EERI), a practical tool for rapid assessment of a country's potential for using ICTs to help mitigate and adapt to environmental and climate change. The EERI aims to raise awareness on ICT-based approaches and management practices than can be used to achieve environmental sustainability.
- As co-Facilitator for the World Summit on the Information Society (WSIS) Action Line C7 on ICT Applications[III], ITU-D collaborates with partners such as the United Nations Environmental Programme (UNEP) on environmental activities. ITU-D Programme 3, jointly with UNEP, supports the Global eSustainability Initiative (GeSI), a global partnership of major players of the ICT sector that promotes technologies for sustainable development.
- The ITU-D website on e-environment and e-sustainability[IV], developed under Programme 3 of the Doha Action Plan, contains ITU internal and external relevant resources and links,

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[II] The Action Line C7 item 20 of the World Summit on the Information Society mentions ICT applications to support sustainable development within the framework of national e-strategies e.g., e-environment related to using for environmental protection and natural resources management, implementing projects for sustainable production, consumption and environmentally safe disposal of ICTs, and establishing disaster monitoring systems.

[III] The WSIS Action Line C7 aims to bring the benefits of ICTs to all aspects of life and includes actions for the following sectors: E-government, E-business, E-learning, E-health, E-employment, E-environment, E-agriculture and E-science.

[IV] See http://www.itu.int/ITU-D/cyb/app/e-env.html including resources on topics such as the use of ICTs for environmental protection and the environmentally safe disposal of e-waste.

- Programme 6 provides assistance on disaster communications/emergency telecommunications to ITU Member States while paying special attention to the needs of least developed countries and Small Island Developing States that are the most vulnerable to the effects of climate change and global warming. Undertakes studies and deliver assistance in the use of active and passive space-based sensing systems as they apply to disaster prediction, detection, monitoring, and mitigation.
- Under Programme 6, design National Emergency Telecommunications Plans (NETPs) and develop Standard Operating Procedures (SOPs) on the application and use of ICT for early warning, response/relief, and reconstruction.
- Programme 6, assist countries in developing National Adaptation Programmes (NAPs) while ensuring that ICT is at the core of such initiatives.
- Programme 6, working with other OCHA, WHO, FAO, WFP, UNHCR, etc. under the United Nations Working Group on Emergency Telecommunications develop Minimum Operating Procedures for disaster relief and other measures in response to climate change and disasters.
- Programme 6, carries out infrastructure damage assessments after disasters and carries out network rehabilitation activities.
- Programme 6 has organized a number of regional and sub-regional workshops on telecommunications/ICTs for disaster management, and a Global Forum on 10-12 December 2007 in Geneva. A “Workshop on remote sensing in disaster management”, was held 10-11 December 2007, which included presentations from many stakeholders including the ITU’s Radiocommunication Bureau which presented on the use of satellites in measuring and monitoring climate change.
- Programme 6 with the International Strategy for Disaster Reduction (ISDR) implements the conclusions of the World Conference on Disaster Reduction for the decade 2005-2015 under the Hyogo Framework.
- Programme 6 with the ITU Regional Office in Bangkok organized a hands-on ITU Asia-Pacific Regional training/workshop on effective use of telecommunications in response to disasters from 24 to 28 November 2008 in Sintok, Alor Setar, Malaysia.
- Programme 6 organized a National Forum on Telecommunications/ICT in Disaster Management and Climate Change at Cyber Jaya, in Kuala Lumpur, Malaysia on 5 December 2008.
- ITU Programme 6 working with the ITU Regional Office for Asia and the Pacific Region participated at the 3rd Asian Ministerial Conference on Disaster Risk Reduction that was held from 2 to 4 December 2008 in Kuala Lumpur, Malaysia. ITU organized a High Level technical session on High technology and scientific applications to disaster risk reduction including climate change. ITU chaired a Ministerial plenary session on international and regional approaches to disaster risk reduction and climate change adaptation. ITU also organized a technical side event on the link between climate change adaptation and disaster management.
- ITU Programme 6 published a number of guidelines, and handbooks on emergency telecommunications and is launching software on wireless emergency messaging systems (WEMS) to be deployed for as part of the alerting process.
- Within the framework of ITU Programme 6 an agreement has been negotiated and is being signed resulting in the contribution to ITU by a private sector partner of a deployable cellular base station worth 500,000 US dollars to be used to assist countries respond better to emergencies.
- The Jakarta area office led the ITU delegation to the Bali UN Climate Change Conference, in Dec. 2007, with participation also from TSB. Daily mission reports are available.
- ITU Regional Seminar on “The role of ICT in protecting Man and Environment: How to limit the impact of its use” in cooperation with the Secretariat of the Council of Arab

Ministers responsible for environmental affairs in the League of Arab States in October 2004.

Radiocommunication Sector

- As the steward of the global framework for spectrum, ITU-R:
  - o Creates regulatory (treaty status Radio Regulations) and technical (ITU-R Recommendation) basis for development and operation of all kind of wireless communications (including those used for remote collaboration);
  - o Provides the necessary radio-frequency spectrum and orbit resources for satellites that monitor the climate and conduct remote sensing of the Earth;
  - o Trough its Secretariat – Radiocommunication Bureau (BR) fulfils international spectrum management functions assisting ITU Member States in development and normal operation of radiocommunication systems (space and terrestrial). During 2008 only BR examined and published more than 120 000 notices to stations of terrestrial services and 1300 filings concerning geostationary (GSO) and non-GSO satellite networks.
- The World Radiocommunication Conferences (WRCs) analyze the spectrum requirements and allocate the necessary radio frequency spectrum for radiocommunication systems and radio based applications employed for environment and climate monitoring including weather forecasting, natural disaster prediction, detection and mitigation.
- WRC-07 and Radiocommunication Assembly (RA-07) adopted a number of Resolutions on remote sensing, which is a vital component in the science of climate change.
- ITU-R Study Groups have adopted ITU-R Recommendations on the development and use of radiocommunication systems and radio-based applications operating in Earth-exploration satellite, meteorological-aids and meteorological-satellite services, which today provide most of data for the Global Observing System (GOS). These data are also used in the Global Climate Observing System (GCOS).
- ITU-R Study Group 7 "Science services" in cooperation with the Steering Group on Radio-Frequency Coordination of the World Meteorological Organization produced WMO/ITU Handbook "Use of Radio Spectrum for Meteorology: Weather, Water and Climate Monitoring and Prediction" providing information on development and a proper use radiocommunication systems and radio-based technologies for environment observation, climate control, weather forecasting and natural and man-made disaster prediction, detection and mitigation. This handbook was signed by the ITU Secretary General Dr. Touré and the WMO Secretary General Mr. Jarraud.
- ITU-R Recommendations, Reports and Handbooks standardizing the use of new radio technologies such as digital modulation, compression and error protection coding techniques, etc. allow:
  - o Significantly reduced power consumption of radio equipment;
  - o Reduced atmosphere/ionosphere heating by very high power transmitters (several MW).

An interesting example of the new technological achievements is the new ultra-wideband (UWB) technology employing extremely low power, smart antennas, etc. All ITU-R Study Groups are concentrating their studies not only on increasing service quality and the efficient use of the radio spectrum, but also on energy saving and reduction of power consumption.

- The Radiocommunication Sector has been working on the spectrum requirements of intelligent transport systems (ITS) since the early-1980s. ITS can assist in reducing carbon emissions through more efficient traffic management, reduction of congestion etc. ITU-R Study Group 5 "Terrestrial services" (SG 8 before 2008) produced ITU-R "Intelligent Transport System" - Handbook on Land Mobile (including wireless) in Land Mobile series.

- Mitigation of the negative effects of climate change is another area of the Radiocommunication Sector activities. In many cases, when disaster strikes the "wired" telecommunication infrastructure is significantly or completely destroyed and only radiocommunication services can be employed for disaster relief operation (especially radio amateurs and satellite systems). ITU-R's Study Groups have developed Recommendations, Reports and Handbooks related to the use of radiocommunications for relief operations.
- At the World Radiocommunication Seminar 2008 (WRS-08) attended by nearly 500 participants, representing 121 countries, several presentations were devoted to the role of radio-based technologies and radiocommunication systems preventing further climate change and mitigating negative effects of climate change.
- ITU-R promotes the use of paperless approach for submission and publication of characteristics of frequency assignments and input documents. The use of paperless document preparation and publication method at WRC-07 (> 2,800 participants) saved several millions of pages. Conference decision to publish series of maritime Service Publications in electronic form from 2011 (Resolution 335 (WRC-07)) will save about 300 tonnes of paper per year as well as reduce the carbon emissions from transporting paper copies.

Telecommunication Standardization Sector

- The World Telecommunication Standardization Assembly 2008 (WTSA-08) adopted Resolution 73, in which Member States recognized the important of action to address climate change, the important role that standards can play and requires all new ITU-T standards (Recommendations) to be checked against energy saving and environmental criteria.
- ITU-T coordinated the organization of ITU Symposia on ICTs and Climate Change, which have taken place in Kyoto, 15-16 April and in London 17-18 June 2008, and the third event will take place in Quito, Ecuador, on 8–10 July 2009, as well as a virtual conference in Soul, Korea on 23 September 2009. The results have fed into relevant meetings such as the OECD ministerial, the G8 summit in Japan, the UNFCCC and in particular WTSA-08. A call for papers/speakers for each Symposium has been issued, a resources website developed, and the coordination of meeting have been made by teleconference.
- The ITU-T Focus Group on ICT and Climate Change produced 4 Deliverables in March 2009, including a common methodology to measure the impact of ICTs on climate change. TSAG at its April 2009 meeting reoriented ITU-T Study Group 5 with the title "Environment and Climate Change" as the lead Study group on ICTs and climate change and established a JCA on this topic.
- Through its Technology Watch function, ITU-T has issued a series of briefing papers relevant to climate change, on the topics of: ICTs and climate change; telepresence (high-performance videoconferencing); remote collaboration tools; intelligent transport systems (ITS); and NGNs and energy efficiency. The climate change paper was reviewed by TSAG at its December 2007 meeting and adopted as a basis for launching a work programme in this area.
- At its December 2007 meeting, TSAG approved a Liaison Statement to all ITU-T Study Groups (TSAG-LS-30), which invites them to assess all existing and new ITU-T Recommendations in the light of climate change.
- On-going standardization work on Next-Generation Networks (NGN) is being conducted through the NGN Global Standards Initiative. A study has estimated that NGNs could reduce energy requirements by up to 40 per cent compared with today's networks through a combination of reduced number of switching centres, more modern equipment with multiple power modes (e.g., VDSL2+), reduced requirements for air-conditioning, support for advance services, and more efficient routing of traffic.

- ITU-T has organized a series of “Fully Networked Car” workshops, the fourth of which was held at the Geneva Motor Show, 4-5 March 2009, with environment as its theme. A number of potential standardization activities in the field of Intelligent transport Systems (ITS) that could mitigate emission levels were identified.
- The ITU-T Director represented ITU at the International Conference to Combat Desertification, in Beijing, January 2008, giving a presentation on the contribution ITU is making in this area.
- ITU-T SG 2 (Operational aspects of service provision, networks and performance) is working on the standardization of call priority in emergency situations (e.g., ITU-T E.106 on the International Emergency Preference System for disaster relief). One of the outcomes of this work is the assignment of a special ITU-T E.164 country code (888) to the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) for the purpose of facilitating the provision of an international system of naming and addressing for terminals involved in disaster relief activities. Work has started for the coordination of the assignment of channel numbers for cell broadcast alert messages in mobile networks. ITU-T, under the leadership of SG 2, coordinates the Partnership Coordination Panel on Telecommunications for Disaster Relief (PCP-TDR).
- ITU-T SG 5 (Environment and climate change) will study methodologies for calculating the amount of GHG emissions from ICTs, and the amount of reduction in the GHG emissions in other sectors as a result of using ICTs. Its scope includes the creation of a framework for energy efficiency in the ICT field, taking account of WTSA Resolution 73. SG 5 will research methodologies for power feeding that effectively reduce power consumption and resource usage. The work of SG 5 will also include studies of methodologies that reduce environmental effects for ICT facilities and equipment.
- ITU-T SG 15 (Optical transport networks and access network infrastructures) develops Recommendations on, inter alia, environmental and safety procedures for outside plant, including the recycling of copper and optical cables materials.
- ITU-T SG 15 has prepared a technical paper (“Energy-saving checklist for standardization activities”) investigating ways to reduce the power consumption of telecommunications equipment. The widespread availability of broadband access is facilitating the wider use of telecommuting. The paper was adopted at the February 2008 meeting, where a series of very well attended tutorials on energy-saving were held. SG 15 has also pioneered the use of questionnaire surveys as a prompt to standards-developers for increasing energy efficiency.
- ITU-T SG 16 (Multimedia terminals, systems and applications) is of particular importance in terms of standards for remote collaboration, such as the H series of ITU-T Recommendations on audiovisual and multimedia systems, including video-conferencing, which provide a means for people to collaborate at a distance without needing to travel.
- ITU-T Study Group 17 (Security, languages and telecommunications software) has developed Recommendation ITU-T X.1303, jointly with OASIS, which provides the basis for a common alerting protocol for use in advance of impending threats, such as tsunamis, typhoons or earthquakes.

General Secretariat

- Through the Strategic Planning and Membership Department (SPM), ITU has been actively participating in the work of the Chief Executives Board (CEB) and its subsidiary bodies on developing a unified and collaborative UN strategy to combat climate change, including a matrix on activities of each agency and program. This work has included providing comments and taking part in negotiations on CEB documents, including the UN Sec-Gen’s paper to the Bali climate change conference, providing an ITU input document to that conference and press release, and representing ITU in the UN Environmental Group.

- SPM is monitoring ongoing negotiations under the Bali roadmap and coordinating ITU participation in upcoming international events on climate change, e.g. the Poznan Conference in 2008 and the WMO Conference in 2009.
- SPM is coordinating efforts to make the ITU climate neutral, pursuant to a policy established at the CEB, including a carbon audit. The Building Division has taken a number of practical steps to improve energy efficiency and to reduce heat-loss, including in the design of the Montbrillant Building.
- Efforts are underway to move increasingly to paperless meetings and the Information Services Department has been providing tools to facilitate remote participation in ITU meetings (see below).

Remote collaboration tools

For those participating in, or organizing ITU meetings, there are a number of tools that can be used to substitute for face-to-face meetings, or to facilitate remote participation in meetings (e.g., for developing countries). These tools include:

- TIES (Telecom Information Exchange Services) (see: http://itu.int/TIES), which includes electronic access to restricted documents, email account, electronic forum etc;
- Other electronic working methods, including informal FTP area and correspondence groups (see: http://itu.int/ITU-T/tsag/edh/ifa-structure.html).
- Free access to ITU-T Recommendations online. Following a decision by the 2007 ITU Council, all ITU-T Recommendations (of which more than 3,100 are in force), are now available free of charge online (see: http://itu.int/ITU-T/publications/recs.html). Over three million ITU-T Recommendations were downloaded in 2007.
- At ITU Council 2008, the decision was also made for the Basic Texts and ITU-R Recommendations (see: http://www.itu.int/publ/R-REC/en) to be available free of charge online on a trial basis for 6 months in 2009.
- Internet Broadcast System (IBS). Many ITU meetings are now broadcast over the web, either with or without restrictions on access, and many have sound and or video archives available for consultation. For instance, the archives for the September 2007 workshop on multimedia in NGN are available online at: http://itu.int/ibs/ITU-T/200709multimedia.
- E-learning. ITU conducts many different courses each year through e-learning, organized both by the HQ in Geneva and the regional offices (see: http://itu.int/ITU-D/hrd/elearning).
- Remote participation tools. ITU is currently evaluating two popular remote participation or groupware packages, and these are available to meeting organizers (e.g., for organizing meetings of rapporteurs, offering webinars, etc.). These include GoToMeeting (see: http://www.gotomeeting.com) and WebEx (see: http://www.webex.com). For more information see the TSAG liaison statement on remote participation tools (TSAG-LS-32).

Information dissemination tools

ITU offers a number of information dissemination tools to its members, including websites, bulletin boards, email reflectors, forum discussions, newslogs, interactive calendars etc. One recent innovation is the use of a wiki created by the ITU-T Focus Group on Identity Management (see: http://www.ituwiki.com/) and subsequently used for other purposes.

ITU and Climate Change website

http://www.itu.int/climate

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

2G	Second Generation mobile communications
3G	Third Generation mobile communications
CALM	Continuous Air Interface for Long and Medium Range communications
CDM	Clean Development Mechanism
CFC	Chlorofluorocarbon
CITIC	Centro Internacional de Investigación Científica en Telecomunicaciones, Tecnologías de la Información y las Comunicaciones
CO_2	Carbon dioxide
COP	Conference of the Parties
CS	ITU Constitution
EERI	e-Environment Readiness Index
ETNO	European Telecommunication Network Operators' association
EU	European Union
FTTH	Fibre-to-the-Home
GDP	Gross Domestic Product
GEF	Global Environment Facility
GeSI	Global eSustainability Initiative
GHG	Greenhouse Gas
GOS	Global Observing System
G-PON	Gigabit Passive Optical Network
GPS	Global Positioning by Satellite
CO_2eq	Carbon Dioxide equivalent
GTS	Global Telecommunication System
GW	Gigawatt
ICTs	Information and Communication Technologies
IEC	International Electrotechnical Commission
IOC	International Oceanographic Commission
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
ITS	Intelligent Transport Systems
ITU	International Telecommunication Union
ITU-D	ITU Telecommunication Development Sector
ITU-R	ITU Radiocommunication Sector
ITU-T	ITU Telecommunication Standardization Sector
NGN	Next-Generation Network
NMS	National Meteorological Service
OCHA	Office for the Coordination of Humanitarian Affairs
PCP-TDR	Partnership Coordination Panel on Telecommunications for Disaster Relief
RA	Radiocommunication Assembly
SG	Study Group
SMS	Short Message Service
TSAG	Telecommunication Standardization Advisory Group (in ITU-T)
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UPS	Uninterruptible power supply
USN	Ubiquitous Sensor Network
UWB	Ultra-wideband
VDSL	Very high speed Digital Subscriber Line
WMO	World Meteorological Organization
WRC	World Radiocommunication Conference
WSIS	World Summit on the Information Society
WTDC	World Telecommunication Development Conference
WTSA	World Telecommunication Standardization Assembly
WWF	World Wide Fund for nature
WWW	World Weather Watch System

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