Academy of ICT Essentials for Government Leaders

Module 10

ICT, Climate Change and Green Growth

Asian Disaster Preparedness Center
and
Richard Labelle

APCICT ASIAN AND PACIFIC TRAINING CENTRE FOR INFORMATION AND COMMUNICATION TECHNOLOGY FOR DEVELOPMENT

The Academy of ICT Essentials for Government Leaders Module Series

Module 10: ICT, Climate Change and Green Growth

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FOREWORD

The world we live in today is inter-connected and fast-changing, largely due to the rapid development of information and communication technologies (ICTs). As the World Economic Forum fittingly states, ICTs represent our "collective nerve system", impacting and connecting every fiber of our lives through intelligent, adaptive and innovative solutions. Indeed, ICTs are tools that can help solve some of our economic, social and environmental challenges, and promote more inclusive and sustainable development.

The increased access to information and knowledge through development of ICT has the potential to significantly improve the livelihoods of the poor and marginalized, and promote gender equality. ICTs can serve as a bridge connecting people from different countries and sectors in the region and beyond by providing more efficient, transparent and reliable means and platforms for communication and cooperation. ICTs are essential to the connectivity that facilitates more efficient exchange of goods and services. Success stories from Asia and the Pacific region abound: e-government initiatives are improving access to and quality of public services, mobile phones are generating incomes and professional opportunities for women, and the voices of the vulnerable are louder than ever though the power of social media.

Yet, the digital divide in Asia and the Pacific is still seen to be one of the widest in the world. This is evidenced by the fact that the countries of the region are placed across the whole spectrum of the global ICT Development Index ranking. Despite the impressive technological breakthroughs and commitments of many key players in the region, access to basic communication is still not assured for all.

In order to bridge the digital divide, policymakers must be committed to further realizing the potential of ICTs for inclusive socio-economic development in the region. Towards this end, the Asian and Pacific Training Centre for Information and Communication Technology for Development (APCICT) was established as a regional institute of the United Nations Economic and Social Commission for Asia and the Pacific (UN/ESCAP) on 16 June 2006 with the mandate to strengthen the efforts of the 62 ESCAP member and associate member countries to use ICT in their socio-economic development through human and institutional capacity development. APCICT's mandate responds to the Declaration of Principles and Plan of Action of the World Summit on the Information Society (WSIS), which states that: "Each person should have the opportunity to acquire the necessary skills and knowledge in order to understand, participate actively in, and benefit fully from, the Information Society and the knowledge economy."

In order to further respond to this call to action, APCICT has developed a comprehensive ICT for development (ICTD) training curriculum, the *Academy of ICT Essentials for Government Leaders*. Launched in 2008 and based on strong demand from member States, the *Academy* presently consists of 10 stand-alone but interlinked modules that aim to impart essential knowledge and expertise to help policymakers plan and implement ICT initiatives more effectively. Widespread adoption of the *Academy* programme throughout Asia and the Pacific attests to the timely and relevant material covered by these modules.

ESCAP welcomes APCICT's ongoing effort to update and publish high quality ICTD learning modules reflecting the fast-changing world of technology and bringing the benefits of ICTD knowledge to national and regional stakeholders. Moreover, ESCAP, through APCICT, is promoting the use, customization and translation of these *Academy* modules in different countries. It is our hope that through their regular delivery at national and regional workshops for senior- and mid-level government officials, the acquired knowledge would be translated into enhanced awareness of ICT benefits and concrete actions towards meeting national and regional development goals.

Noeleen Heyzer

Under-Secretary-General of the United Nations
and Executive Secretary of ESCAP

PREFACE

In the effort to bridge the digital divide, the importance of developing the human resource and institutional capacity in the use of information and communication technologies (ICTs) cannot be underestimated. In and of themselves, ICTs are simply tools, but when people know how to effectively utilize them, ICTs become transformative drivers to hasten the pace of socio-economic development and bring about positive changes. With this vision in mind, the *Academy of ICT Essentials for Government Leaders* (*Academy*), a comprehensive ICT human capacity building resource that will help developing countries fully benefit from the opportunities provided by ICTs, was developed.

The *Academy* is the flagship programme of the United Nations Asian and Pacific Training Centre for Information and Communication Technology for Development (APCICT), and is designed to equip government officials with the ICT knowledge and skills to fully leverage ICT for socio-economic development. The *Academy* has reached thousands of individuals and hundreds of institutions throughout the Asia Pacific and beyond since its official launch in 2008. The *Academy* has been rolled-out in over 20 countries in the Asia Pacific region, adopted in numerous government human resource training frameworks, and incorporated in the curricula of university and college programmes throughout the region.

The impact of the *Academy* is in part a result of the comprehensive content and targeted range of topics covered by its eight initial training modules, but also due to the *Academy's* ability to configure to meet local contexts and address emerging socio-economic development issues. As a result of strong demand from countries in the Asia Pacific, APCICT in partnership with its network of partners has developed additional *Academy* training modules designed to enhance capacity in the use of ICT in areas such as disaster risk management (DRM) and climate change abatement, and in the use of social media for development.

Adhering to APCICT's "We D.I.D. It In Partnership" approach, all *Academy* modules have been Developed, Implemented and Delivered in an inclusive and participatory manner, and they draw upon the expertise and experience from an extensive and exceptional group of stakeholders. The entire *Academy* has been developed through a systematic approach based on needs assessment surveys conducted across the Asia Pacific region, and consultations with government officials, members of the international development community, and academics and educators. Research and analysis on the strengths and weaknesses of existing training materials, and a peer review process carried out through a series of regional and subregional workshops are part of the systematic approach to ensure that the modules are relevant and effective. Through this approach, the *Academy* programme has been developed into a comprehensive curriculum covering a range of important ICT for development (ICTD) topics, and indicative of the many voices and contextual nuances present across the region.

APCICT's inclusive and collaborative approach to development of the *Academy* has also created a strong and fast-growing network of partners to facilitate the delivery of ICTD training to government officials, policymakers and development stakeholders throughout the Asia Pacific region and beyond. The *Academy* continues to be rolled-out and adopted into training frameworks at the national and regional levels in different countries and regions as a result of close collaboration between APCICT and training institutions, government agencies, and regional and international organizations. This principle of partnership will continue to be a driving force as APCICT works with its partners to continuously update and further localize the *Academy* material, develop new *Academy* modules to address identified needs, and extend the reach of *Academy* content to new target audiences through new and more accessible mediums.

Complementing the face-to-face delivery of the *Academy* programme, APCICT has also developed an online distance learning platform called the *APCICT Virtual Academy* (http://e-learning.unapcict.org), which is designed to enable participants to study the material at their own pace. The *Virtual Academy* ensures that all the *Academy* modules and accompanying materials are easily accessible online for download, dissemination, customization and localization. The *Academy* is also available in DVD to reach those with limited or no Internet connectivity.

To enhance accessibility and relevance in local contexts, APCICT and its partners have collaborated to make the *Academy* available in Armenian, Azeri, Bahasa Indonesia, English, Khmer (Cambodia), Mongolian, Myanmar, Pashto, Russian, Tajik and Vietnamese, with plans to translate the modules into additional languages.

Clearly, the development and delivery of the *Academy* would not have been possible without the commitment, dedication and proactive participation of many individuals and organizations. I would like to take this opportunity to acknowledge the efforts and achievements of our partners from government ministries, training institutions, and regional and national organizations who have participated in *Academy* workshops. They not only provided valuable inputs to the content of the modules, but more importantly, they have become advocates of the *Academy* in their countries and regions, and have helped the *Academy* become an important component of national and regional frameworks to build necessary ICT capacity to meet the socio-economic development goals of the future.

I would like to add a special acknowledgment to the dedicated efforts of a number of outstanding individuals who have made Module 10 possible. They include authors from the Asian Disaster Preparedness Center (ADPC) and Richard Labelle. I also thank the Information and Communication Technology and Disaster Risk Reduction Division (IDD) and the Environment and Development Division (EDD) of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), the Economic Commission for Africa (ECA), the Economic Commission for Latin America and the Caribbean (ECLAC), the Economic and Social Commission for Western Asia (ESCWA), Microsoft, and the National Information Society Agency of the Republic of Korea for their support in shaping the content of Module 10. A note of gratitude is extended to the national and subregional partners as well as resource persons of the *Academy* who participated in the numerous workshops, trainings and Partners Meetings organized for the development of Module 10. APCICT would also like to thank those who participated in the multiple rounds of review of the manuscript, and Christine Apikul for editing the module.

I sincerely hope that the *Academy* will help nations narrow ICT human resource gaps, remove barriers to ICT adoption, and promote the application of ICT in accelerating socio-economic development and achieving the Millennium Development Goals.

Hyeun-Suk Rhee

Director
UN-APCICT/ESCAP

ABOUT THE MODULE SERIES

In today's "Information Age", easy access to information is changing the way we live, work and play. The "digital economy", also known as the "knowledge economy", "networked economy" or "new economy", is characterized by a shift from the production of goods to the creation of ideas. This underscores the growing, if not already central, role played by information and communication technologies (ICTs) in the economy and in society as a whole.

As a consequence, governments worldwide have increasingly focused on ICT for development (ICTD). For these governments, ICTD is not only about developing the ICT industry or sector of the economy but also encompasses the use of ICTs to engender economic as well as social and political growth.

However, among the difficulties that governments face in formulating ICT policy is that policymakers are often unfamiliar with the technologies that they are harnessing for national development. Since one cannot regulate what one does not understand, many policymakers have shied away from ICT policymaking. But leaving ICT policy to technologists is also wrong because often technologists are unaware of the policy implications of the technologies they are developing and using.

The *Academy of ICT Essentials for Government Leaders* module series has been developed by the United Nations Asian and Pacific Training Centre for Information and Communication Technology for Development (APCICT) for:

1. Policymakers at the national and local government level who are responsible for ICT policymaking;

2. Government officials responsible for the development and implementation of ICT-based applications; and

3. Managers in the public sector seeking to employ ICT tools for project management.

The module series aims to develop familiarity with the substantive issues related to ICTD from both a policy and technology perspective. The intention is not to develop a technical ICT manual but rather to provide a good understanding of what the current digital technology is capable of or where technology is headed, and what this implies for policymaking. The topics covered by the modules have been identified through a training needs analysis and a survey of other training materials worldwide.

The modules are designed in such a way that they can be used for self-study by individual readers or as a resource in a training course or programme. The modules are stand-alone as well as linked together, and effort has been made in each module to link to themes and discussions in the other modules in the series. The long-term objective is to make the modules a coherent course that can be certified.

Each module begins with a statement of module objectives and target learning outcomes against which readers can assess their own progress. The module content is divided into sections that include case studies and exercises to help deepen understanding of key concepts. The exercises may be done by individual readers or by groups of training participants. Figures and tables are provided to illustrate specific aspects of the discussion. References and online resources are listed for readers to look up in order to gain additional perspectives.

The use of ICTD is so diverse that sometimes case studies and examples within and across modules may appear contradictory. This is to be expected. This is the excitement and the challenge of this newly emerging discipline, as well as its promise, as all countries begin to explore the potential of ICTs as tools for development.

Supporting the *Academy* module series in print format is an online distance learning platform—the *APCICT Virtual Academy* (http://unapcict.org/e-learning)—with virtual classrooms featuring the trainers' presentations in video format and PowerPoint presentations of the modules.

In addition, APCICT has developed an e-Collaborative Hub for ICTD (e-Co Hub – http://www.unapcict.org/ecohub), a dedicated online site for ICTD practitioners and policymakers to enhance their learning and training experience. The e-Co Hub gives access to knowledge resources on different aspects of ICTD and provides an interactive space for sharing knowledge and experiences, and collaborating on advancing ICTD.

MODULE 10

This module addresses the role that information and communication technologies (ICTs) can play in enhancing the ability and capacity of humans to deal with the impact of climate change and contribute to sustainable development. Dealing with the impact of climate change means either reducing significantly or eliminating its negative effects on people and the natural environment, and this is called abating climate change. The principles of sustainable development is an important guide to ensure that the use of ICTs to abate climate change is done in a way that does not impact on the ability of future generations to meet their own needs.

This module focuses on the role that ICTs can play in abating climate change by adopting actions to **mitigate** the impact of climate change and by adopting actions to **adapt** to climate change. Since climate and the environment are linked, this module also considers the role of ICTs in helping humans understand the environment that surrounds them, which is a prerequisite for tackling the problems of climate change.

While the module also considers the role of ICTs in disaster risk reduction (DRR) and disaster risk management (DRM), it does so in regards to some new ICT-based applications that are not covered in Module 9, which deals in more detail with the role of ICTs in DRR and DRM.

Module Objectives

The module aims to:

1. Inform decision makers of the challenge posed by climate change and its impact on development in developing countries of Asia and the Pacific;

2. Raise awareness of the role that ICTs have in climate change adaptation and mitigation;

3. Describe the importance of Green Growth, its relevance to the developing world and the role of ICTs in Green Growth; and

4. Discuss and suggest policies for the use of ICTs for abating climate change and promoting Green Growth.

Learning Outcomes

After working on this module, readers should be able to:

1. Discuss the challenges posed by climate change and its impact on development in the Asia Pacific region.

2. Describe the steps that are needed to abate climate change, including some of the policy issues that need to be addressed.

3. Present trends in the use of ICTs and how they are being harnessed by some governments as well as some private sector operators and investors to address issues of climate change and sustainable development.

4. Describe Green Growth and provide examples of its implementation from around the world.

Something To Do

In preparation for taking this module, complete one or more of the tasks below:

1. Read Annex 1: Climate Change Trends. This will provide you with a basic introduction to climate change and its impact in the Asia Pacific region.
2. Read *Our Common Future*, the report of the World Commission on Environment and Development (WCED) published in 1987,[1] and related reports on sustainable development.
3. Read or be familiar with the *ICTs for e-Environment* report published by the International Telecommunication Union (ITU).[2] This report provides an overview of the role that ICTs play in environmental observation, interaction and management.
4. Read or be familiar with the *Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (IPCC) published in 2007.[3]
5. Be familiar with the most recent United Nations Framework Convention on Climate Change (UNFCCC) national communications prepared by your country.

1 WCED, *Our Common Future*, Report of the World Commission on Environment and Development (1987). Available from http://www.un-documents.net/wced-ocf.htm.

2 ITU, *ICTs for e-Environment: Guidelines for developing countries with a focus on climate change* (Geneva, ITU, 2008). Available from http://www.itu.int/ITU-D/cyb/app/docs/itu-icts-for-e-environment.pdf.

3 See also http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml.

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Acronyms

ACCCRN	Asian Cities Climate Change Resilience Network
ADB	Asian Development Bank
AGB	Above-Ground Biomass
APCICT	Asian and Pacific Training Centre for Information and Communication Technology for Development
ASEAN	Association of Southeast Asian Nations
BPAP	Business Processing Association of Philippines
BPO	Business Process Outsourcing
CAREN	Central Asian Research and Education Network
COP	Conferences of the Parties
CRiSTAL	Community-Based Risk Screening Tool – Adaptation and Livelihoods
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DSSAT	Decision Support System for Agrotechnology Transfer
ESCAP	Economic and Social Commission for Asia and the Pacific
ESIC	Employee State Insurance Corporation (India)
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information System
ICT	Information and Communication Technology
ICTD	Information and Communication Technology for Development
IEA	International Energy Agency
ICIMOD	International Centre for Integrated Mountain Development
IMPACT	International Model for Policy Analysis of Agricultural Commodities and Trade
IPCC	Intergovernmental Panel on Climate Change
IT	Information Technology
ITS	Intelligent Transportation System
ITU	International Telecommunication Union
JAXA	Japan Aerospace Exploration Agency
MDG	Millennium Development Goal
NASA	National Aeronautics and Space Administration (USA)
OECD	Organisation for Economic Co-operation and Development
PC	Personal Computer
R&D	Research and Development

REDD	Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
RFID	Radio-Frequency Identification Technologies
SMART	Self-Monitoring, Analysis and Reporting Technology
SMEs	Small and Medium Enterprises
SREX	Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation
TTP	Thimphu Tech Park (Bhutan)
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USB	Universal Serial Bus
WCED	World Commission on Environment and Development
WSN	Wireless Sensor Network
WWF	World Wide Fund for Nature

List of Icons

Case Study


Questions To Think About


Something To Do

Test Yourself

1. AN INTRODUCTION TO CLIMATE CHANGE AND GREEN GROWTH

This section aims to:
1. **Present an overview of what climate change is and why it is important;**
2. **Provide different approaches to tackling climate change; and**
3. **Introduce Green Growth.**

1.1 What is climate change?

Climate change is described as: a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer.[4]

Studies suggest that climate change can result in shifts in temperatures and precipitation, some good and some with challenges to environments, livelihoods, health, and to the frequency and intensity of climate-related natural hazards such as flood and landslides.

Climate change is related to greenhouse gas (GHG) emissions. The two main sources of GHG emissions are from: (1) the burning of fossil fuels (e.g., coal, petroleum, natural gas); and (2) the clearing of carbon sinks in the natural environment, for example through deforestation (i.e., the clearing of forest and other vegetation that represent an important store of global carbon).

The response to climate change calls for actions that will either help people and communities **adapt** to the climate impacts of a changing environment or **mitigate** the amount of GHGs released into the atmosphere. **Green Growth** is an additional approach to development that has the potential to combine goals for climate change adaptation, climate change mitigation and economic growth.

Adaptation to climate change requires countries to modify their behaviour in order to reduce the "vulnerability of natural and human systems against actual or perceived climate change effects."[5] Governments and organizations can adapt to climate change by preparing for changing environmental and climatic conditions before their full impacts are felt by the communities, target groups, environments and ecosystems.

The World Wide Fund for Nature (WWF) has identified two priorities for adaptation. These are the establishment of a "world-wide early warning system and development support for poor countries to get access to drought resistant crops."[6] ICTs contribute to achieving both of these priorities.

4 Christopher B. Field and others, eds., *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*, A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (Cambridge and New York, Cambridge University Press, 2012). Available from http://ipcc-wg2.gov/SREX/.

5 IPCC, *IPCC Glossary Working Group III* (2007). Available from http://www.ipcc.ch/ipccreports/ar4-wg3.htm.

6 Stefan Henningsson, "ICT as a winner in the low carbon economy - enabling energy services for 9 billion people", presentation made at the UNFCCC, Copenhagen, Denmark, 8 December 2009. Available from http://unfccc.int/meetings/cop_15/side_events_exhibits/items/5095.php.

Adaptation measures are especially important for developing countries because they must deal with the immediate impacts of climate change. Many of the world's poorest populations, and therefore the people most at risk to climate change, are in developing countries where the capacity to deal with disasters and climate change in general is limited.

Climate change adaptation requires the following:

1. A sound understanding of the natural environment and how it is challenged and modified by climate change over time and space and how these changes will affect human and natural ecosystems. ICTs are indispensible for environmental observation, analysis, planning, management and monitoring, which can help policymakers formulate informed decisions on actions for climate change adaptation.

2. Assisting vulnerable communities adapt to the realities of existing as well as projected climate changes. This includes livelihood improvement so that people are less at risk from a changing climate (e.g., modifying agricultural practices). Part of this readiness also involves preparing populations and societies to deal with more frequent disasters and extreme weather and related events. ICTs are widely used in all phases of the disaster risk management (DRM) cycle (see *Academy Module 9: ICT for Disaster Risk Management*).

3. Building capacities of organizations to deal with changing climates will enhance local community and organizational self-sufficiency in learning, planning and adapting to changing climate.

4. Forest and biodiversity conservation, sustainable land-use management, disaster early warning as well as awareness promotion and capacity building are central to adaptation.

Mitigation refers to: "Technological change and substitution that reduce resource inputs and GHG emissions per unit of output. Although several social, economic and technological policies would produce an emission reduction, with respect to climate change, mitigation means implementing policies to reduce GHG emissions and enhance carbon sinks."[7]

Energy demand and the emission of GHGs are directly linked because fossil fuels are one of the main contributors to GHG emissions and to the global warming that is associated with climate change.

While historically, the main source of GHG emissions from fossil fuels has been the developed countries, this is changing rapidly as emerging economies grow and increase in population and consumption more rapidly than advanced countries. As these countries become richer, the drive to a higher standard of living is pushing consumption and driving economic growth, which in turn is driving the demand for and price of fossil fuel-based energy resources. Data shows that in 2009, China overtook the USA to become the world's largest energy user. Preliminary data from the International Energy Agency (IEA)[8] indicate that in 2009, China consumed about 4 per cent more energy than the USA. Furthermore, the outlook for world energy demand to 2035 based on the New Policies Scenario of the IEA[9] shows the significant growth in demand from China, whereas in the Organisation for Economic Co-operation and Development (OECD) countries growth in energy demand is largely static.

7 IPCC, *IPCC Fourth Assessment Report: Climate Change 2007, Annex 1: Glossary* (2007). Available from http://www.ipcc.ch/publications_and_data/ar4/wg3/en/annex1sglossary-a-d.html.

8 IEA, *World Energy Outlook 2010* (Paris, 2010).

9 Ibid.

Climate change mitigation would require:

1. Using more efficient energy generation technologies. ICTs can be utilized to improve the generation, storage and distribution of energy to minimize energy loss.

2. Using more energy efficient technologies. ICTs can be used in sectors such as construction and transportation to plan its processes with a view to minimize energy use.

3. Replacing fossil fuels with none or low carbon-emitting energy generating technologies such as renewable energy technologies or nuclear energy.

4. Adopting more sustainable natural resource management, and harvesting or extraction technologies and practices.[10]

5. Adopting policies and practices that encourage conservation of energy and natural resource.

Mitigation is important because it directly addresses the root cause of climate change and is essential for meeting the GHG emission reduction targets required to stabilize global climate before predicted catastrophic change sets in.

At present, countries around the world are consuming energy from fossil fuels at a rate that is generating alarming amounts of GHGs, resulting in dramatic increases in the temperature of the earth's atmosphere as well as perturbations in the climate. The consequences of such dramatic emissions of GHGs into the atmosphere are predicted by some to be catastrophic. Evidence to date supports this assertion. There are no simple solutions to this problem, and a combination of solutions needs to be considered.

At the core is the need to be more efficient in the use of energy and natural resources while at the same time developing non-carbon generating and non- or minimally-polluting energy generating technologies such as those associated with the use of renewable energy sources (e.g., wind power, solar power, hydro power, wave and tidal power, geothermal power, etc.).

1.2 Green Growth as a strategy for economic growth and sustainable development

In 2008, countries of the Asia Pacific region and from around the world were confronted by a global economic slowdown that led to a significant increase in the price of energy. Several countries responded with subsidy programmes to stimulate economic activity, investing in infrastructure and government services, as well as research and development (R&D) activities. However, some governments, including many countries in the Asia Pacific region, realized that this was an opportunity to simultaneously address the threat of climate change, rapidly rising energy prices and the insecurity posed by uncertain fossil fuel supplies. These countries realized that in an energy-challenged world where the risk of severe climate related disruptions due to GHG emissions is significant, business as usual was not an option. They looked to a new paradigm of economic development based on the principles of sustainable development: Green Growth.

10 UNFCCC Conference of the Parties, Outcome of the Work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention, Cancun Agreements of the 2010 Climate Change Conference, Draft decision/CP.16 (2010). Available from http://unfccc.int/adaptation/cancun_adaptation_framework/items/5852.php.

Green Growth refers to economic development and growth that takes into consideration the need to reduce energy consumption and water use, conserve renewable natural resources, and limit waste and pollution. It is defined as "economic progress that fosters environmentally sustainable, low-carbon and socially inclusive development."[11]

Questions To Think About

1. What are the challenges that climate change presents to your country, jurisdiction, organization or community?
2. In your country, jurisdiction, organization or community, what policies have been or are being put in place to tackle the climate change challenge?
3. What are the ways in which your country, jurisdiction, organization or community is (or could be) using ICTs to address climate change?

Summary

1. Countries must respond to climate change by adapting to its impacts and mitigating GHG emissions.
2. Green Growth is a strategy to achieve sustainable development that focuses on improving the eco-efficiency of production and consumption. It is also related to and supportive of climate change adaptation and mitigation.
3. ICTs have an essential role in enhancing the achievement of the goals for adaptation, mitigation and Green Growth.

11 UN and ADB, *Green Growth, Resources and Resilience: Environmental Sustainability in Asia and the Pacific* (2012). Available from http://www.unescap.org/esd/environment/flagpubs/GGRAP/documents/Full-Report.pdf.

2. ICT TRENDS AND THEIR IMPLICATIONS FOR TACKLING CLIMATE CHANGE

This section aims to:

1. **Provide an overview of the current trends that are driving the use of ICTs for environmental management and as tools to abate climate change;**
2. **Discuss the relevance of ongoing and emerging technological development for developing countries; and**
3. **Outline policy considerations for climate change abatement.**

The use of ICTs for environmental management including for climate monitoring is increasing rapidly as a result of an unprecedented number of relatively recent scientific and technical innovations. These trends are based on continued innovation and R&D in the areas of digitization and dematerialization, as well as green computing. For more information on the latest trends in ICTs, please refer to *Academy Module 4: ICT Trends for Government Leaders*.

2.1 Important ICTs for climate change mitigation and adaptation, and Green Growth

Digitization refers to the changing of manual processes to digital ones. Content such as tidal data, daily rainfall, and other records and documents are increasingly available as electronic files. The creation of electronic versions of historical records is a good example of digitization of written material.

Dematerialization means replacing human activities or even goods and services with electronic equivalents. Examples include using the Internet for banking, and for buying or selling goods and services, and using video conferencing to replace attendance at meetings and events such as conferences, etc.

Below are examples of specific technologies that support digitization and dematerialization.

Video conferencing. Telepresence is a form of high definition video conferencing using dedicated Internet connections. It allows the replacement of travel in favour of network-based video conferences. Existing video conferencing facilities using a desktop computer are useful but still cannot offer the immersive experience of telepresence. The ICT company Cisco attributes USD 390 million in cost savings to the use of telepresence[12] in its daily operations for 158 weeks. These savings were equivalent to 201.7 metric tons of carbon dioxide (CO_2) saved, 36,546 cars off the road, and 97,543 meetings that took place without the requirement for travel.[13] Many developing countries have established high-end telepresence facilities on a commercial basis and some hotel chains now offer access to telepresence facilities.[14]

12 Monique Meche, "ICT: Enabling the Sustainable City and Community", presentation made at the Sustainable Development Forum, 20 January 2010. Available from http://go.worldbank.org/Y5VU0AJTK0.

13 Jennifer Sanford, "ICT: Enabling the Sustainable City and Community", presentation made at EE Global, 10 May 2010. Available from http://eeglobalforum.org/10/workshop_presentations/jennifer_sanford_info_comm.pdf.

14 James A. Martin, "Hotel Guests Checking Into Public Cisco TelePresence Rooms", Cisco, 26 January 2010. Available from http://newsroom.cisco.com/dlls/2010/ts_012610.html.

Virtualization technologies. Desktop virtualization is a fancy phrase for replacing individual desktop computers with a main server and keyboards and monitors. This technology replaces the need for having a desktop computer at each desk or work station in a school, hospital, government or private sector office. Virtualization of desktops is an application with great potential for developing countries because of the savings in energy, materials and cost associated with replacing computers in schools, offices and in other sectors using this technology.

Miniaturization. In the environment and climate field, miniaturization is very significant because smaller computing devices attached to various sensors make it easier to observe, monitor, measure and control the environment that surrounds us. Smaller ICTs can more readily be physically embedded in objects and spaces and this is an important consideration when looking at innovative uses of ICTs for studying and acting upon the environment. Objects that have microprocessors embedded in them are called “smart objects”.

In some devices moving parts are replaced by small solid-state circuits, where electrons move around as they would in an electrical circuit. A familiar example is the memory chips found in universal serial bus (USB) keys, entrance ID cards for offices, and advance payment cards for urban train systems. These devices require less energy to operate, work quieter and faster, and are more robust if dropped. Other solid-state technologies include transistors, microprocessor chips, the integrated circuit, light emitting diodes and liquid-crystal displays. Solid-state technologies are found in computers, cellular phones, digital appliances and various recording devices.

Microprocessors are the brains of computing devices like desktop computers, and are becoming smaller and more powerful, cheaper, and highly energy efficient. These are finding their way into everyday objects and spaces such as machines, appliances, buildings and natural environments such as forests. They are being used to allow smart applications to be developed, and applied to or embedded into objects and spaces.

One negative aspect of processor design is associated with the energy and resources required to produce microprocessors. According to some researchers, the energy cost, or embedded energy cost as well as resources, i.e., amount of water and purified air as well as metals and other materials, etc., required for the production of microprocessors is very high and undermines the efficiency that ICTs enable as a result.[15] The other downside of the pervasiveness of ICTs comes from the massive amounts of electronic waste (e-waste) associated with discarded ICT devices. Some jurisdictions are striving to eliminate e-waste.[16] More research is needed, such as comprehensive life cycle analysis studies of microprocessor design and manufacturing, to measure the real energy needs and environmental costs associated with the production of microprocessors.

Sensor technology. Advances in sensing technologies are some of the most important reasons that ICTs are extending human capacity to better understand and manage the environment. The digitization and miniaturization of these devices have already been mentioned. This means that sensors can be made much smaller and less energy demanding. This is an important characteristic of environmental sensors. The less energy these sensors use, the longer they can be deployed without having to be serviced or their batteries replaced. Unlike sensors used for satellite-based remote sensing, these developments in sensing technology are predominantly for use at or near the surface of the planet.

15 Kris De Decker, “The monster footprint of digital technology”, *Low-tech Magazine*, 16 June 2009. Available from http://www.lowtechmagazine.com/2009/06/embodied-energy-of-digital-technology.html.

16 European Commission, “Recast of the WEEE Directive”, 12 January 2011. Available from http://ec.europa.eu/environment/waste/weee/.

Wireless Sensor Networks (WSNs). WSNs or wireless sensor and actuator networks (WSANs) are spatially distributed sensors that monitor physical or chemical conditions in the environment. In some cases, they allow the perception of the physical or chemical properties of objects or spaces. In others, they can interact with these objects and spaces, and be used for identification of objects, people, etc., and for location sensing.[17] Here are some specific examples:

1. Use of WSNs for environmental monitoring and related applications to increase the quality and decrease the cost of collecting environmental data. Application areas include: farming, environmental management, security and safety, and industries such as mining, manufacturing and construction.[18]

2. Use of a network of wireless sensors in a rainforest to monitor the recovery of regenerating rainforest from previous agricultural grassland.[19]

Cloud computing. Cloud computing refers to applications and digital services that reside exclusively on the Internet, located on server systems (i.e., a large number of powerful computers that are networked and can only be accessed using the Internet). In exchange for a fee, the cloud can replace computer operating systems and applications with equivalent services located on remote servers, and services such as a full information technology (IT) department, including server facilities, human resources and payroll functions online, as well as sales and customer relationship services. This can cut not only capital costs, but also the cost of purchasing applications and online services; it can also reduce the amount of energy consumed as well as the cost of that energy.[20]

Social networking. Social networks are Internet-based services that provide content and services, and allow users to publish their own content and share this with other users of their designation. Social networks such as Facebook, Twitter, Wikipedia and YouTube are among the most popular Internet sites and home to hundreds of thousands of applications. Social networking technologies are increasingly being used by individuals, the private sector, civil society organizations and by governments to enhance communication with stakeholders. They can be used for raising awareness, mobilizing action and influencing policy decisions (advocacy). Social networks are also useful public feedback mechanisms. They may strengthen communities of practice and networking between individuals and organizations with shared interests and concerns, and thus extend collaboration and knowledge transfer.

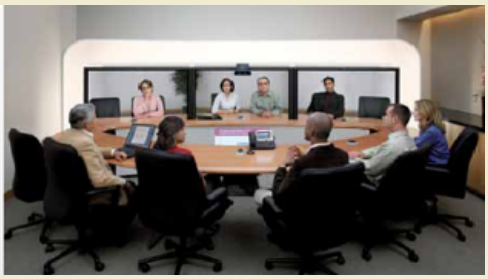
17 Jose Paradells Aspas, Anna Calveras Auge and Carlos Gomez Montenegro, “Smart Cities: Going towards the future”, presentation made at 49th FITCE Congress, Santiango de Compostela, Spain, 1-4 September 2010. Available from http://www.fitce2010.org/ponencias/1_JUEVES_SESION4_Josep_Paradells.pdf.

18 CSIRO, “Wireless sensor networks: a new instrument for observing our world”, 12 May 2011. Available from http://www.csiro.au/science/Sensors-and-network-technologies.html.

19 CSIRO, “Environmental monitoring. Monitoring rainforest regeneration”, 16 November 2010. Available from http://research.ict.csiro.au/research/labs/autonomous-systems/sensor-networks/environmental-monitoring.

20 James Harris and Steven Nunn, “Cloud Computing’s Great Promise”, Forbes.com, 30 June 2010. Available from http://www.forbes.com/2010/06/30/pharmaceuticals-mobile-salesforcecom-technology-cloud-computing.html?boxes=Homepagetoprated.

Raising local participation at global climate change forums with telepresence



Images source: Copenhagen Sustainable Meetings Coalition, COP15 United Nations Climate Conference, Copenhagen: Event Sustainability Report (2009). Available from http://www.sustainableeventsdenmark.org/assets/2011/11/cop15-event-sustainability_REPORT.pdf.

During the 15th session of the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC COP 15) held during December 2009 in Copenhagen, telepresence was highlighted as a way of enhancing participation in substantive discussions related to the COP. The Copenhagen Sustainable Meeting Protocol was developed as a result in order to share and capture the experiences gained during organization of COP 15 and telepresence continued to play a part during COP 16 in Cancun, and COP 17 in Durban.

Strong leadership and drive, strategic approaches, engagement with stakeholders, integrated operations and transparent administration were highlighted as key to sustainable event organization with telepresence playing an important part in enabling more people to join these events and contribute.

Key points

Participants from around the world were able to participate "virtually" in COP 15 side events clocking over 250 hours of telepresence meetings held over 149 sessions. The travel-related costs savings and emissions reduction serves as an example of how telepresence can be a good model to follow when organizing meetings, especially where participants come from all over the world.

Further reading

Copenhagen Sustainable Meetings Coalition, *COP 15 United Nations Climate Conference, Copenhagen: Event Sustainability Report* (2009). Available from http://www.sustainableeventsdenmark.org/assets/2011/11/cop15-event-sustainability_REPORT.pdf.

Copenhagen Sustainable Meetings Coalition, *Copenhagen Sustainable Meetings Protocol: Sharing Best Practice and Leadership Strategie*s (undated). Available from http://www.mci-group.com/~/media/MCI/Files/MCIPublications/csmp_whitepaper%209.ashx.

2.2 e-Waste and recycling

The last decades have had a phenomenal growth in consumption of electronics such as computers and their peripheral equipment including monitors and printers, mobile phones and domestic appliances. For example, India had about 5 million personal computers (PCs) in 2006, while China had roughly 14 million PCs in 2005. Electronics are major consumers of many precious and special metals and contribute to the global demand for metals. Unfortunately, the available data on e-waste arising from ICTs and other appliances is poor and insufficient, and techniques are required to estimate the volume generated in the region.
Modern electronics can contain up to 60 different elements, many of which are valuable. The most complex mix of substances is usually present in the printed wiring boards. Toxic and hazardous elements are also present in e-waste, and therefore government and private sector need to find and implement sound processes of collection and treatment. The use and generation of toxic/hazardous substances during e-waste processing (e.g., mercury in gold amalgamation or dioxins from inappropriate incineration) need to be considered.

The e-waste recycling chain could be divided into three main steps: (1) collection, (2) dismantling and pre-processing, and (3) end-processing for final metal recovery.

1. The collection of e-waste is of crucial importance as this determines the amount of material that may be recovered. In addition, uncontrolled discarding or inappropriate waste management generates significant hazardous emissions, with severe impacts on human health and the environment. Promoting the specialized collection of e-waste can therefore reduce hazardous emissions, reduce the volume of waste, and serve as a source of the same materials used to manufacture ICTs.

2. Dismantling and pre-processing is done to liberate the valuable components from each other prior to the final recovery processes, as well as to safely remove and store or treat hazardous substances. Batteries can be sent to dedicated facilities for the recovery of cobalt, nickel and copper. The circuit boards present in ICT equipment contain most of the precious and special metals as well as lead (solders) and flame retardant containing resins. Manual removal of the circuit boards will prevent losses of precious and special metals. With the appropriate investment in technology and regulation for safety, developing and transition countries with rather low labour costs may offer pre-processing services.

3. Specific technologies are required to treat the chemical and other hazards they contain, and recover the recyclable materials such as aluminium, copper, palladium and gold. After the collection of ICTs, efficient recycling should be applied to keep valuable e-waste components (e.g., metals) in the economy and safely dispose of harmful components in order to prevent risks to human health and the environment.

Efficient recycling operations to recover the contained metals in old computers may contribute to reducing GHG emissions stemming from the mining, concentrating, smelting and refining of precious and special metals, and needs only a fraction of energy compared to mining ores in nature. For more information about recycling of e-waste, please refer to the United Nations Environment Programme (UNEP) study *Recycling – From E-Waste to Resources* (2009).

WEEE Recycle in India

Images source: WEEE Recycle website.

e-Waste is recognized as a major challenge in the waste management policies of India. India's National Environment Policy (2006) emphasizes the need for recovery and reuse of any material to reduce waste and extract valuable components such as metals like gold and copper. Recycling activities are carried out by small and medium enterprises (SMEs) in the informal sector in some of the densely populated cities of India. With little or no regulation in the informal sector, SMEs are using highly hazardous and polluting techniques to recycle e-waste.

WEEE Recycle is a project of Indian and European partners to institutionalize a collection system and channelization of e-waste for recycling using environmentally sound technologies involving SMEs in the informal sector. Focused on four cities (Delhi, Kolkata, Pune and Bangalore), e-waste collection points have been established and informal sector workers have been organized and trained in environmentally sound recycling practices and standards.

An R&D component ensures that the project follows international standards and the latest developments in technologies and techniques for e-waste recycling. The R&D component aims to: adopt or adapt environmentally sound recycling technologies for specific waste streams; increase efficiency in recovery; standardize the recycling product; and develop green products for safer recycling especially for the items being extensively recycled.

Key points

- Promoting ICT industries and applications brings with it a need to recognize the recycling of e-waste as a social problem.
- Recycling e-waste is a labour-intensive enterprise attractive to the informal sector**.** Raising capacities for safe and environmentally sound recycling practice should be addressed.
- R&D should be undertaken to improve recycling techniques, and promote green products.

Further reading and contact information

WEEE Recycle website, http://www.weeerecycle.in/index.php.

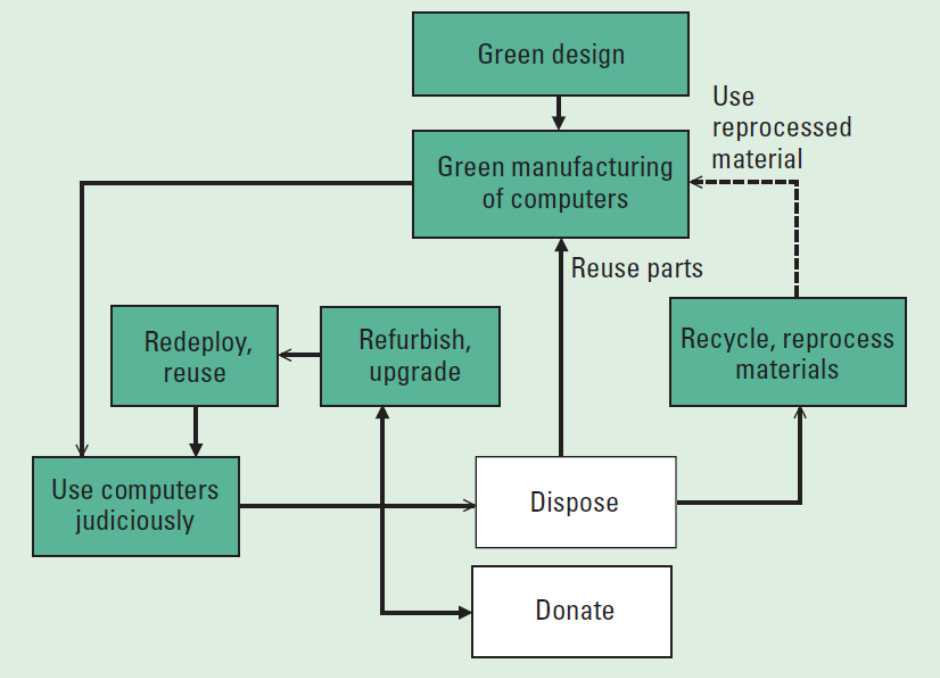
Contact: Advisory Services in Environmental Management, GIZ, contact@asemindia.com.

2.3 Green computing

Green computing refers to a holistic approach to addressing the environmental impacts of ICTs. It is the contribution of the ICT sector and industries to sustainable development, that is, they strive to be economically viable and have a minimal impact on the environment.

Each stage of a computer's life (from production through disposal) represents the consumption of electricity, raw materials, chemicals and water; each stage generates hazardous waste, and directly or indirectly increases carbon emissions.[21] Green computing ensures the sustainable design, manufacture, use and disposal of computers, servers, and associated devices (monitors, printers, storage devices, etc.).

Figure 1. Green a computer's entire lifestyle



Source: San Murugesan, "Harnessing Green IT: Principles and Practices", *IEEE IT Professional*, January-February 2008, p. 27. Available from http://www.sis.pitt.edu/~dtipper/2011/GreenPaper.pdf.

The approach follows four paths to address the environmental impacts of ICT:

1. Green design – Design that takes into consideration energy efficiency and minimal impact on the environment.

2. Green manufacturing – Production of ICTs that has minimal or no environmental impact. EPEAT (http://www.epeat.net) is a global registry for greener electronics. Manufacturers can register their products in EPEAT. EPEAT-registered products have reduced environmental impact across their production life cycles. This includes reduced use of toxins in manufacturing, more efficient operation and easier recycling. EPEAT product registration is country-specific because product identification and environmental performance can vary by location. As of 2012, Asia Pacific countries that are included in the EPEAT system are: Australia, China, Japan, New Zealand, Singapore and Taiwan.

21 San Murugesan, "Harnessing Green IT: Principles and Practices", *IEEE IT Professional*, January-February 2008, pp. 24-33. Available from http://www.sis.pitt.edu/~dtipper/2011/GreenPaper.pdf.

3. Green use – Practices that reduce energy consumption. They include turning off computers and using computer monitor energy savers. ENERGY STAR is an international standard for energy efficient products, which means that products certified by ENERGY STAR will consume less energy throughout their useful life.[22] Green use also involves refurbishing old computers by upgrading or reconditioning their parts; and the promotion of reuse by donating an older model computer to others (people or organizations) who are willing to use it.

4. Green disposal – Promotion of the proper disposal of electronics in specialized e-waste management systems, and the recycling of unwanted electronic equipment by recovering usable raw materials from ICT components. The United Kingdom has regulations that can be used as reference (see http://www.netregs.gov.uk/netregs/legislation/380525/473094/?lang=e).

Data centres

Data centres are facilities used to house computer systems and associated components, such as telecommunications and storage systems. They generally include redundant or backup power supplies, redundant data communications connections, environmental controls (e.g., air conditioning, fire suppression) and security devices.[23] Data centres consume large amounts of electrical power, but they can be designed and built to be green. The power consumption of data centres comes from two main sources: (1) for normal operations, and (2) for cooling to achieve peak performance. Placing data centres in locations that rely on fossil fuels for the generation of electrical power releases large amounts of CO_2, thus green computing means locating data centres in places that rely on renewable or non-polluting energy, or on energy sources that do not emit carbon. Data centres may also be located in climates where the air is sufficiently cold enough to cool servers. Some countries are marketing themselves as destinations for data centres because they offer a combination of access to either plentiful and relatively inexpensive renewable power for data centre operations and/or a cooler climate.

2.4 Policy considerations

1. Assess and measure the impact of different e-government and e-commerce applications on the environment. The energy savings should be one of the criteria for providing e-government and e-commerce services to peri-urban and to rural locations, depending on the ease and availability of Internet access. Schools, hospitals and government offices are possible beneficiaries.

2. Assess and measure the carbon footprint (the amount of carbon emitted), the amount of heavy metals and hazardous materials used, and energy consumption costs for the standard life of computers, and make this part of the criteria for government purchases of computers. The longer term energy costs of older computers may not warrant their acquisition in the first place.

3. Develop national standards for the assessment of the eco-friendliness and energy efficiency of ICTs. These standards may comprise of the carbon footprint, toxicity and energy consumption.

22 See ENERGY STAR Program Requirements for Computers, Version 5.0. Available from http://www.energystar.gov/ia/partners/prod_development/revisions/downloads/computer/Version5.0_Computer_Spec.pdf.

23 Wikipedia, “Data center”. Available from http://en.wikipedia.org/wiki/Data_center.

4. Formulate policies and incentives over the use and disposal of older energy inefficient microprocessors and computing platforms, and develop capacities to enforce these policies.

5. Host data centres for cloud computing. By 2020, it is expected that data centres and telecommunications infrastructure will require nearly 2 billion kilowatt hours of energy (compared to 623 million today), and server farms and data centres will produce 257 metric tons of CO_2 annually. Countries that have a sizeable geothermal energy supply and low CO_2 emissions can consider this as an opportunity to market itself as a destination for green data centres.

6. Be aware of discussions and opportunities to enlist the help of other countries in securing the technologies and management practices for mitigating climate change.

7. An integrated ICT waste policy and management is needed to address environmental impacts along the whole life cycle of products, materials and processes.

8. Promote investment in e-waste collection, recycling and recovery of secondary raw materials.

9. Shift to green computing. Countries need to enact policies that will prepare them to take advantage of this shift. For example, study the technological experience and existing related policy in other countries that have implemented the shift.

Something To Do

Remind your colleagues about saving energy by creating and circulating a checklist. You can include the following tips:

1. Use a screen-saver to minimize the energy used by your monitor.
2. Turn off your computer before going for a long meeting or lunch.
3. Before going home, switch off all computers, monitors, printers, facsimile machines, scanners and photocopiers in the office.
4. Check to see if the computers, printers and photocopiers have a power-saving feature? If yes, make sure that it is enabled.
5. If no, look for products with power-saving features when acquiring your next equipment.
6. Before printing a document, think carefully -
   - Do you really need to print, or can you just read it from your computer?
   - Can you do double-sided printing to save on paper?

Below are references to some energy-saving tips for organizations:

1. Better Business Guide to Energy Saving – http://www.carbontrust.com/media/31675/ctv034_better_business_guide_to_energy_saving.pdf.
2. Sustainable Office Checklist, New South Wales, Australia – http://www.environment.nsw.gov.au/resources/government/100051SusChklist.pdf.
3. Ohio University Energy Saving Tips – http://www.ohio.edu/facilities/recycle/erecycling.htm.

3. ICT APPLICATIONS FOR ADAPTING TO CLIMATE CHANGE

This section aims to:
Provide examples of some ICT applications for climate change adaptation that -
1. Enhance environmental understanding;
2. Help people, communities and organizations adapt to climate change; and
3. Strengthen capacity for environmental and climate change adaptation.

ICTs have the potential to inform and enhance the processes for formulating policies and making decisions towards the achievement of climate change adaptation goals set by governments, sectors and communities. This chapter presents some of the arguments why these goals are important, and how technologies may be applied to reach them.

3.1 Why do we need to adapt to climate change?

There are impacts of climate change on ecosystems and humans that are expected to be detrimental. Information about these impacts, however, is still generalized over large areas. Some findings are presented below:[24]

1. By the 2080s, many millions more people than today are projected to experience floods every year due to sea level rise. The numbers affected will be largest in the densely populated and low-lying mega deltas of Asia and Africa, while small islands are especially vulnerable.

2. Mountain snow pack, glaciers and small ice caps play a crucial role in freshwater availability. Widespread mass losses from glaciers and reductions in snow cover over recent decades are projected to accelerate throughout the twenty-first century, reducing water availability, hydropower potential, and changing seasonality of flows in regions supplied by melt water from major mountain ranges (e.g., Hindu-Kush, Himalaya, Andes), where more than one-sixth of the world population currently lives.

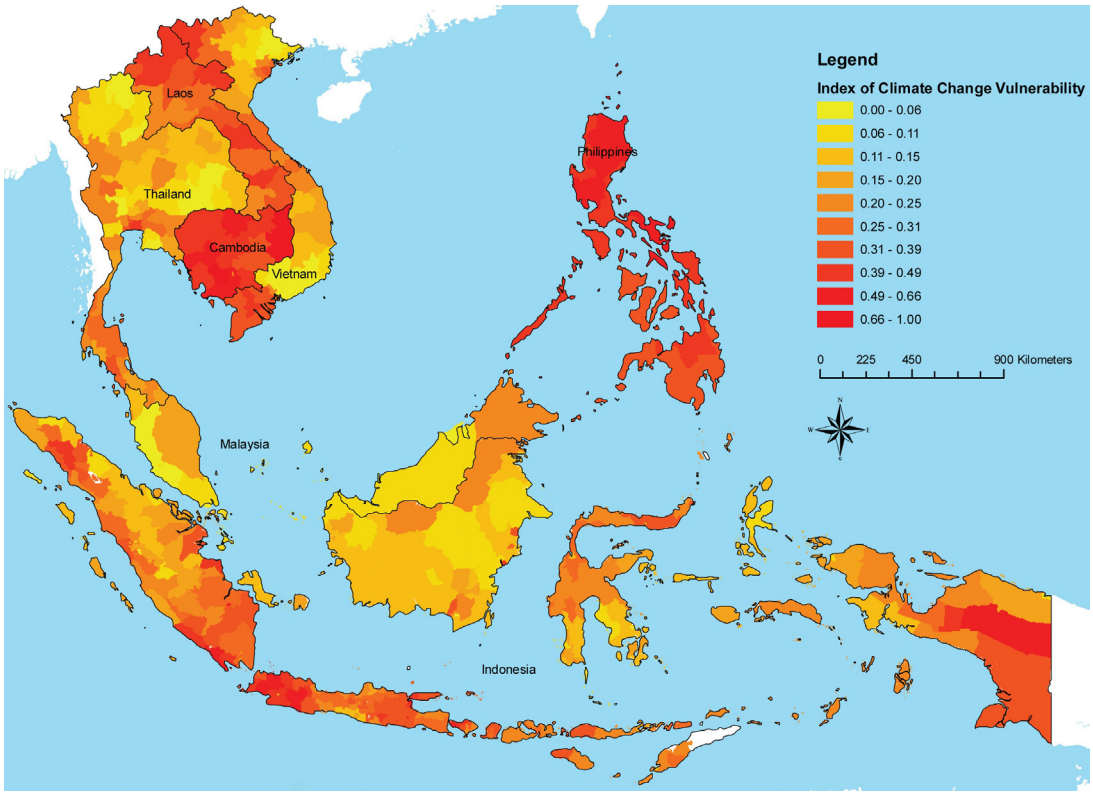
3. Runoff is projected with high confidence to increase by 10 to 40 per cent by mid-century at higher latitudes and in some wet tropical areas, including populous areas in East and South-East Asia, and decrease by 10 to 30 per cent over some dry regions at mid-latitudes and dry tropics, due to decreases in rainfall and higher rates of evapotranspiration.

4. By the 2050s, freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease.

5. Endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected to rise in East, South and South-East Asia due to projected changes in the hydrological cycle.

24 IPCC, *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Geneva, 2007).

Figure 2. South-East Asia's vulnerability to extreme climate hazards



Source: IDRC, "Show and Tell: Plotting Climate Change Hot Spots" (2009). Available from http://www.idrc.ca/eepsea/ev-148556-201-1-DO_TOPIC.html

In small island developing states, e.g., the South Pacific, Timor-Leste and Maldives, the following impacts are projected:

1. Sea level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards, thus threatening vital infrastructure, settlements and facilities that support the livelihood of island communities.

2. Deterioration in coastal conditions, for example through erosion of beaches and coral bleaching, is expected to affect local resources.

3. By mid-century, climate change is expected to reduce water resources in many small islands, to the point where they become insufficient to meet demand during low-rainfall periods.

4. With higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands.

In local contexts and for various sectors, the information presented is not specific enough to be used for planning and decision-making.[25] It is therefore important to develop a process of dialogue between the climate scientists and the local communities or vulnerable sectors to identify the potential climate change impacts on the livelihood and welfare in the locality, and on specific sectors, respectively. This initial step is essential for the incorporation of climate change adaptation in local or sector planning.

25 Ibid.

There will also be positive impacts from climate change, as when colder regions become warm enough to expand the type of crops that they can grow and export. Monitoring and predicting positive impacts and planning to utilize these for the benefit of one's country is also a form of climate change adaptation.

Table 1 shows several potential ICT applications for adaptation by sectors.

Table 1. Climate change adaptation and ICT applications

Vulnerable Sectors	Examples of Adaptation Measures	Sample Areas of ICT Applications
Water resources	1. Better management and use of water supply to adapt to changes in availability and quality 2. Water policy reform	1. Sensors to monitor soil moisture, water flow in streams and rivers, and precipitation 2. Sensors to monitor water quality (soil, pollution and salt)
Agriculture and food security	1. Development of crops that are tolerant or resistant to flood, drought, cold or heat 2. Diversification of crops, based on predicted changes in climate	1. Remote sensing and sensor systems to identify adapted cropping and farming systems 2. WSNs for drought monitoring, irrigation control, and monitoring the water and nutrient status of crops, etc.
Human health	1. New or improved disease or vector surveillance 2. Improvement in the use of early warning systems by the health sector	1. Online applications for public feedback on disease 2. Geographic information system (GIS) to analyse disease occurrence, spread and climate change impacts
Ecosystems	1. Creation of parks, reserves and protected areas 2. Monitoring of species and biodiversity 3. Vulnerability assessment of ecosystems 4. Better land-use planning and zoning that integrates projected changes in climate 5. Protective policy measures against projected impacts of climate changes	1. Remote sensing for: • Measuring forest canopy cover • Tracking the health of forests • Recording and tracking plant diseases, pathologies and disease vectors • Measuring forest loss 2. GIS for integrating information data sets and land-use planning applications
Disaster risk management	1. Improvement in monitoring and early warning of climate-related hazards 2. Policy measures for integrating information related to climate change adaptation into DRM planning	1. Modelling the changing exposure and vulnerability to climate-related disaster risks 2. Developing comprehensive early warning systems for climate-related hazards (see *Academy Module 9: ICT for Disaster Risk Management*)

Source: Adapted from Angelica Valeria Ospina and Richard Heeks, ICTs and Climate Change Adaptation: Enabling Innovative Strategies, Strategy Brief 1, Climate Change, Innovation and ICTs Project, 2011. Available from http://www.niccd.org/node/20.

3.2 Facilitating climate change observation

ICTs can strengthen the capacity of countries to collect data about the climate (temperature, humidity rainfall and snowfall) and sea levels. The data is important for describing the climate itself (which is based on the 30-year averages for temperature, humidity and precipitation) and local sea levels. The data collected through automated means can be combined with historical records and manual collection methods.

The following are some examples of the use of ICT applications for climate change observation:

1. Some national meteorological institutes are investing in automated meteorological stations to improve the frequency and reliability of climate data.

2. Remote sensing has contributed to climate modelling of the globe and its regions through the monitoring of precipitation using radar.

3. Remote sensing has also contributed to monitoring sea levels with specific satellites altimetry (the measurement of elevation).

Global precipitation measurement

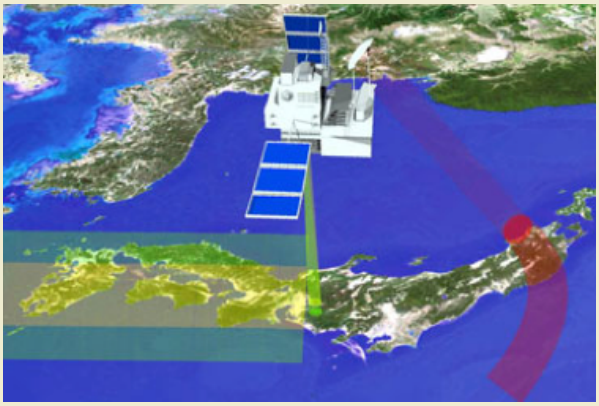
In order for climate change adaptation to be possible, precipitation measurements are important. Satellites can play an important part in this effort due to their capability to scan large parts of the atmosphere. The Japan Aerospace Exploration Agency (JAXA) as well as National Aeronautics and Space Administration (NASA), USA, among others, have been working to monitor and measure global precipitation in an effort to support climate change related research as well as other areas.

Key points

- Precipitation measurement is an important part of developing climate change adaptation measures.
- Satellites can be very effective in this effort due to their global reach.

Further reading

JAXA, “Global Precipitation Measurement”, http://www.jaxa.jp/projects/sat/gpm/index_e.html.

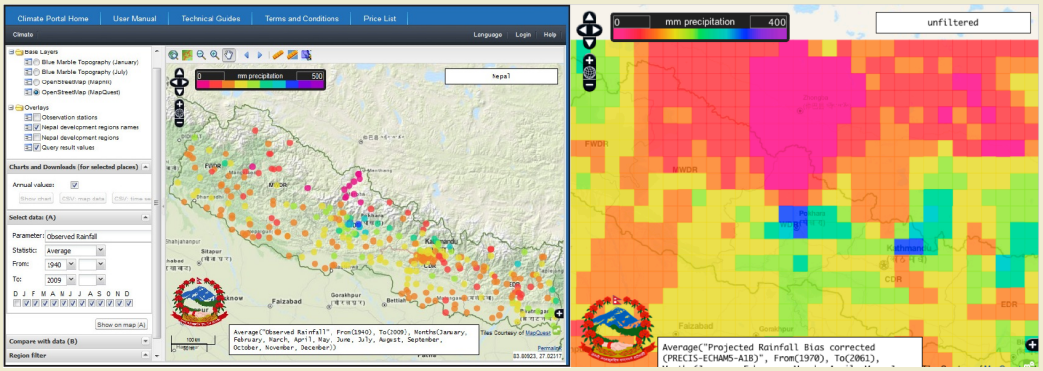


Images source: http://www.jaxa.jp/projects/sat/gpm/index_e.html.

3.3 Climate change modelling

One of the defining challenges in climate change research and decision-making is to adequately characterize and manage the uncertainties associated with projections of climate change, particularly at local scale and for parameters (such as precipitation) that are not modelled easily. To ensure that adaptation decisions are robust under uncertain future conditions, it is important to consider the range of possible future climate conditions. The climate science community developed techniques and methods, mostly using supercomputers, to perform a set of climate models and emissions scenarios. Downscaling is another set of modelling, using supercomputers or even an ordinary laptop, generally to improve the level of detail needed at the scale of a country or local area.

The Nepal Climate Portal



Images source: ADPC.

The Nepal Department of Hydrology and Meteorology had a project on climate data digitization and downscaling of climate projections for the benefit of policy development and impact analyses at the sector level. It supported data digitizing, quality control and archiving of historical meteorological data in Nepal, and downscaling of future climate change projections for Nepal. The historical and projected data can be viewed through the Nepal Climate Data Portal (http://www.dhm.np/dpc). Users can generate different information products, including: printable maps, time-series charts, data downloading and purchasing, data comparison and aggregation, data filtering, flexible data queries, multiple color legend options, and information about observation stations.

Key points

- Downscaling of climate change projections is a vital step towards developing suitable adaptation measures.
- Tools to digitize historical data and computer modelling of climates are important for developing future climate projections used in planning adaptation measures.

Contact information

dg@dhm.gov.np or http://dhm.gov.np/whoiswho.

Dr. Senaka Basnayake, Senior Climatologist, Asian Disaster Preparedness Center, senaka_basnayake@adpc.net.

3.4 Facilitating climate change adaptation in vulnerable sectors

Some sectors were identified by the Intergovernmental Panel on Climate Change (IPCC) as vulnerable to the impacts of climate change such as water, health, agriculture, coasts, ecosystems and DRM. Adaptation involves the following steps:

1. The analysis of what makes a sector vulnerable.

2. Agreement on an adaptation vision or target.

3. Identification of different options that may be taken, development of strategies to implement these options, and prioritization of these options.

4. Implementation of the chosen adaptation actions, and practice regular monitoring of the project as well as any updates from the climate science community.

Risk screening tools have been developed to minimize *maladaptation* by focusing projects on reducing vulnerability and raising capacity for adaptation (see case study below on CRiSTAL).

CRiSTAL, the community-based risk screening tool

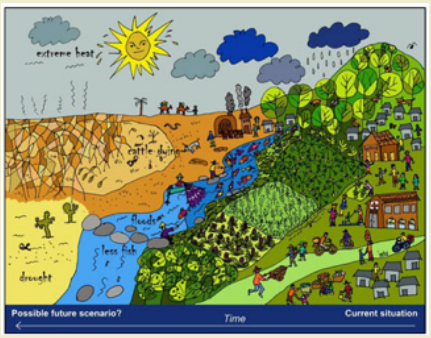
Project planners and managers can use the Community-Based Risk Screening Tool – Adaptation and Livelihoods (CRiSTAL) tool to integrate climate change adaptation and risk reduction into community-level projects. These projects are mostly aimed at revitalizing ecosystems, strengthening local capacities for risk management and diversifying livelihoods of farmers, fishers and foresters. CRiSTAL is a spreadsheet program that is relatively easy to use to minimize maladaptation by providing concrete information on how projects are linked to and influence climate-related vulnerabilities and adaptive capacities. Multiple consultations have to be conducted to gather the necessary information engaging different gender, economic and social groups. The user manual can be used in the field to gather relevant data that can then be fed into the CRiSTAL spreadsheet document back at an office.

Key points

- ICT tools such as CRiSTAL serve as easy to use methods that ensure the consideration of climate change adaptation and risk reduction when developing community-level projects.
- Projects developed using this methodology can serve as examples for regional and national level projects.

Further reading

CRiSTAL website, http://www.iisd.org/cristaltool.



Images source: http://www.iisd.org/cristaltool.

The *IPCC Fourth Assessment Report* gives the following projected general impacts on various sectors:[26]

26 Ibid.

Climate change and water. Climate change is expected to add to the stresses on water resources. In areas where glaciers are projected to lose mass or snowfall is expected to decrease, freshwater availability will be reduced along with hydropower potential. The extent of areas exposed to drought is projected to increase, potentially affecting multiple sectors such as agriculture, water supply, energy production and health. In areas where precipitation is expected to increase, water runoff is projected with high confidence to increase by 10 to 40 per cent by mid-century at higher latitudes and in some wet tropical areas, including populous areas in East and South-East Asia. This will result in increased flood risk in the future, and is likely to pose challenges to society, physical infrastructure and water quality. To plan for these expected impacts, focused climate impact studies are needed to determine if climate change will have significant impacts in the near future on water availability and water quality, and whether government and water utilities can meet the needs of citizens at desired levels of reliability and affordability.

Climate change, agriculture and food security. Crop productivity is projected to increase slightly for some crops in the areas generally located 50 degrees above and below the equator, where the local mean temperature will rise from 1-3°C. However, productivity may decrease if local mean temperature increases further. At lower latitudes, especially in seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases (1-2°C), which would increase the risk of hunger. For example, in the Pacific island nations, the projected climate change (increased temperatures, more frequent and prolonged dry conditions, increased variability of rainfall, and sea level rise) is likely to have impacts on crops due to heat stress, droughts, soil erosion, salt water intrusion and tropical cyclones.[27]

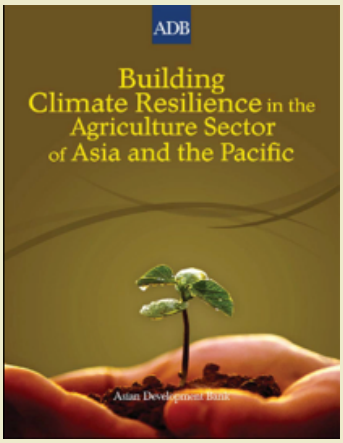
Climate change and human health. The health status of millions of people is projected to be affected through different drivers of health including population growth, demographic characteristics, urbanization, public health funding, scientific developments and environmental conditions.[28] The reduction in water supply can affect the reliability and quality of food sources, resulting in increases in malnutrition. Extreme weather events may lead to increased deaths, diseases and injury. Air pollution may increase due to changes in precipitation, temperature, humidity and air circulation, as well as from increased pollutants from natural sources, e.g., drought conditions increasing the potential of forests and vegetation catching fire. Contamination of food and water sources may increase the incidence of diarrhoea and other water-borne diseases. Changes in environmental conditions may alter the spatial distribution of some infectious diseases and their pathogens. Climate change is projected to bring some benefits in temperate areas through an anticipated reduction in death from exposure to the cold, but overall it is expected that negative health effects will outweigh the benefits, especially in developing countries.

Climate change and ecosystems. The resilience of many ecosystems will be challenged by the combination of projected climate changes, associated disturbances (e.g., flooding, drought, wildfire, insect infestation, ocean acidification) and other change drivers (e.g., land use change, pollution, fragmentation of natural systems, overexploitation of resources). The effects of climate change on forest resilience include changes in the location of areas suitable for particular species to grow, changes in pest and disease outbreaks, and altered biological cycles, as well as increases in the productivity of both timber and non-timber forest products. Approximately 20 to 30 per cent of plant and animal species assessed so far are likely to be at increased risk of extinction if increases in global average temperature exceed 1.5-2.5°C.

27 ADB, *Food Security and Climate Change in the Pacific: Rethinking the Options* (Manila, 2011). Available from http://www.adb.org/publications/food-security-and-climate-change-pacific-rethinking-options.

28 WHO, *Heat Waves, Floods and the Health Impacts of Climate Change: A Prototype Training Workshop for City Officials* (Kobe, 2010). Available from http://www.who.int/kobe_centre/publications/heatwaves_floods/en/index.html.

Assessing climate change impacts on agriculture



The Asian Development Bank (ADB) sponsored a study that assessed the impact of climate change on the agriculture sector. The study used predictions of global climate models to develop scenarios to 2050 for the Asia Pacific region and to derive implications for food security.

The resulting report asserts that agriculture is a sector most vulnerable to climate change in the Asia Pacific region since more than 60 per cent of the population of ADB's developing member countries directly or indirectly rely on agriculture as a source of livelihood. The report anticipates that disruptions in this sector will have global negative implications on food availability, access and utilization.

The study utilized several models and model outputs to come up with the impacts, adaptation and resilience measures, and policy recommendations. The models used include:

- Results from three general circulation models
- The International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) partial equilibrium model of world agriculture that is designed to examine alternative futures for global food supply, demand, trade, prices and food security; it covers over 40 agricultural commodities
- The Decision Support System for Agrotechnology Transfer (DSSAT) crop modelling suite that has several modules including land, soil, generating daily weather values, and (currently) 28 crop models.

Key points

- Adaptation in agriculture requires assessment of the cross impacts of climate, crop response and related development decisions.
- At a regional level, computer models can be utilized to estimate the complex impacts of climate change and evaluate agriculture policy options.

Further reading

ADB, *Building Climate Resilience in the Agriculture Sector of Asia and the Pacific* (Manila, 2009). Available from http://www.adb.org/publications/building-climate-resilience-agriculture-sector-asia-and-pacific.

International Food Policy Research Institute, "IMPACT Model", http://www.ifpri.org/book-751/ourwork/program/impact-model.

DSSAT.net website, http://dssat.net/.

Urban Services Monitoring Systems

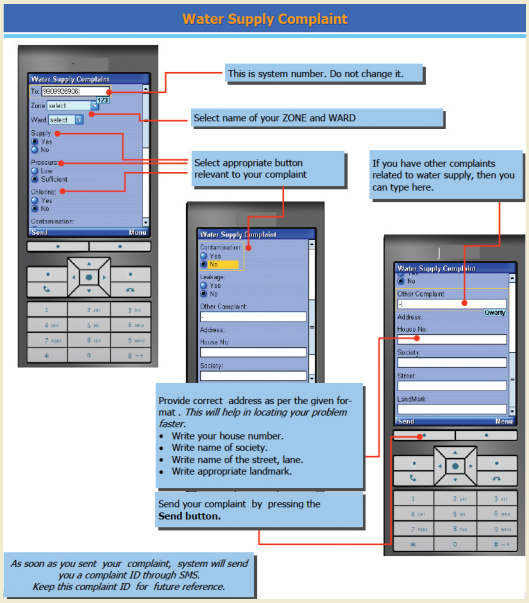


Image source: UrSMS Brochure, http://www.acccrn.org/sites/default/files/documents/URSMS_booklet.pdf.

Urgent attention must be given to improving the surveillance of sanitation and water systems, near-real-time management information systems, as well as the linkages between the hydraulics and sanitation departments. Moreover, vector-borne diseases are complex issues that need to be understood better with ongoing research and surveillance systems.

The Urban Service Monitoring System developed by the Surat Municipal Corporation in India, under the Asian Cities Climate Change Resilience Network (ACCCRN), aimed to improve the monitoring and handling of complaints related to health, water supply, sewerage and solid waste services. A text messaging system has been developed that can be downloaded and used by citizens to report complaints and needs. In addition, a reporting and web-based GIS interface has been developed to aid decision makers. This system can be modified for use during emergencies such as floods.

Key points

- Adaptation could include monitoring sanitation and water systems.
- ICT-enabled crowdsourcing of monitoring information can improve linkages with communities.

Further reading

UrSMS Project website, http://surat.ursms.net/cms/home.aspx.

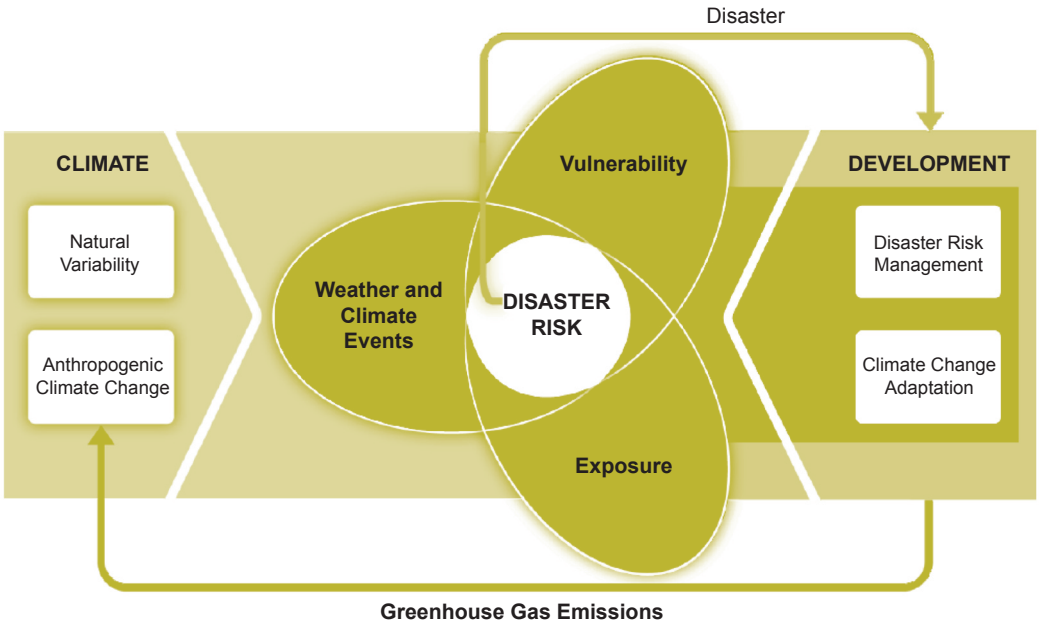
UrSMS Brochure, http://www.acccrn.org/sites/default/files/documents/URSMS_booklet.pdf.

ACCCRN, "Urban Service Monitoring System (UrSMS)", http://www.acccrn.org/resources/documents-and-tools/urban-service-monitoring-system-ursms.

Climate change and DRM. The *IPCC Fourth Assessment Report* estimates that by the 2080s, many millions more people are projected to experience floods every year due to sea level rise. The vulnerable industries, settlements and societies are generally those in densely populated and low-lying megadeltas of Asia and small islands, and in coastal and river flood plains. The most vulnerable also includes those whose economies are closely linked with climate-sensitive resources, and those in areas prone to extreme weather events, especially where rapid urbanization is occurring.

IPCC published the SREX report[29] that integrates perspectives from several research communities studying climate science, climate impacts, adaptation to climate change and DRM. The report analysed the scientific literature for the relationship between climate change and extreme weather and climate events (or "climate extremes"), and the implications of these events for society and sustainable development. The report states that the character and severity of impacts from climate extremes depend on the extremes themselves, on exposure and on vulnerability. But they are influenced by a wide range of factors, including anthropogenic climate change, natural climate variability, and socio-economic development (see figure 3). DRM and adaptation to climate change are needed to influence the development process in order to reduce exposure and vulnerability, and increase resilience to the impacts of climate extremes.

Figure 3. Exposure and vulnerability to weather and climate events determine impacts and the likelihood of disasters



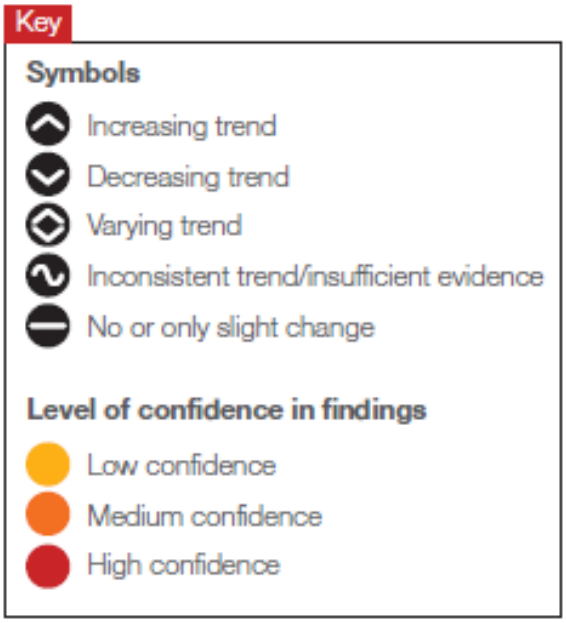
Source: IPCC, *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*, Special Report of the Intergovernmental Panel on Climate Change (2012), p. 4. Available from http://ipcc-wg2.gov/SREX/).

The report described the possible impacts of climate extremes by region. For Asia, climate extremes, increasing vulnerability and increasing exposure are expected to result in increasing economic losses, have adverse impacts on key economic sectors (water, agriculture and food security, forestry, health, tourism) and on infrastructure, and will interact significantly with the urban and urbanization processes in densely populated Asian cities. Recommendations for the way forward include integrating DRM, climate change adaptation and sustainable development.

29 IPCC, *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*, Special Report of the Intergovernmental Panel on Climate Change (2012). Available from http://ipcc-wg2.gov/SREX/.

Figure 4. Projected changes in temperature and precipitation extremes, including dryness, in Asia

Region and Sub-region	Trends in maximum temperature (the frequency of warm and cold days)[13]	Trends in minimum temperature (the frequency of warm and cold nights)[14]	Trends in heat waves/ warm spells[15]	Trends in heavy precipitation (rain, snow)[16]	Trends in dryness and drought[17]
North Asia	Likely increase in warm days (decrease in cold days)	Likely increase in warm nights (decrease in cold nights)	Likely more frequent and/or longer heat waves and warm spells	Likely increase in heavy precipitation for most regions	Inconsistent change
Central Asia	Likely increase in warm days (decrease in cold days)	Likely increase in warm nights (decrease in cold nights)	Likely more frequent and/or longer heat waves and warm spells	Inconsistent signal in models	Inconsistent change
East Asia	Likely increase in warm days (decrease in cold days)	Likely increase in warm nights (decrease in cold nights)	Likely more frequent and/or longer heat waves and warm spells	Increase in heavy precipitation across the region	Inconsistent change
Southeast Asia	Likely increase in warm days (decrease in cold days)	Likely increase in warm nights (decrease in cold nights)	Likely more frequent and/or longer heat waves and warm spells Low confidence in changes for some areas	Inconsistent signal of change across most models (more frequent and intense heavy precipitation suggested over most regions)	Inconsistent change
South Asia	Likely increase in warm days (decrease in cold days)	Likely increase in warm nights (decrease in cold nights)	Likely more frequent and/or longer heat waves and warm spells	Slight or no increase in %DP10 index More frequent and intense heavy precipitation days over parts of S. Asia	Inconsistent change
West Asia	Likely increase in warm days (decrease in cold days)	Likely increase in warm nights (decrease in cold nights)	Likely more frequent and/or longer heat waves and warm spells	Inconsistent signal of change	Inconsistent change
Tibetan Plateau	Likely increase in warm days (decrease in cold days)	Likely increase in warm nights (decrease in cold nights)	Likely more frequent and/or longer heat waves and warm spells	Increase in heavy precipitation	Inconsistent change



Source: CDKN, *Managing climate extremes and disasters in Asia: Lessons from the SREX report* (2012), p. A6.

Red Cross/Red Crescent Climate Centre seasonal forecasting

Facing sharp increases in weather-related disasters, the Red Cross/Red Crescent Climate Centre produces seasonal forecasts using ICT, and employs modelling tools to assist in determining human resource needs and relief needs estimates. Users of this information can refer to the guidelines provided to assess the impact of too much or too little rain over a coming period on food security, health, DRM, displacement of people, and livelihoods. With this information, better preparedness measures and updated contingency plans taking into consideration the needs of vulnerable groups, as well as capacity building needs can then be addressed in a more informed way. While seasonal forecasts do not project far into the future, such applications can be used to manage current climate risks.

Images source: Red Cross/Red Crescent Climate Centre website.

Key points

- Seasonal forecasting using ICT and modelling tools is increasingly playing an important role in climate change adaptation.
- Aid agencies that respond to weather-related disasters need more accurate forecasts of seasonal changes to prepare the required resources and develop effective contingency plans.

Further reading

Red Cross/Red Crescent Climate Centre website, http://www.climatecentre.org.

3.5 Helping people, communities and organizations to adapt

ICTs have the potential to raise awareness, build capacity, and transform how organizations deliver goods and services to be better adapted for the future. On the web, the availability of courses, learning and sharing networks, and free resources related to climate change adaption are contributing to strengthening people's resilience to climate change. For example:

e-Learning

1. The United Nations Climate Change Learning Platforms.[30]

2. An online course on "Integrated Water Resources Management in relation to Climate Change" offered by the United Nations Educational, Scientific and Cultural Organization (UNESCO).[31]

3. The *APCICT Virtual Academy*, an online distance learning programme of the *Academy of ICT Essentials for Government Leaders*. Trainers are able to download and customize training materials, and learners are able to take each module as self-paced/self-study online courses.

4. Various specialized courses offered by learning institutions around the world using high speed Internet connections.

Online resources

1. Climate Change Adaptation in Asia and the Pacific knowledge portal, a collaboration of the Adaptation Knowledge Platform and the Asia Pacific Adaptation Network.[32]

2. Adaptation Atlas, a web-based application that enables user-driven, dynamically generated maps of climate impacts and adaptation activities. It includes a database of impacts from peer reviewed climate studies and of adaptation projects.

3. weADAPT[33] has been collaborating with Google.org to explore ways of improving access to information on climate adaptation using Google Earth.[34]

4. Adaptation Learning Mechanism, an online discussion forum.[35]

5. Various specialized training manuals and resources published by specialized institutions around the world that are accessible over the Internet.

3.6 Policy considerations

Adaptation has been described as deceptively simple as a concept, but it has complexity in terms of how the different adaptive actors (such as individuals, communities, economic sectors, etc.) interact to produce development and disaster risk.[36]

ICTs can provide the opportunity to create, manage, exchange and facilitate the application of knowledge, information and data. Where there is a gap, investment in the relevant ICTs should be considered.

30 UNCC: Learn, "UN Climate Change Platforms", http://www.uncclearn.org/knowledge-platforms.

31 UNESCO-IHE, "IWRM as a Tool for Adaptation to Climate Change", http://www.unesco-ihe.org/Education/Short-courses/Online-courses/IWRM-as-a-Tool-for-Adaptation-to-Climate-Change.

32 http://www.asiapacificadapt.net.

33 http://www.weadapt.org.

34 Stockholm Environment Institute and Climate Systems Analysis Group, University of Capetown, "Africa Communication, Visualization, Information", presentation made at COP 15, Copenhagen, Denmark, 7-18 December 2009. Available from http://unfccc.int/meetings/cop_15/side_events_exhibits/items/5084.php.

35 http://www.adaptationlearning.net.

36 Mark Pelling, *Adaptation to Climate Change: From Resilience to Transformation* (2011).

1. At present, it is a challenge to achieve greater precision and less uncertainty over projections of impacts for cities, towns, small islands, small climate phenomena such as cyclones, and for areas with complex features such as mountains and valleys. Investment in ICTs for meteorological observation and environmental observation are important to meeting this challenge.

2. It is important to identify the sectors and communities exposed and vulnerable to the impacts of climate change (such as agriculture, environment, health, water, and coastal towns and cities), and monitor the different degrees of exposure and vulnerability. Investment in gathering and digitizing socio-economic data, earth observation data, and analysing these using GIS platforms is necessary.

3. It is vital to integrate efforts aimed at climate change adaptation from different planning sectors and actors (governments, communities, international aid agencies) so that the efforts are coherent and do not overlap or cause any impediments to progress. This planning may be done by national governments as their national adaptation programmes for each of their potentially affected sectors, and by local governments and communities. ICTs can help policymakers and sectoral experts analyse the potential cross-impacts of adaptation plans.

Test Yourself

1. How can ICTs be used to improve climate change observation?
2. Downscaling is performed to adequately characterize and manage the _____ associated with projections of climate change.
3. What are the sectors that can be affected by climate change? Name at least two, and describe one potential ICT application for each.

4. ICT APPLICATIONS FOR MITIGATING CLIMATE CHANGE

This section aims to:
1. **Provide an overview of the ways in which ICTs are used to mitigate climate change, particularly by enabling energy efficiencies in other sectors (also known as second order effects).**

4.1 Why do we need to mitigate climate change?

Most of the global average warming over the past 50 years is very likely due to anthropogenic GHG increases and it is likely that there is a discernible human-induced warming averaged over each continent (except Antarctica). Unless this trend is reversed, the IPCC warns that there will be dire consequences to life on Earth.

Developing countries are different from developed countries in terms of sources of GHG emissions: lower emissions from energy but higher emissions from manufacturing, construction, deforestation, and agriculture. Developing countries also have different needs such as poverty reduction that may rank higher on the policy agenda[37] and are related to higher emissions due to manufacturing, agriculture and deforestation.

The reduction of GHG emissions is therefore important in order to avert the catastrophe expected by the IPCC. **Climate change mitigation** refers to human actions to reduce the sources of GHGs or enhance their removal from the atmosphere. ICTs can contribute to this goal by: monitoring the emissions; enabling the efficient use of energy and resources; enabling the reduction of GHG emissions; and promoting green and transformative ICTs.

4.2 Facilitating environmental observation

The ability of humans to study, understand, monitor, predict and to some extent manage the environment is based on our powers of observation and analysis. ICTs are tools that facilitate and enable these human capacities. Remote sensing refers to the process of recording information from sensors mounted either on satellites or aircraft. It enables viewing of the same area over long periods of time, and is used to monitor environmental change, human impact, and natural processes. This helps scientists and planners create models to simulate trends observed; and monitor climate, weather and water.[38]

37 Helen Roeth and others, "ICTs and Climate Change Mitigation in Developing Countries", Strategy Brief 4, Climate Change Innovation and ICTs Project, University of Manchester, 2012. Available from http://www.niccd.org/sites/default/files/ICTs_and_Climate_Change_Mitigation_Strategy_Brief.pdf.

38 The use of remote sensing for DRR and DRM is discussed in more detail in *Academy Module 9: ICT for Disaster Risk Management*. Case studies on the use of remote sensing for DRR and DRM can also be found in APCICT's *ICTD Case Study 2: ICT for Disaster Risk Reduction*, available from http://www.unapcict.org/ecohub/ict-for-disaster-risk-reduction-1.

Due to concerns about pollution, sustainability and environmental well being, there is an important and growing market for such ICT devices in the public and private sectors to aid regulation. Many companies are now developing sustainability plans and publishing sustainability reports on a regular basis. Devices are thus developed and marketed for environmental observation, monitoring and control.

The Global Climate Observing System

In many developing countries, the high costs and lack of capacity to use information from satellites are hindrances to better climate related studies and planning. The Global Climate Observing System aims to overcome this barrier with a mechanism for gathering and sharing information on the earth's atmosphere, oceans, water bodies and land. Through this mechanism, countries and scientists can access data for research on future climate variations and for planning. It was initiated by various international agencies including the World Meteorological Organization (WMO) and the UNEP, mainly to support the UNFCCC. Scientists can access data to study CO_2 and methane levels, ozone and aerosol properties, temperature, wind, water vapor and precipitation, surface radiation, essential climate variables of surfaces and sub-surfaces, sea levels, sea-surface temperature, salinity, pressure, current monitoring, river discharge and lakes, snow cover, glaciers and permafrost.

Key points

- Data and information obtained through ICT-enabled observations of the atmosphere, water and land assists in developing climate change mitigations measures.
- For developing countries, cooperation mechanisms that support climate-related studies are critical.

Further reading and contact information

Global Climate Observing System website, http://www.wmo.int/pages/prog/gcos/index.php.

Global Observing Systems Information Center website, http://gosic.org/gcos.

Contact: Carolin Richter, Director, GCOS Secretaria, crichter@wmo.int.

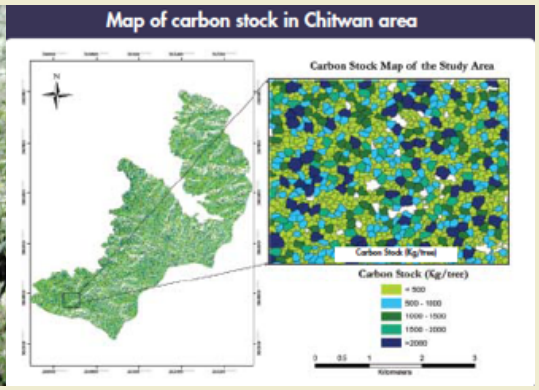
Measuring carbon storage by forests in Nepal

Measurement and early warning methods are critical for developing strategies and taking actions to respond to climate change. Forests are major carbon sinks. To protect the 40 per cent forest cover in Nepal, researchers and scientists are working with communities to calculate the amount of carbon stored in three watersheds.

Above-ground biomass (AGB) estimation is a key way of quantifying carbon stocks in forests and by using remote sensing, the spatial distribution of forest biomass can be calculated at reasonable costs within acceptable accuracy ranges. The International Centre for Integrated Mountain Development (ICIMOD), in collaboration with researchers from the University of Twente in the Netherlands, used high resolution satellite imagery together with object-based image analysis techniques to delineate and classify crown projection area of individual trees for AGB estimation.

The project covers over 10,000 hectare of community-managed forests with an outreach of over 16,000 households directly benefiting more than 89,000 forest-dependent people. The initiative forms part of Nepal's "Reducing Emissions from Deforestation and Forest Degradation in Developing Countries" (REDD) strategy. REDD is a mechanism introduced by the UNFCCC.

Key points
Carbon calculation is done by using an equation based on diameter at breast height of trees combined with information from remote sensing satellites. Satellite-borne sensors make it possible to monitor areas that are not readily accessible and to carry out cost effective measurements in vast areas.



Images source: Eak Bahadur Rana.

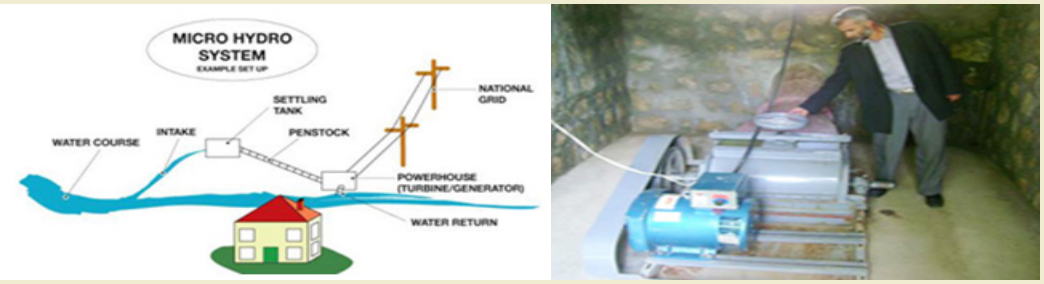
Further reading
ICIMOD, *Earth Observation and Climate Change* (2011). Available from http://books.icimod.org/uploads/tmp/icimod-earth_observation_and_climate_change.pdf.

Community REDD website, http://www.communityredd.net.

4.3 Enhancing the efficient use of energy

Whether or not energy is produced with as little GHG emission as possible, minimizing the wastage of energy is a critical issue for developed and developing countries alike. The greatest inefficiencies in energy use come from producing, distributing and consuming electricity. Centralized energy infrastructure can waste more than two-thirds of produced energy.[39] In many countries, the energy generation and distribution system—the electricity grid—is outdated and has not benefited from newer management models. ICTs have an important role to play in the Smart Grid electrical power system by enhancing the efficiency of the energy generation, transmission and distribution system.[40]

Small hydropower automatic control



Images source: http://www.acted.org/en/afghanistan-10-years-later-community-development-priority.

Hydropower automatic control systems can improve the operational reliability of hydropower plants as well as the quality of power output. They reduce the number of operating personnel required and their workload, raise the operational stability of the grid and optimize plant operations. Depending on the needs of the power plant and configuration of equipment, a total computer control system may be designed or used together with conventional equipment to achieve varying degrees of automatic control. These systems are applicable in both newly-built power plants and for improving the performance of old power plants. It is already used in rural parts of Afghanistan and Thailand, among others.

Key points

- Automatic control systems are effective at reducing costs and improving quality of power production.
- The system is an opportunity to modernize infrastructure and related services.

Further Reading

Siemens, "Small Hydro Power", http://www.energy.siemens.com/mx/en/power-generation/renewables/hydro-power/small-hydro-power/.

Agency for Technical Cooperation and Development, "Afghanistan 10 years later: Community development as a priority", 7 October 2011, http://www.acted.org/en/afghanistan-10-years-later-community-development-priority.

39 European Renewable Energy Council and Greenpeace, "Energy [R]evolution. A sustainable world energy outlook Fig. 4.1", June 2010.

40 IEEE, "IEEE takes the lead on smart grid", 10 March 2010. Available from http://smartgrid.ieee.org/ieee-smartgrid-news/75-ieee-takes-the-lead-on-smart-grid.

4.4 Reducing GHG emissions through dematerialization

In the last decade, some investors have considered that the development of clean technologies not only make business sense but is part of an inescapable trend. This is due to increasing concerns about the cost and availability of fossil fuels, natural resource shortages, security concerns and global environmental problems such as climate change. Cleantech is a new focus of entrepreneurship and industrial development that has been attracting researchers, innovators as well as investors.

For these reasons, the private sector has since the early 2000s been actively investing in clean energy technologies. Growth in the sector is very significant. The IEA estimates that growth in new-build renewable energy assets was 85 per cent in 2007. The year 2008 was the first year in which renewable power generation attracted more investment than traditional fossil fuel-based power generation.[41]

As more and more governments encourage the development of alternative energy resources and encourage greater efficiency in energy use, these companies as well as many public and private sector investors have been actively supporting the development of clean technologies to reduce and/or increase the efficiency of energy use.

ICT-enabled technologies help to better understand, monitor, use, manage and control energy and material use and consumption, and GHG emissions. One of the best examples of these is dematerialization.

According to the *Climate Group Smart 2020 Report*,[42] dematerialization involves "the substitution of high carbon products and activities with low carbon alternatives e.g., replacing face-to-face meetings with videoconferencing, or paper with e-billing." It includes:

1. Digitization of materials such as paper, CDs, video tapes, etc. so that content is manipulated using strictly digital technologies.

2. Travel replacement technologies such as telepresence technologies and other high definition high bandwidth video conferencing systems.

3. Replacement of brick-and-mortar retail outlets with digital malls and shops and store fronts.

4. e-Government – online government services replaces the need for a physical presence across a country or jurisdiction.

5. e-Commerce – online purchasing of goods and services replaces the need for a physical presence.

Dematerialization could have a significant impact on the delivery of government services. Although e-government is usually associated with enhanced service delivery and increased process efficiency in terms of workflow, it also can have a significant impact in reducing energy consumption and GHG emissions. By dematerializing many government services, increased efficiencies in terms of energy and material use can and are being realized. The advantages of e-government can be especially important in developing countries where the cost of energy is high.

41 IEA, *World Energy Outlook 2009* (Paris, 2009). Available from http://www.iea.org/textbase/nppdf/free/2009/WEO2009.pdf.

42 The Climate Group, *SMART 2020: Enabling the low carbon economy in the information age* (2009). Available from http://www.smart2020.org/publications/.

In many developing countries, the main benefit of e-government is that it brings government and government services closer to the people without requiring they consume energy and produce GHG emissions. For the poor, the benefits are not in terms of reducing energy consumption, which for them may involve a significant cost, it is really in saving time and money. Dematerializing government services allow people in more distant or remote areas to take advantage of government services without having to leave their workplace or home and spend time, money and releasing GHG when travelling to obtain services face-to-face.

High-level government officials in Orissa use videoconferencing to reduce travel-related emissions

Images source: eOdisha.com, 2011.

In an attempt to reduce travel-related costs, an e-government project provided telepresence capabilities in 32 locations in the Indian state of Orissa. One video conferencing studio was set up in each of the district headquarters, plus one for the Chief Minister, and one for the State Assembly. These studios are connected to the network National Informatics Centre, enabling communications throughout the country. Although the drivers of this initiative were initially techno-centric, over time, the potential for reducing GHG emissions has become apparent.

Key points

- Telepresence and video conference facilities set up for government at the national and state levels have the potential to reduce GHG emissions.
- This type of ICT application can reduce travel-related costs and serve as models to be replicated throughout the public sector.

Further reading

Debendra Kumar Mahalik, "Reducing Carbon Emissions through Videoconferencing: An Indian Case Study" (University of Manchester, 2012). Available from http://www.niccd.org/sites/default/files/NICCD_Mitigation_Case_Study_VideoConferencing.pdf.

Project Panchdeep, India

Images source: Project Panchdeep website.

Project Panchdeep is an e-government project of the Employee State Insurance Corporation (ESIC) of India that aims to improve delivery of insurance and health care services for employers, employees, and state and central government workers. Users benefit from faster claims processing, and single ID cards issued provide access to all ESIC facilities, including the use of any hospital or dispensary that are part of the network. A single unified information system was rolled out to automate ESIC processes for increased efficiency, transparency and accountability.

The thin-client technology that is being used enables desktop PCs and servers to be shared by several users. This has significantly brought down the hardware and software costs related to the project, reduced GHG emissions from the IT production process and data centres, and reduced e-waste. Thin-clients are considered green also because they use only about 5 watts of electricity.

Key points
The results of the project include a large database of medical records, computerization of 144 hospitals, 620 insurance branches, 1,388 dispensaries and clinics, 51 regional offices of ESIC, and creation of India's largest fingerprint database. It is an example of large scale cloud computing (thin client workstations) and implementation of green IT systems.

Further reading
Project Panchdeep website, http://esic.nic.in/panchdeep.htm.

NComputing website, http://www.ncomputing.com.

K2 Communications, "Wipro selects NComputing platform to power ESIC's Project Panchdeep", http://www.mydigitalfc.com/corporate-releases/wipro-selects-ncomputing-platform-power-esic%E2%80%99s-project-panchdeep-684.

e-Commerce is the equivalent of e-government applied to the private sector. Like e-government, e-commerce enhances service delivery to the paying public seeking commercially available goods and services. Workflow and process efficiency improve considerably by allowing for home-based work. Store fronts can be dematerialized and online market places can replace brick and mortar shops and shopping centres.

By dematerializing or digitizing certain goods such as music, reading materials and audio visual materials like video or film, raw materials and energy can be saved and GHG emissions reduced by downloading the digital product. This also reduces the need to store inventories of products, and eliminates the need to build warehouses, and heat and/or cool them.

e-Government and e-commerce applications on mobile phones are viable even in countries limited by the availability of electricity. The Cisco Visual Networking Index 2010-2015[43] reports that "48 million people in the world have mobile phones, even though they do not have electricity at home." As people use mobile technologies to go online, the demand for e-goods and e-services is expected to grow exponentially.

The Philippines is leading the way in call centres

Reflecting maturation in business outsourcing, Philippines has overtaken India in providing call centre services to large multinational firms located in countries such as USA. The high level of English speaking people in the Philippines makes it ideal for providing these types of services. This shows that efficiency can be achieved using ICT and has the potential to further reduce travel and other related costs in high carbon emitting countries like USA, while contributing significantly to developing economies.

Images source: http://www.fusionbposervices.com/blog/philippines-bpo-promote-themselves-globally.html.

Increases in the government's foreign currency reserves and assets, as well as higher demand for commercial office spaces in Philippines were both attributed to growth in business process outsourcing (BPO) according to the Senate Economic Planning Office. The Business Processing Association of Philippines (BPAP) estimates that the BPO-IT industry has grown at an annual rate of 30 per cent over the last decade.

Key points

- Travel and employee related costs and emission in developed countries can be reduced by outsourcing business processes to developing countries.
- ICT and human resource development are key to the uptake of BPO.

Further reading

BPAP website, http://www.bpap.org.

Senate Economic Planning Office, Economic Report, March 2012, http://www.senate.gov.ph/publications/ER%202012-01%20-%20March%202012.pdf.

43 Cisco, "Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2010–2015". Available from http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html.

4.5 The SMART transformation

The ICT sector has a unique ability to deliver low-carbon, energy-efficient alternatives to the current methods of providing goods and services. It can be utilized to make energy consumption and GHG emissions visible, and then facilitate a radical transformation of infrastructure to change behaviours, processes, capabilities and systems. ICTs can work coherently with other technologies to have the greatest impact.

This goal can be summarized as the SMART transformation:[44]

1. **S**how energy consumption and emissions information, traced across different processes, including those beyond the ICT sector's own products and services.

2. **M**onitor energy consumption and emissions across the economy in real time, and thus provide the data needed to optimize for energy efficiency.

3. **A**ccount for energy consumption and emissions alongside other key business priorities by developing appropriate tools.

4. **R**ethink how to live, learn, play and work in a low carbon economy, initially by optimizing efficiency, but also by providing viable low-cost alternatives to high carbon activities.

5. **T**ransform the economy towards low-carbon, energy-efficient business models and practices.

Smart technologies enhance competitiveness and for this reason, they are relevant to emerging economies and to any country seeking to strengthen their industrial and manufacturing sectors. Smart technologies are relevant especially if the intention is to compete internationally in global markets where increasingly, smart technologies are used and can increasingly be accessed and interacted with, and in some cases controlled via the Internet.

Smart grids

Governments and utilities are looking at renewable energy as a way to improve existing (and largely) inefficient electrical grid systems, to meet growing energy demands, and to do so in a more sustainable way.

The advantages of renewable energy technologies are that they use widely available energy sources (such as the wind and the sun) and have a low carbon footprint over the course of their life cycle. The challenge of using renewable energy sources is that many of these renewable energy sources are intermittent, and therefore are not readily integrated and used by the existing electrical grid. Sun, wind, tidal and wave energy power stations only work when there are sun, wind, tides and waves, respectively; they cannot provide a baseline amount of power for other types of generating stations.

44 The Climate Group, *SMART 2020: Enabling the low carbon economy in the information age* (2009). Available from http://www.smart2020.org/publications/.

Smart grids promote the monitoring of power consumption and use over the electricity grid for more efficient power distribution (routing) and power use by the grid itself. They have the potential to make greater use of renewable and non-GHG emitting sources of energy, including supporting decentralized energy production from renewable resources. Some of the advantages of the smart grid are as follows:[45]

1. More efficient energy routing and thus, the optimization of energy usage, reduction of the need for excess capacity and increase in power quality and security.

2. Better monitoring and control of energy and grid components.

3. Improved data capture and thus, improved outage management.

4. Two-way flow of electricity and real-time information allowing for the incorporation of green energy sources, demand-side management and real-time market transactions.

5. Elements related to smart buildings, smart motors, smart lighting systems, smart vehicles, electric vehicles, smart transportation systems, etc. could function to complement the energy efficiency of a smart grid (see next sub-sections).

6. Decentralized energy production through the integration of renewable energy sources into the grid, to reduce carbon-intensive power generation, and enable the grid to respond to power surges and power outages.

Smart buildings

The buildings sector consists of residential and commercial buildings, and accounts for about 20 per cent of the total delivered energy consumption in the world, making these the largest consumer of energy worldwide.[46] From an energy perspective, buildings are "complex systems consisting of the building envelope and its insulation, space heating and cooling systems, water heating systems, lighting, appliances and consumer products, and business equipment."[47] The energy efficiency of appliances can also influence energy use. Direct emissions from buildings account for around 10 per cent of global CO_2 emissions, and indirect emissions from the use of electricity in the sector increases this share to almost 30 per cent.[48]

Furthermore, IBM estimates that 40 per cent of the world's current output of raw materials goes into buildings.[49] Many of these raw materials and in particular "steel, concrete/cement, bricks and glass require very high temperatures that can only be reached today by the burning of fossil fuels. It is considered that today about 10% of all CO_2 emissions globally come from the production of building materials."[50] This amount will be higher in the developing regions of the world as more new construction is taking place in these countries.

45 OECD, *Smart Sensor Networks: Technologies and Applications for Green Growth* (Paris, 2009). Available from http://www.oecd.org/sti/44379113.pdf; and Helen Roeth and others, "ICTs and Climate Change Mitigation in Developing Countries", Strategy Brief 4, Climate Change Innovation and ICTs Project, University of Manchester, 2012. Available from http://www.niccd.org/sites/default/files/ICTs_and_Climate_Change_Mitigation_Strategy_Brief.pdf.

46 US Department of Energy, *International Energy Outlook 2010* (Washington, D.C., US Energy Information Administration, 2010).

47 IEA, *Energy Technology Perspectives 2010 – Scenarios & strategies to 2050* (Paris, 2010). Available from http://www.iea.org/publications/free_new_Desc.asp?PUBS_ID=2100.

48 Ibid.

49 IBM, "Smarter buildings", 5 February 2011. Available from http://www.ibm.com/smarterplanet/us/en/green_buildings/ideas/.

50 European Commission, *ICT for a Low Carbon Economy: Smart Buildings – Findings by the High-Level Advisory Group and the REEB Consortium On the Building and Construction Sector* (Brussels, European Commission, 2009). Available from http://ec.europa.eu/information_society/events/shanghai2010/pdf/smartbuildings-ld_for_press_pack.pdf.

The Shanghai Tower

The Shanghai Tower, scheduled for completion in 2014, will be the second tallest building in the world and the tallest building in China. It will measure 682 meters in height, and have 128 storeys. The tower was designed and is being built using building information modelling.[4]

The tower will be organized as nine cylindrical buildings stacked atop each other and enclosed by the glass façade's inner layer. Between that and the outer layer, which twists as it rises, nine indoor zones will provide public space for visitors. The design of the glass façade is described to be able to reduce wind loads on the building by 24 per cent. This means that less construction materials are needed.

The twisting feature will collect rainwater to be used for the tower's air conditioning and heating systems. Wind turbines will generate power for the building. It will be the first super-tall double-skin building in the world, acting much like a "thermos bottle" to insulate it and save energy.

Images source: http://en.wikipedia.org/wiki/File:Shanghai_Tower,_07-21-2012.JPG.

Key points

- Building information modelling using computers is an effective way of designing eco-efficient buildings that save energy and materials and promote new ways of addressing climate change.
- Big projects can serve as models for future building design but requires long-term life cycle thinking and vision.

Further reading

Gensler Design Update, Shanghai Tower, http://www.gensler.com/uploads/documents/Shanghai_Tower_12_22_2010.pdf.

The *State of Asian Cities 2010/11* report states that: "In countries like China, Japan and the Republic of Korea, buildings—especially high-rise—tend to be made of materials with high embodied energy (i.e., the materials were energy-intensive to manufacture). On top of this, building design has little regard for the local environment."[51] In Asia, more than 20,000 new housing units are needed every day creating a huge demand for construction materials.

With this context, smart building uses ICTs to reduce energy consumption and increase energy efficiency. Applications include the following:

1. Building information modelling software enables architects, planners, engineers and builders to simulate a building, optimize the energy and material use (water and carbon), streamline the construction workflow, and allow the user to explore multiple design options.

51 UN Habitat, *The State of Asian Cities 2010/11* (Fukuoka, 2010), p. 21. Available from http://www.unhabitat.org/pmss/listItemDetails.aspx?publicationID=3078.

2. The integration of sensors within a building provide information on energy usage and occupancy patterns.

3. Home energy management or building management system can automatically manage and reduce energy consumption, as well as manage distributed energy resources.

4. Integration of the home or building management system within a network of buildings or smart grid allows timely response to variations in energy supply and demand.

Smart transportation and logistics

The transport sector generated about 25 per cent of global CO_2 emissions in 2008, and 26 per cent oil consumption; and the regional share of CO_2 emissions is rising. The bulk of the emissions came from the road sector (79%), then aviation (13%) and rail (4.4%).[52] To help reduce emissions, an intelligent transportation system (ITS) can be created to optimize transport via traffic flow monitoring, planning and simulation technologies. ICTs "enable elements within the transportation system – vehicles, roads, traffic lights, message signs, etc., to become intelligent by embedding them with microchips and sensors and empowering them to communicate with each other through wireless technologies."[53] ITS can be grouped into five categories:[54]

1. Advanced traveller information systems provide drivers with real-time information about road and weather conditions, and other related information.

2. Advanced transportation management systems include traffic control devices, such as traffic signals, ramp meters, variable message signs, and traffic operations centres.

3. ITS-enabled transportation pricing systems include systems such as electronic toll collection, congestion pricing, fee-based express lanes, and vehicle miles-travelled usage-based fee systems.

4. Advanced public transportation systems, for example, allow trains and buses to report their position so passengers can be informed of their real-time status (arrival and departure information).

5. Fully integrated ITSs, such as vehicle-to-infrastructure and vehicle-to-vehicle integration, enable communication among assets in the transportation system, for example, from vehicles to roadside sensors, traffic lights, and other vehicles.

These technologies can be used to reduce congestion and enhance traffic flow in cities. Making transportation more efficient precludes or at least reduces the need to build more highways by enhancing the carry efficiency of existing roadways and transportation infrastructure. The use of real-time traffic data can improve traffic flow by reducing stops by as much as 40 per cent, travel time by 25 per cent, gas consumption by 10 per cent and reduction in GHG emissions by 22 per cent.

52 UNESCAP, *Statistical Yearbook for Asia and the Pacific 2011* (Bangkok, 2011). Available from http://www.unescap.org/stat/data/syb2011/.

53 Stephen Ezell, *Explaining International IT Application Leadership: Intelligent Transportation Systems*, (Washington, D.C., Information Technology and Innovation Foundation, 2010). Available from http://www.itif.org/publications/explaining-international-it-application-leadership-intelligent-transportation-systems.

54 Ibid.

One clear beneficiary to improvements in traffic management is businesses that rely heavily on logistics. Logistics is the process for optimizing the flow of goods and services while considering the traffic environment, the traffic congestion and energy consumption within the framework of a market economy.[55] It is the search for the greatest efficiency possible to optimize production and service delivery while meeting, if not exceeding, the needs and expectations of customers, and keeping costs and other liabilities as low as possible. Increasingly, liabilities include environmental impacts such as GHG emissions, waste and pollution.

ICTs can enhance the efficiency of logistics by improving:[56]

1. Tracking of materials, processes, goods, and inventory.

2. Optimizing fuel consumption, length and timing of travel, frequency of deliveries.

3. Navigation of new routes using onboard navigation systems.

55 Eiichi Taniguchi and others, *City Logistics: Network Modelling and Intelligent Transport Systems* (Amsterdam, Pergamon, 2001).

56 Helen Roeth and others, "ICTs and Climate Change Mitigation in Developing Countries", Strategy Brief 4, Climate Change Innovation and ICTs Project, University of Manchester, 2012. Available from http://www.niccd.org/sites/default/files/ICTs_and_Climate_Change_Mitigation_Strategy_Brief.pdf.

Kuala Lumpur's integrated transport information system

Images source: ITIS website.

A comprehensive traffic information system was developed for Kuala Lumpur to monitor traffic flow and analyse the data on road conditions in the Klang Valley,[5] and to provide useful traffic information to road users.

The system is designed to process and disseminate information from closed-circuit television cameras combined with automated information from Klang Valley's incident detection system and vehicle location system. As a result, real-time video and images, congestion maps, and incident maps can be analysed by the Transport Management Centre. Relevant information is shared with the public through variable message sign boards located on roads and on the web, which can be accessed with mobile devices. A call centre is available for people to call in for information.

The benefits of this system include: (1) improved trip planning and reduced travel time by road users; (2) long-term transport planning by authorities and better road utilization; (3) increased safety and security and emergency response; (4) reduced traffic congestion and reduced pollution due to less time spent idling; and (5) overall improved quality of life. All services are available free of charge for users.

Key points

- Road users can benefit from integrated traffic information management and dissemination systems through reduced congestion and easier travel, resulting in reduction of GHG emissions.
- ICTs including inter-connected computer systems, databases, closed-circuit television cameras and other sensors work together to make these systems a reality.

Further reading

Integrated Transport Information System website, http://www.itis.com.my/atis/index.jsf.

4.6 Policy considerations

1. Climate change mitigation is currently undertaken to a greater extent in developed and emerging economies that have more capacity and infrastructure to support the research and investment required to apply green technologies, i.e., technologies that help to reduce negative impacts on the natural environment and abate climate change.

2. Developing countries should consider exploring technologies for climate change mitigation and assess their potential to adopt or adapt these technologies in their jurisdictions. Countries may not be able to implement all of the ideas outlined in this section, but some limited applications could have a very large impact in the amount of energy saved.

3. There is also a need for awareness promotion of the benefits of reducing GHGs, and of utilizing ICTs for climate change mitigation and saving energy. Demonstration and pilot projects are important for raising awareness.

4. In developing countries, smart grid projects are an opportunity to leapfrog other countries in modernizing the electrical grid. In addition, if there is less existing (legacy) electrical grid, it is possible to invest in new technologies without having to undertake expensive retrofits of existing power transmission and distribution systems.

5. Countries and municipalities can start small first. For example, converting households to using smart meters is usually a very useful first step towards smart grids because they immediately show the consumer how much energy is consumed in relation to specific behaviours, for example, turning on the television.

6. Countries and development actors need to work closely with other countries and development actors as well as with the private sector to experiment and pilot these smart technologies in the broadest way to ensure benefits.

Something To Do

Form small groups and discuss the following:

1. How are you using the Internet to address climate change challenges?
2. What are the online resources, applications and services that you are using or find relevant to abating climate change?
3. What are the constraints that you face in accessing and/or using these resources, applications and services?
4. What policy changes and actions need to be in place to overcome the constraints faced?

5. ICT FOR GREEN GROWTH AND SUSTAINABLE DEVELOPMENT

This section aims to:
1. **Answer questions of what is Green Growth, why promote Green Growth and what is driving the move to Green Growth;**
2. **Provide an overview of Green Growth initiatives in the Asia Pacific region; and**
3. **Explore the role of ICTs in achieving Green Growth.**

5.1 What is Green Growth?

Green Growth is a way to pursue economic growth and development, while preventing environmental degradation, biodiversity loss and unsustainable natural resource use. It builds on existing sustainable development initiatives in many countries and aims at identifying cleaner sources of growth, including seizing the opportunities to develop new green industries, jobs and technologies, while also managing the structural changes associated with the transition to a greener economy.[57]

UNESCAP presents Green Growth and Green Economy as a new development paradigm, wherein economic development and environmental sustainability reinforce each other. It requires "integrated strategies that support systemic change in integrated, complementary and mutually reinforcing ways."[58] Looking towards the environment as a partner, investments are encouraged in economic activities that build on and enhance the earth's natural capital. Green Growth focuses on reducing ecological scarcities and environmental risks, and promoting sustainable agriculture and forest management, and sustainable fisheries. Green Growth also includes activities that reduce GHG emissions and save energy, such as the development of renewable energy, low-carbon transport, and energy- and water-efficient buildings.

The idea is basically a new paradigm on how to run an economy in a way that limits environmental degradation and ensures prosperity.[59]

57 OECD, *Interim Report of the Green Growth Strategy: Implementing our Commitment for a Sustainable Future* (2010). Available from http://www.oecd.org/document/3/0,3746,en_2649_201185_45196035_1_1_1_1,00.html.

58 UN and ADB, *Green Growth, Resources and Resilience: Environmental Sustainability in Asia and the Pacific* (Bangkok, 2012), p. xv. Available from http://www.unescap.org/esd/environment/flagpubs/GGRAP.

59 Stacy Feldman, "Green Growth, South Korea's National Policy, Gaining Global Attention", *Solve Climate News*, 26 January 2011. Available from http://bit.ly/ifvdQt.

5.2 What drives the move to Green Growth?

The Asia Pacific region is growing rapidly. The region has become the world's largest resource user, consuming about 60 per cent of global resources (see box 1). Even though the economic slowdown of 2008-2009 has reduced growth rates, these have started moving up again as of late 2009 and 2010. The continued growth has been attributed to the success of poverty reduction efforts, rapid urbanization and a growing middle or consuming class. This growth, however, is accompanied by increasing demands for energy, land, natural resources and ecosystem services. The projected resources requirements in the Asia Pacific region are such that they will exceed the earth's carrying capacity in the region. In fact, as of 2010, insecurity about food, water and energy supplies remains very high; even though the region has moved to promote environmentally sustainable development.

As a result, several countries are looking at improving the efficiency of energy and natural resource utilization. The countries of the Asia Pacific realize that business as usual is just not possible.

Box 1. Some facts about the Asia Pacific region that drive support for Green Growth

These are among the most important of the many reasons that the Green Growth concept is gaining momentum in the region and worldwide:

1. By the start of the twenty-first century, the region had become the world's largest resource user. It was consuming 35 billion tons of metal ores, industrial minerals, fossil fuels, construction minerals and biomass each year. This is equivalent to 60 per cent of global material consumption.

2. As of 2005, to produce one unit of Gross Domestic Product (GDP) the region required three times the input of resources as the rest of the world.

3. During most of the last four decades, the region's energy use grew faster than global energy use.

4. In 2008, the region used 45 per cent of global primary energy.

5. From 1990 to 2005, regional GHG emissions rose from 14.5 billion to 19.5 billion tons.

6. In 2000, the region used 2,383 billion m^3 of water in agriculture, manufacturing industries and households, or about 63 per cent of the water used globally.

7. The regional average water use of 644 m^3 per capita was above the world average of 619 m^3 per capita. North and Central Asia was the largest water user at 1,011 m^3 per capita.

Source: UN and ADB, *Green Growth, Resources and Resilience: Environmental Sustainability in Asia and the Pacific* (Bangkok, 2012), pp. 25-27. Available from http://www.unescap.org/esd/environment/flagpubs/GGRAP.

5.3 Regional level promotion of Green Growth

The Asia Pacific region as a whole has been an early promoter and adopter of Green Growth. UNESCAP has taken the lead in mobilizing awareness and support for Green Growth throughout the region and beyond by convening conferences, raising awareness, gaining support and undertaking programmes and activities on the topic throughout the region.

The concept of Green Growth gained significant momentum from initiatives in the Asia Pacific region. In 2005, on the occasion of the Fifth Ministerial Conference on Environment and Development that took place in Seoul, UNESCAP received a mandate to promote Green Growth as a strategy to achieve sustainable development while at the same time achieving Millennium Development Goals (MDGs) Target 1 on poverty reduction and Target 7 on environmentally sustainable.[60]

As a result of this conference, a regional implementation plan for sustainable development in the Asia Pacific region was agreed. The plan called for improving environmental sustainability; enhancing environmental performance; promoting environmental protection as an opportunity for sustainable economic growth; and integrating DRM into socio-economic development policies and planning. A Ministerial Declaration on Environment and Development in Asia and the Pacific was agreed. The Seoul Initiative on Environmentally Sustainable Economic Growth (Green Growth) was also agreed. This initiative set several targets as follows:

1. Target 1 – Improving eco-efficiency for environmental sustainability.

2. Target 2 – Enhancing environmental performance.

3. Target 3 – Promoting environmental protection as an opportunity for sustainable growth.

4. Target 4 – Integrating DRM and preparedness in socio-economic development policies and planning.

Since the conference, several regional programmes and activities have been launched to help achieve the objectives agreed to in 2005. These include the following regional and international initiatives:

1. ADB's Climate Change Program, Energy Efficiency Initiative, Carbon Market Initiative, Sustainable Transport Initiative, and Cities Development Initiative for Asia.

2. The United Nations' proposals for a Green New Deal.

3. UNEP's Green Economy Initiative.

4. The Green Jobs Initiative led by UNEP, the International Labour Organization, the International Organization of Employers, and the International Trade Union Confederation. A report that emerged from the Green Jobs Initiative sparked interest in the potential for creating green jobs in developing countries.

5. UNESCAP's Green Growth online e-learning facility offers a set of interactive modules to learn about the fundamentals of Green Growth, livable cities, the low carbon Green Growth road map, and sustaining growth. Case studies are also available, and certificates are issued for each successfully completed module. The courses are designed for all stakeholders involved in a country's transition to Green Growth.[61]

60 UNESCAP, Preview. Green Growth, Resources and Resilience. Environmental sustainability in Asia and the Pacific, 2010 (United Nations, 2010).

61 UNESCAP, Green Growth online e-learning, http://www.greengrowth-elearning.org/lms/.

The April 2010 Association of Southeast Asian Nations (ASEAN) Summit concluded in Hanoi with the adoption of the ASEAN Leaders' Statement on Sustained Recovery and Development. The statement documents the leaders' commitment to "promote green growth, investments in long-term environmental sustainability, and sustainable use of natural resources in order to diversify and ensure resilience of our economy."[62] In May 2010, the Sixty-sixth Session of the Economic and Social Commission for Asia and the Pacific adopted the Incheon Declaration on Green Growth.

Many countries in the region have pursued Green Growth policies and have also invested in strategies and policy reform consistent with Green Growth. China, India, Japan, the Republic of Korea and other emerging economies believe that greening their economies is no longer a matter of choice.[63]

The Green Growth concept has been seized upon by the Government of the Republic of Korea as a way forward in a resource constrained world. The Republic of Korea has deepened the concept to include goals that have been at the heart of the concept of sustainable development including poverty reduction and human development. Several countries in the region including Cambodia, Fiji, Kazakhstan, the Maldives and Mongolia have made major policy statements supporting Green Growth.

Box 2. Green Growth in the Republic of Korea

In January 2009, the Republic of Korea announced a "Green New Deal" aimed at responding to the economic downturn in the short term by creating jobs while also strengthening the foundation for Green Growth in the medium to long term. This is a major effort to create "new growth engines and jobs through green technology and clean energy, affect current consumption and production patterns, and tackle the country's heavy dependence on imported oil and gas, which account for a third of total imports."[64]

The Green New Deal received funds of about USD 42 billion to be spent between 2009 and 2012. A Five Year Green Growth Plan was released in July 2009 with total funding of KRW 107.4 trillion (USD 89.5 billion).

5.4 The Low-Carbon Green Growth Roadmap

The *Low-Carbon Green Growth Roadmap for Asia and the Pacific*[65] is a guide for policymakers in the region on overcoming the challenges from resource constraints and the climate crisis. The report explains the paradigm for low-carbon Green Growth, and offers a roadmap comprised of five tracks. The report was developed by UNESCAP with funding from the Korea International Cooperation Agency.

62 ASEAN Leaders' Statement on Sustained Recovery and Development, presented in Hanoi, Viet Nam, 9 April 2010. Available from http://www.asean.org/24512.htm.

63 Stacy Feldman, "Green Growth, South Korea's National Policy, Gaining Global Attention", *Solve Climate News*, 26 January 2011. Available from http://bit.ly/ifvdQt.

64 International Labour Office, "Republic of Korea's response to the crisis", G20 Country Briefs, 2010. Available from http://www.ilo.org/public/libdoc/jobcrisis/download/g20_korea_countrybrief.pdf.

65 UNESCAP, *Low-Carbon Green Growth Roadmap for Asia and the Pacific* (Bangkok, 2012). Available from http://www.unescap.org/esd/environment/lcgg/.

Countries wishing to sustain economic growth while lowering the environmental impacts will have to undergo a transformation of their economic systems to attain "resource efficiency". The Roadmap identifies the following critical challenges to sustaining development:

1. Resource constraints are threatening future growth prospects. The world is projected to require more food, water and energy by 2030; and countries in the region are vulnerable to energy and food price volatility. These two trends taken together, achievements in development and poverty reduction are in jeopardy.

2. Climate change threatens development gains. As noted in Chapter 3 on ICT applications for adapting to climate change, the Asia Pacific countries are projected to experience climate extremes, and if combined with exposure and vulnerability to disaster risk, there is a potential for significant increase in death and economic loss.

3. The region needs to improve its ecological efficiency. In 2005 the Asia Pacific countries used three times as much resources per unit of GDP as the rest of the world. Resource-intensive growth is not the way for the future.

4. The gap between ecological and economic efficiencies has to be closed. The economic structure has to be examined to improve governance patterns and institutional capacities for enabling Green Growth, to develop standards and regulation to support Green Growth-oriented socio-economic development planning, and to orient the public's lifestyle choices towards green consumption. Pricing must reflect real costs of production and consumption, so that energy and ecological footprints are visible.

Based on these challenges, the Roadmap identifies five main tracks on which to drive the system change for low-carbon Green Growth:

1. Improving the quality of growth and maximizing net growth.

2. Changing the invisible structure of the economy: Closing the gap between economic and ecological efficiencies.

3. Changing the visible structure of the economy: Planning and designing eco-efficient infrastructure.

4. Turning green into a business opportunity.

5. Formulating and implementing low-carbon development strategies.

Factsheets and case studies for each track are available online.[66]

5.5 Role of ICTs in achieving Green Growth

ICTs facilitate the efficiency gains that many Green Growth initiatives depend on. All of the smart interventions mentioned in this module depend on ICTs for their implementation. Smart cities are not smart without ICTs to allow the linkages and communication and control systems that a smart city requires.

66 Factsheets and case studies are available from http://www.unescap.org/esd/environment/lcgg/case-studies-fact-sheets.asp.

The key ICT driven Green Growth initiatives in terms of their impact on reducing GHG emissions and fossil fuel consumption are:

1. Smart grids because of the major reliance on fossil fuels for energy generation and the important efficiencies that a modern ICT-enabled electrical generation and distribution system can help realize. Smart grids are essential for integrating renewable energy resources and driving an efficient energy market.

2. Smart buildings, because of the importance of buildings and the rapid rate of urbanization worldwide.

3. Smart transportation and logistics systems, including smart supply chains. These ICT-driven innovations will make business more energy efficient.

4. Smart motors – any motor- or electricity-driven task or application can be controlled by a microprocessor. This can lead to significant energy savings and reductions in GHG emissions.

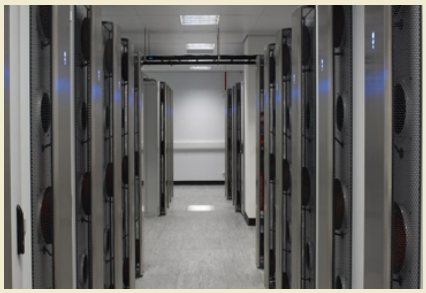
5. ICTs for helping people to learn about the impact of their behaviour in terms of energy use, GHG emissions and environmental impacts. By allowing rapid display of effort, energy and natural resources consumed, we are in a better position to understand the impacts of our behaviour and modify them accordingly.

For example, the Republic of Korea views Green Growth[67] as a "New Paradigm for Economic Growth". It seeks to break away from the conflicting nature of "green" and "growth" and achieve economic growth while maintaining environmental integrity. The Republic of Korea will use the Green Growth idea to restructure and strengthen the economy, change the consumption and production patterns, and create new "green collar" jobs and green industries. Green Growth will be the major driver of change in the Republic of Korea, from economic policies to people's lifestyle.

Another example is the UNESCAP online e-learning facility for Green Growth capacity development, which is a zero-emissions platform for assistance to policymakers in the region.

67 Presidential Committee on Green Growth, *Green Growth: A new path for Korea* (2010). Available from http://www.greengrowth.go.kr/english/en_main/index.do.

Thimpu Tech Park



Images source: http://www.databhutan.com/.

Bhutan has abundant hydroelectric resources that can provide reliable, relatively lower cost and greener power for data centre operators. Bhutan's year round cool climate makes it cheaper to cool these centres. Catering to domestic and international clients, Bhutan Data Centre Services is located within the Thimphu Tech Park (TTP) and adheres to international standards for data centre operation including disaster resilient construction.

A second Internet gateway was opened in March 2012 to increase connectivity and redundancy. Investments are taking place in broadband infrastructure and business services and facilities that are needed to attract data centre services providers, among others, to the IT Park.

TTP is the first IT Park in Bhutan and the government is creating business incentives as well as developing human resources to attract companies and investors. Aimed at promoting the entrepreneurial spirit within the country, the initiative includes a new business technology centre and a new business incubation centre.

Key points

By capitalizing on comparative geophysical and human resource advantages, the government of Bhutan is promoting greener development opportunities. Hydroelectricity use and cooler weather reduces ICT-related emissions that contribute to climate change.

Further reading

Thimpu Tech Park website, http://www.thimphutechpark.com.

Bhutan Data Centre Services website, http://www.databhutan.com.

Using earth observation satellites for low-emission climate resilient development in Maldives



Images source: Victoria Wittig, "Climate & Development Vulnerabilities in Laamu Atoll", presentation of the Food and Agriculture Organization of the United Nations (undated).

The Government of Maldives, jointly with regional development partners, has initiated a project to promote Low Emission Climate Resilient Development. Earth observation satellite images and sensors together with climate change risk data and information are used as part of the assessment and monitoring activities.

The population and ecosystem are affected by climate change and the at-risk areas that need to be addressed include fisheries, agriculture, coasts, water, waste, health and energy. The aim of the project is to build resilient communities and promote low emissions development to mitigate the negative impacts of climate change in the Maldives.

Key points

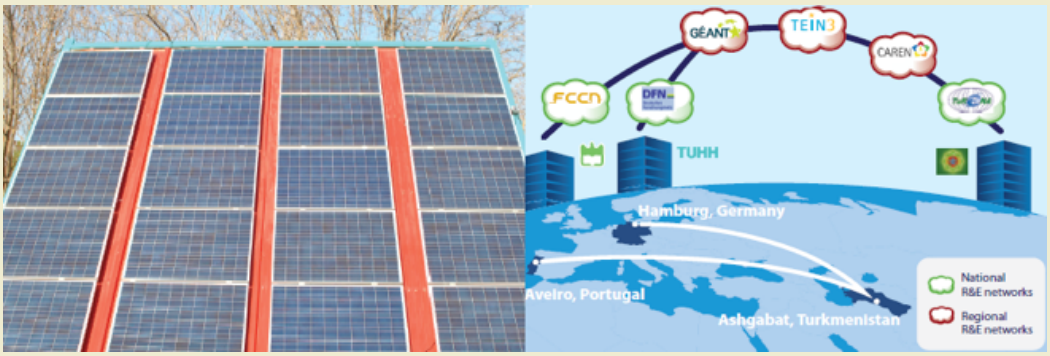
- Critical to a country's Green Growth strategy are building climate-resilient communities and promoting low emissions development that employs new ways of doing things.
- The use of satellite sensor technology is helpful for monitoring emissions.
- In developing countries, governments can work jointly with regional development partners to develop comprehensive projects that address sustainable and eco-efficient development.

Further reading

Project website, http://www.undp.org.mv/v2/?lid=228.

Chapter 5 of the *Asia-Pacific Disaster Report 2012*. Available from http://www.unescap.org/idd/pubs/Asia-Pacific-Disaster-Report-2012.pdf.

Solar energy in Turkmenistan



Images source: CAREN, "CAREN helps harness Turkmenistan's sunshine", Case Study (undated). Available from http://caren.dante.net/Media_Centre/Documents/solar_case_study_FINAL.pdf.

Turkmenistan enjoys 7.4 hours of sunshine per day, and the government has made solar power a strategic priority. Through distance learning and skills transfer via high speed Central Asian Research and Education Network (CAREN) and pan-European GÉANT research networks, the required engineering skills and technology needs are being acquired. Spearheaded by the Gün (Sun) Institute in Ashgabat that has been established as a centre of excellence for the emerging Central Asian renewable energy sector, the collaboration commenced in 2009 with the three-year, European Union-funded TEMPUS project.

The Gün Institute's solar pavilion provides a real-time test-bed to study the local performance of solar technology for the effects of radiation, wind speed and dust, humidity, solar strength, power output, temperature, and atmospheric conditions on solar power production. Real-time performance data will be integral to a planned advanced control and monitoring system.

A high-speed ICT-based e-learning platform called *e-sapak* facilitates real-time sharing of solar energy-related information and data among experts and researchers from universities in Spain, Germany and Portugal, and those from Gün Institute. Specialists from Europe have trained local engineers in solar technology harnessing skills, based on the knowledge gained through the performance monitoring component of the project. Content, lessons, video conferencing and learning resources have resulted in over 700 people being trained.

Key points

- Building ICT driven networks of sensors for monitoring and sharing research is an important first step in developing green energy sources.
- This new area of development requires collaboration and cooperation that support green energy and climate related studies.

Further reading and contact information

CAREN, "CAREN helps harness Turkmenistan's sunshine", case study (undated). Available from http://caren.dante.net/Media_Centre/Documents/solar_case_study_FINAL.pdf.

Contacts:
Mr. Charyyar Amansahedov, Academy of Science of Turkmenistan, amansakhatov@yandex.ru.
Mr. Askar Kutanov, Central Asian Research and Education Network, National Academy of Sciences, Kyrgyz Republic, askarktnv@gmail.com.

China's SMART grid development

The State Grid Cooperation of China, the largest utility provider in the world, has embarked on smart grid development and roll-out to be completed by 2015 with planned improvements until 2020. Some interesting features include the use of wind power and the setting up of vehicle charging stations to encourage hybrid and electrical vehicle use. The use of ICT to make the system efficient and integrated is at the heart of the initiative. As part of China's overarching strategy, mini-grids for rural electrification using renewable sources is also being pursued. The Western provinces are particularly difficult to cover with existing grids. A step approach is adopted whereby the needs of the public are initially catered to by providing electricity for household use through mini-grids.

Key points

- ICTs form the foundation for developing smart grids.
- State-level drive to develop smart grids is necessary to push this type of Green Growth strategy.

*Images source:*State Grid Corporation of China, "Smart Grid Implementation and Standardization in China", presentation, November 2011. Available from http://www.smartgrid.com/wp-content/uploads/2011/09/6___Changyi.pdf.

Further reading

UNESCAP, Low Carbon Green Growth Roadmap for Asia and the Pacific: Case Study - China's mini-grids for rural electrification, http://www.unescap.org/esd/environment/lcgg/documents/roadmap/case_study_fact_sheets/Case%20Studies/CS-China-mini-grids-for-rural-electrification.pdf.

State Grid Corporation of China, "Smart Grid Implementation and Standardization in China", presentation, November 2011, http://www.smartgrid.com/wp-content/uploads/2011/09/6___Changyi.pdf.

Jeju's renewable energy micro-grid

Images source: IBM, EMS Strategy: EMS Adoption in a Micro Grid Solution & EMS Standardization (2010). Available from http://www.smartgrid.com/wp-content/uploads/2011/09/12___Richard.pdf.

Using an advanced ICT-enabled network of power generation and climate measurement tools, the Jeju Island micro-grid is a state-of-the-art solution to addressing climate change and efficient energy production and distribution. Primarily reliant on renewable energy, this initiative is part of the vision for building a nationwide smart grid. Starting with smart grid test-bed set-up in 2009, a nationwide roll-out by 2030 is planned. This initiative serves as a model with an estimated investment of around USD 57.8 million from 2009 to 2013.

Key points

- ICT can enable scale-up of micro-grids.
- Improvements in renewable energy efficiency can promote Green Growth.

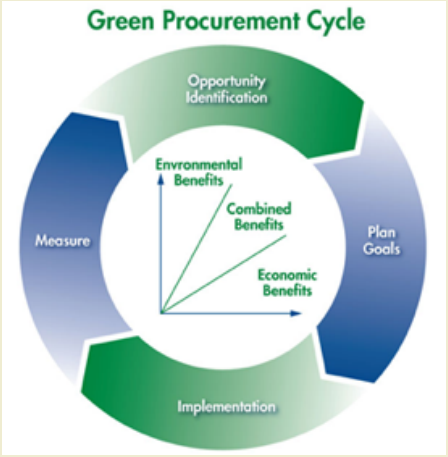
Further reading

Ministry of Knowledge Economy, "Smart Renewable – Case Study: SG Jeju Demonstration Site", presentation, http://www.smartgrid.com/wp-content/uploads/2011/09/3___Yong_Ha_Park____KSGW_SR_Case_StudyPOSCO.pdf.

Green Growth and green procurement in Viet Nam

As part of its Green Growth strategy, the government of Viet Nam is introducing an electronic bidding system (e-procurement) for public procurement as a first step. The system intends to improve efficiency and transparency, and is part of the green industry growth strategy of the country. The system will promote life cycle cost calculation rather than short-term costs, as well as promote transparency in the government's purchasing of goods and services.

Given the significant purchasing power and regulatory influence of governments, green public procurement has the potential to shift market practices to adopt greener approaches. Efforts in Viet Nam, as well as in other countries such as China and India, are also intended to focus green industrial growth in selected sectors that can have a bigger impact on promoting sustainable development.



Images source: http://www.shafferdesignworks.com/CUQuarterly/Q22008/NetworkingMidAtlMeeting.html.

Key points

- ICT-enabled green public procurement is a new and emerging way of carrying out critical procurement functions within the public sector.
- Life cycle cost calculation and improved transparency are characteristics of such improvements in procurement.

Further reading

International Institute for Sustainable Development, *Procurement, Innovation and Green Growth: The story so far...* (Manitoba, 2012). Available from www.iisd.org/pdf/2012/procurement_innovation_green_growth.pdf.

Responsible Purchasing Network website, http://www.responsiblepurchasing.org.

Integrated stormwater management system in Cebu

System components (pumps, tanks, piping, computers, data acquisition and control, remote administration system etc) of the ISWM System Machine Roomr

Responding to increasing demand for water, reducing water supply in aquifers, rainwater wastage, mismanagement of untreated wastewater, and inadequate flood management, a pilot project was initiated in Cebu City, the Philippines, to highlight the benefits of integrated stormwater management.

Images source: Rene Burt N. Llanto and Juan Edgar C. Osorio, "Eco-Efficient Water Infrastructure Development in the Philippines: Integrated Storm Water Management in Cebu", presentation made at the Third Regional Workshop on Eco-Efficient Water Infrastructure in Asia, Bangkok, Thailand (undated).

Using computing simulation modelling, the system's components included (among other components) rainwater collection, primary rainwater treatment, a micro-membrane filtration system, and a water treatment facility for reusing. These components were tested for feasibility, and then installed in a facility to cover the pilot area. Rainfall data analysis, and monitoring and controlling systems for remote areas were further facilitated through the use of ICTs.

The system resulted in 75 per cent reduction in dependency on the main aquifer. It replenished water supply and enabled sound flood management. It was also a good way to raise public awareness on the benefits of such systems.

Key points

- Computer simulation and ICT-linked sensors and data analysis are important in developing and operating integrated stormwater and other water management systems.
- Better use of water resources, rainwater, management of wastewater and flood management are critical in fast urbanizing cities.

Further reading

UNESCAP, Low Carbon Green Growth Roadmap for Asia and the Pacific: Case Study - Philippines' integrated stormwater management, http://www.unescap.org/esd/environment/lcgg/documents/roadmap/case_study_fact_sheets/Case%20Studies/CS-Philippines-Integrated-Stormwater-Management.pdf.

Rene Burt N. Llanto, "Challenges and Opportunities in Integrated Storm Water Management in Cebu, Philippines", presentation, http://www.unescap.org/esd/Energy-Security-and-Water-Resources/water/wastewater_management/PDF/12[Philippines]ISWM%20Final%20Presentation.pdf.

5.6 Policy consideration: Developing an ICT-based climate change mitigation strategy

The ITU *e-Environment Report*[68] recommends strengthening the capacity of developing countries to use ICTs for environmental action: management, conservation and sustainable development. To do this, the report prescribes developing a strategic planning framework for mitigating climate change that is based on ICTs, and an e-environment action plan.

An ICT-based strategy could identify and assess the opportunities for using ICTs to mitigate climate change, while at the same time considering the costs and tradeoffs. The strategy could look at leveraging international support and goodwill, and promoting Green Growth opportunities in the local market place.[69]

These goals of the strategy could include measures to reduce environmental impact, energy use and the emission of GHGs while at the same time promoting economic, human and social development.

Questions To Think About

Are your country's efforts in economic development consistent with Green Growth? Based on the cases cited, what do you think are the potential Green Growth initiatives that your country can try? Think of at least two initiatives, and describe what role ICTs would play.

68 ITU, *ICTs for e-Environment: Guidelines for Developing Countries with a Focus on Climate Change* (Geneva, 2008). Available from http://www.itu.int/ITU-D/cyb/app/docs/itu-icts-for-e-environment.pdf.

69 Ibid.

6. CONCLUSION

The mainstreaming of ICTs in all aspects of human endeavour has enabled significant transformations in the way we work and live. Module 10 has outlined some of these and their potential for abating climate change and promoting sustainable development. With the appearance and convergence of the technological trends noted in this module, we are now also acquiring the ability to understand and learn from our environment in ways that were never even considered possible until now.

Much remains to be done to take full advantage of some of these technologies, and still, technological development continues and will likely result in even more useful applications that can be more readily and at lower cost be applied around both the developed as well as the developing worlds.

In order for countries and development stakeholders to be able to take advantage of some of the issues and recommendations made here, awareness of the potential of ICTs for abating climate change must continue to be promoted. This is where the users of Module 10 have an important role to play.

This module cannot and does not intend to cover everything that ICTs could do to help countries, organizations, communities and people prepare for a rapidly changing climate. That is not possible. Module 10 users need to adapt the contents of this manual to their own needs and circumstances. They need to continue with the research work that this module has started. They need to explore the knowledge resources identified in this module and ask themselves to what extent they are appropriate to their own needs and circumstances. They need to undertake their own enquiries and do their own discovery work to adapt this knowledge and experience to their own needs.

Research should be undertaken before the module is taught locally in order to adapt the contents of the module to local needs and circumstances. This will help identify priority areas that need to be emphasized during the workshop, as well as identify locally appropriate and relevant case studies. In particular, local case studies would be most useful.

As consensus on the threat of climate change grows, countries are coming together. One of the most practical outcomes of this module is identifying ICT-based technologies and management practices that can greatly contribute to abating climate change. Support for undertaking the needed R&D work, including adapting many of the existing technologies to the needs and circumstances of the developing world will have to take place. It is to be hoped that eventually, the UNFCCC and similar frameworks will result in agreement to facilitate the massive transfers of technology and know how to make this happen.

Module 10 provides a very useful guide for countries and organizations to identify and rate their technology transfer needs. It also helps countries and development stakeholders justify their needs in order to secure the support, financial and otherwise, to adopt and adapt the most appropriate technologies that will help them abate climate change, while at the same time meet their development goals and priorities.

Readers are furthermore encouraged to contribute their own knowledge as mentioned above and share this at the e-Co Hub that APCICT has established for this purpose. In this way, the work that has gone into Module 10 can continue and be shared.

MODULE SUMMARY

The following key points were discussed in this module:

1. Climate change is a growing worldwide challenge. While most decision makers are aware of the threat posed by climate change, awareness of the options for abating climate change using smart technologies and ICTs is only now becoming apparent. This module looks closely at the main challenges in order to better highlight the ICT-based solutions that are being used to address some of these challenges.

2. The module examines the important role that ICTs can play in enhancing environmental observation, interaction and management, and in abating climate change. It addresses how ICTs contribute to climate change mitigation and adaptation.

3. As countries and the private sector recognize the fact that energy resources are limited and increasingly expensive, and that a high carbon economy may no longer be desirable or even possible, the module describes the shift to an environmentally friendly form of development that is captured in the concept of Green Growth. It highlights the essential role of ICTs in encouraging innovation and achieving Green Growth. The relationship of these concepts to developing countries is explored.

4. This module will help participants understand the issues and build their capacity to identify opportunities for using ICTs to abate climate change. It will also help participants contribute constructively to discussions about how to promote sustainable development in the countries, communities, organizations, and in their daily lives through the use of ICTs.

5. The module suggests policies for using ICTs for adapting to climate change impacts, mitigating climate change, and promoting Green Growth as a development strategy.

Glossary

Adaptation to climate change	Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects. Various types of adaptation exist, e.g., anticipatory and reactive, private and public, and autonomous and planned. Examples include raising river or coastal dykes, and the substitution of more temperature shock resistant plants for sensitive ones.
Biofuels	Combustible renewables and waste comprised of solid biomass, liquid biomass, biogas, industrial waste and municipal waste used for energy purposes.
Carbon capture and storage	A controversial practice that is being considered as a way of directly reducing GHG emissions from burning fossil fuels by removing or "capturing" the atmospheric CO_2 generated during combustion using a variety of technologies and industrial processes for removing or scrubbing the CO_2 from the effluent gases in fossil fueled power plants.
Carbon footprint	A measurement of all GHGs we individually produce and has units of tons (or kg) of CO_2 equivalent.
Cleantech	Clean technologies to reduce or increase the efficiency of energy use.
Climate change	A change of climate that is attributed directly or indirectly to human activity, alters the composition of the global atmosphere, and is in addition to natural climate variability observed over comparable time periods.
Cloud computing	Applications and digital services that reside exclusively on the Internet, that is they are located on server systems (i.e., a large number of powerful computers that are networked) and can only be accessed using the Internet.
Combustion efficiency	A measure of how efficiently conventional fuels are burned by a particular device or machine.
Crowdsourcing	A new web-based business model that harnesses the creative solutions of a distributed network of individuals through what amounts to an open call for proposals, and is used for obtaining feedback and data, information and in some cases, as a way of distributing or sharing work and effort.
Dematerialization technology	The substitution of high carbon products and activities with low carbon alternatives e.g., videoconferencing for face-to-face meetings, e-billing for paper.
Digitization	The changing of manual processes to digital ones.
Earth-based sensor	Terrestrial, ICT-based technologies that are used to understand the global environment.
Geothermal power	The constant temperature of the earth creates underground sources of heat, hot water and steam that become fuel to produce geothermal energy. Modern technology accesses these by drilling, and then using the heat or hot water directly or using it to create power.
Global positioning systems	A system consisting of 25 satellites in six orbital planes at 20,000 km altitude with 12-hour periods, used to provide highly precise position, velocity and time information to users anywhere on Earth or in its neighbourhood at any time.
Green (technology)	Technologies that help to reduce negative impacts on the natural environment and abate climate change.
Green Growth	A policy focus that emphasizes environmentally sustainable economic progress to foster low-carbon, socially inclusive development.

Grid computing	A variation on cloud computing where computers contribute processing power to solve complex calculations and/or model complex phenomena such as the weather or other environmental or ecosystemic phenomena, events or processes, etc.
Life cycle assessment	A methodology that is used to determine the environmental impact of the conception, production, use and disposal of manufactured goods and specifically ICTs.
Maladaptation	Any changes in natural or human systems that inadvertently increase vulnerability to climatic stimuli; an adaptation that does not succeed in reducing vulnerability but increases it instead.
Miniaturization	The process of making a technology smaller and require less energy to operate.
Mitigation of climate change	A human intervention to reduce the sources or enhance the sinks of GHGs.
RFID, Radio-frequency identification technologies	Passive RFID technologies use ambient energy and react to external stimuli to communicate. Active RFID chips have their own energy source that they use to initiate communications with passive RFID chips from which they may gather data.
Remote sensing	The technology of acquiring data and information about an object or phenomena by a device that is not in physical contact with it. In other words, remote sensing refers to gathering information about the earth and its environment from a distance.
Renewable energy	Alternate energy sources that take advantage of widely available energy sources such as the wind, sun, tides and waves to create power.
Sensor technology	Device that produces an output (usually electrical) in response to stimulus such as incident radiation. Analysing the transmitted data provides valuable scientific information about the earth.
Smart technology	Using ICT-based technologies to enhance energy efficiency and the operation of an energy system.
Social networking	Internet-based services that provide content and services and allow users to publish their own content and share this with other users of their designation. Social networking is the use of these applications.
Telepresence	A form of high definition video conferencing using dedicated Internet connections.
Virtualization	The consolidation of use of client devices and services, such as those provided by the desktop computing environment, in order to increase access, reduce costs and GHG emissions, and save energy.

Sources:

D. Brabham, “Crowdsourcing as a Model for Problem Solving”, *International Journal into New Media Technologies*, 14(1), 2008.
Carbon Footprint, “What is a Carbon Footprint?” Available from http://www.carbonfootprint.com/carbonfootprint.html.
EPA, “Glossary of Climate Change Terms”. Available from http://www.epa.gov/climatechange/glossary.html#G.
EPA, “Geothermal Energy”. Available from http://www.epa.gov/ne/eco/energy/re_geothermal.html.
IEA, “Combustible Renewables and Waste”. Available from http://www.iea.org/stats/defs/sources/renew.asp.
IPCC, “Working Group II: Impacts, Adaptation and Vulnerability – Annex B: Glossary of Terms”. Available from http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=689.
ITU, “Next Generation Networks Global Standards Initiative”. Available from http://www.itu.int/en/ITU-T/gsi/ngn/Pages/default.aspx.
NASA, “Glossary”. Available from http://earthobservatory.nasa.gov/Glossary/index.php?mode=alpha&seg=f&segend=h.
UNEP, “List of Acronyms and Glossary Terms”. Available from http://www.unep.org/dec/onlinemanual/Resources/Glossary/tabid/69/Default.aspx?letter=C.
UNESCAP, “About Green Growth”. Available from http://www.greengrowth.org/?q=static-page/sat-10012011-1104/about-green-growth.

Further Reading

General: Climate change

1. Global Carbon Project. Available from http://www.globalcarbonproject.org/.
2. IPCC (2007). *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Geneva. Available from http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm.
3. (2007). *IPCC Fourth Assessment Report: Climate Change 2007. Annex 1: Glossary*. Available from http://www.ipcc.ch/publications_and_data/ar4/wg3/en/annex1sglossary-a-d.html.
4. (2012). *Managing the risks of extreme events and disasters to advance climate change adaptation*. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Available from http://ipcc-wg2.gov/SREX/report/.
5. ITU (2008). *ICTs for e-Environment: Guidelines for developing countries with a focus on climate change*. Geneva. Available from http://www.itu.int/ITU-D/cyb/app/docs/itu-icts-for-e-environment.pdf.
6. Stern, Nicholas (2010). *Stern Review on the Economics of Climate Change.* London: HM Treasury. Available from http://www.hm-treasury.gov.uk/sternreview_index.htm.
7. UNFCCC (2010). Climate Change. Available from http://unfccc.int/files/documentation/text/html/list_search.php?what=keywords&val=&valan=a&anf=0&id=10.
8. Issues in the negotiating process: A brief history of the climate change process. Available from http://unfccc.int/cop7/issues/briefhistory.html.
9. WCED (1987). *Our Common Future*. Report of the World Commission on Environment and Development. Available from http://www.un-documents.net/wced-ocf.htm.

Climate change adaptation and ICT applications

1. Adaptation Atlas. Available from http://www.adaptationatlas.org.
2. ADB (2009). *Building Climate Resilience in the Agriculture Sector in Asia and the Pacific*. Manila. Available from http://www.adb.org/sites/default/files/pub/2009/Building-Climate-Resilience-Agriculture-Sector.pdf.
3. (2011). *Food Security and Climate Change in the Pacific: Rethinking the options*. Manila.
4. Climate Change Adaptation in Asia and the Pacific Knowledge Portal. Available from http://www.asiapacificadapt.net.
5. Ministry of Environment and Forest, Government of the People's Republic of Bangladesh (2005). *National Adaptation Programme of Action* (NAPA). Dhaka. Available from http://www.moef.gov.bd/bangladesh%20napa%20unfccc%20version.pdf.
6. NatureServe – A network connecting science with conservation. Available from http://www.natureserve.org.
7. Nepal Climate Portal. Available from http://www.dhm.np/dpc.
8. Ospina, Angelica Valeria and Richard Heeks (2011). ICTs and Climate Change Adaptation: Enabling Innovative Strategies. Strategy Brief 1. Climate Change, Innovation and ICTs Project. Available from http://www.niccd.org/node/20.
9. Pachube. Available from http://www.pachube.com.
10. Pelling, Mark (2011). *Adaptation to Climate Change: From resilience to transformation*.
11. UN CC:Learn – One UN Training Service Platform on Climate Change. Available from http://www.uncclearn.org.
12. UNFCCC. Essential Background. Available from http://unfccc.int/essential_background/items/2877.php.
13. weADAPT. Available from http://www.weadapt.org.

14. WHO (2009). Protecting the health of vulnerable people from the humanitarian consequences of climate change and climate related disasters. Paper presented at the Sixth session of the Ad Hoc Working Group on Long-Term Cooperative Action under the Convention. Bonn, Germany, 1-12 June. Available from http://unfccc.int/resource/docs/2009/smsn/igo/047.pdf.
15. (2010). *Heat waves, floods and the health impacts of climate change: A prototype training workshop for city officials*. Available from http://www.who.int/kobe_centre/publications/heatwaves_floods/en/index.html.
16. WMO (2011). World Weather Watch Programme. Available from http://www.wmo.int/pages/prog/www/index_en.html.

ICT for mitigating climate change

1. Accenture (2005). Driving high performance in government: maximizing the value of public-sector shared services. *The Government Executive Series*. Available from http://www.accenture.com/xdoc/ca/locations/canada/insights/studies/driving.pdf.
2. Bio Intelligence Service (2008). *Final report: Impacts of information and communication technologies on energy efficiency*. European Commission DG INFSO. Available from ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/sustainable-growth/ict4ee-final-report_en.pdf.
3. Climate Risk Pty (2007). *Towards a High-Bandwidth, Low-Carbon Future: Telecommunications-based Opportunities to Reduce Greenhouse Gas Emissions*. Australia: Fairlight. Available from http://www.climaterisk.com.au/wpcontent/uploads/2007/CR_Telstra_ClimateReport.pdf.
4. Roeth, Helen, and others (2012). ICTs and Climate Change Mitigation in Developing Countries. Strategy Brief 4. Climate Change Innovation and ICTs Project. Available from http://www.niccd.org/sites/default/files/ICTs_and_Climate_Change_Mitigation_Strategy_Brief.pdf.

ICT for understanding and monitoring the environment

1. GEO (2011). What is GEOSS: The Global Earth Observation System of Systems, 25 April. Available from http://www.earthobservations.org/geoss.shtml.
2. ITU/WMO (2009). *Use of Radio Spectrum for Meteorology: Weather, Water and Climate Monitoring and Prediction*. Geneva. Available from http://www.itu.int/publ/R-HDB-45/en.
3. Pellerin, Cheryl (2009). "Planetary Skin" Tool Aims to Improve Response to Climate Change: NASA, Cisco collaborate to integrate climate data, Web technology, 19 March. Available from http://www.america.gov/st/energy-english/2009/March/20090319153825lcnirellep0.4414484.html.

Deforestation

1. UN-REDD Programme (2009). About Reducing Emissions from Deforestation and Forest Degradation. Available from http://www.un-redd.org/AboutREDD/tabid/582/Default.aspx.

Energy demand

1. IEA (2010). World Energy Outlook 2010. Presentation made in Beijing, China, 17 November. Available from http://www.energy.eu/publications/weo_2010-China.pdf.
2. Greenpeace and European Renewable Energy Council (2010). *Energy [R]evolution: A Sustainable World Energy Outlook.* 3rd edition. Available from http://www.greenpeace.org/international/en/publications/reports/Energy-Revolution-A-Sustainable-World-Energy-Outlook/.
3. WWF (2011). *The energy report – 100% renewable energy by 2050*. Gland. Available from http://wwf.panda.org/what_we_do/footprint/climate_carbon_energy/energy_solutions/renewable_energy/sustainable_energy_report/.

Clean energy

1. Earley, Rich (2011). Making a dent in energy waste – the pursuit of efficiency. *EnergyBiz*, vol. 8, no. 3. Available from http://www.nxtbook.com/nxtbooks/energycentral/energybiz_20110506/#/0.
2. IEA (2010). *Energy technology perspectives 2010 – Scenarios & strategies to 2050*. Paris: OECD/IEA. Available from http://www.iea.org/publications/free_new_Desc.asp?PUBS_ID=2100.
3. (2011). *Clean energy progress report. IEA input to the Clean Energy Ministerial (CEM)*. Paris: OECD/IEA. Available from http://www.iea.org/papers/2011/CEM_Progress_Report.pdf.
4. Pew Charitable Trusts (2010). *Who's winning the clean energy race.* 2010 edition. Philadelphia. Available from http://www.pewenvironment.org/news-room/other-resources/investing-in-clean-power-329295.
5. (2011). Investing in Clean Power, 29 March. Available from http://www.pewenvironment.org/news-room/other-resources/investing-in-clean-power-329295.

Smart grid

1. Department of Energy (2010), *Communications requirements of smart grid technologies*. Washington, D.C. Available from http://www.gc.energy.gov/documents/Smart_Grid_Communications_Requirements_Report_10-05-2010.pdf.
2. IEEE Smart Grid. Smart Grid Conferences, Standards & News. Available from http://smartgrid.ieee.org.

ICT-enabled energy efficiencies in buildings

1. European Commission (2011). *The European strategic research roadmap to ICT enabled energy-efficiency in buildings and construction (REEB)*, 17 January.
2. IBM (2011). Smarter buildings, 2 May. Available from http://www.ibm.com/smarterplanet/us/en/green_buildings/ideas/.
3. Major Economies Forum (2009). *Technology action plan – buildings sector energy efficiency*. Available from http://www.majoreconomiesforum.org/images/stories/documents/MEF%20Buildings%20Sector%20EE%20TAP%2011Dec2009.pdf.
4. TERI University (2010). Development of environmental building regulations and guidelines to achieve energy efficiency in Bangalore City. Booklet on energy efficiency guidelines for new and existing buildings. Bangalore: TERI Press. Available from http://toolkits.reeep.org/index.php?work=detail&asset=projectOutput&id=223.

Smart cities

1. Accenture (2011). Building and Managing an Intelligent City. Available from https://microsite.accenture.com/sustainability/research_and_insights/Pages/Building-Managing-Intelligent-City.aspx.
2. Bloomberg New Energy Finance (2011). *Leadership Forum – Energy smart technologies – Results book 2010*, 14 January. Available from http://bnef.com/events-awards/leadership-forums/est.
3. UN-Habitat (2008). *State of the world's cities 2010/2011: Bridging the urban divide*. London: Earthscan. Available from http://www.unhabitat.org/content.asp?cid=8051&catid=7&typeid=46&subMenuId=0.
4. UN-Habitat and Earthscan (2011). *Cities and climate change: Policy directions – Global report on human settlements 2011*. Abridged edition. London: Earthscan. Available from http://www.unhabitat.org/content.asp?typeid=19&catid=555&cid=9272.
5. Urban and Regional Innovation Research Unit. Available from http://www.urenio.org.

Cloud computing

1. Accenture and WSP Environment & Energy (2010). Cloud Computing and Sustainability: The Environmental Benefits of Moving to the Cloud. Available from http://www.microsoft.com/Presspass/press/2010/nov10/11-04CloudBenefitsPR.mspx.

e-Waste and e-recycling

1. UNEP (2009). Recycling – From E-Waste to Resources. Available from http://www.unep.org/pdf/pressreleases/E-waste_publication_screen_finalversion-sml.pdf.

Green computing

1. Murugesan, San (2008). Harnessing Green IT: Principles and Practices. *IEEE IT Professional*, January-February, pp. 25-26. Available from http://www.sis.pitt.edu/~dtipper/2011/GreenPaper.pdf.

Sensor networks

1. Akyildiz, Ian F., and Mehmet Can Vuran (2010). *Wireless sensor networks*. Ian F. Akyildiz Series in Communications and Networking. United Kingdom: Wiley.
2. ITU (2008). *Ubiquitous sensor networks (USN)*. *ITU-T Technology Watch Report #4*. Geneva. Available from http://www.itu.int/oth/T2301000004/en.

Internet trends

1. Cisco (2010). Cisco Visual Networking Index: Forecast and Methodology, 2009-2014. Available from http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-481360_ns827_Networking_Solutions_White_Paper.html.
2. (2011). Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2010–2015. Available from http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html.
3. ITU (2010). *ICT facts and figures. The world in 2010*. Geneva. Available from http://www.itu.int/ITU-D/ict/material/FactsFigures2010.pdf.
4. Meeker, Mary, Scott Devitt, and Liang Wu (2010). Internet trends. Morgan Stanley presentation made at CM Summit, New York City, 7 June. Available from http://www.slideshare.net/CMSummit/ms-internet-trends060710final.

ICT, the environment, climate change and sustainable development

1. Greenpeace (2011). New Greenpeace report digs up the dirt on Internet data centres, 21 April. Available from http://www.greenpeace.org/international/en/news/features/New-Greenpeace-report-digs-up-the-dirt-on-Internet-data-centres/.
2. ISO (2006). ISO standards for life cycle assessment to promote sustainable development, 7 July. Available from http://www.iso.org/iso/pressrelease.htm?refid=Ref1019.
3. The Climate Group. SMART 2020: Enabling the low carbon economy in the information age. Available from http://www.smart2020.org/publications/.

Green Growth

1. OECD (2010). *Interim Report of the Green Growth Strategy: Implementing our Commitment for a Sustainable Future*. Paris. Available from http://www.oecd.org/document/3/0,3746, en_2649_201185_45196035_1_1_1_1,00.html.
2. UN and ADB (2012). *Green Growth, Resources and Resilience: Environmental Sustainability in Asia and the Pacific*. Available from http://www.unescap.org/esd/environment/flagpubs/GGRAP.
3. UNESCAP (2012). Low-Carbon Green Growth Roadmap for Asia and the Pacific. http://www.unescap.org/esd/environment/lcgg/.

Notes for Trainers

As noted in the section entitled "About The Module Series", this module and others in the series are designed to have value for different sets of audiences and in varied and changing national conditions. The modules are also designed to be presented, in whole or in part, in different modes, on- and off-line. The modules may be studied by individuals and by groups in training institutions as well as within government offices. The background of the participants as well as the duration of the training sessions will determine the extent of detail in the presentation of content.

These "Notes" offer trainers some ideas and suggestions for presenting the module content more effectively. Further guidance on training approaches and strategies is provided in a handbook on instructional design developed as a companion material for the *Academy of ICT Essentials for Government Leaders* module series. The handbook is available at: http://www.unapcict.org/academy.

Content and methodology

The approach taken in this module is to link the evidence of climate change and the underlying factors that are causing or exacerbating climate change to the role that ICTs can play in helping people, communities and countries address these problems and challenges head on. The module then goes on to consider the main ICT-based innovations and technologies that underpin the potential for abating these causes that these technologies promise. Finally, the module examines the most important applications of ICTs for adaptation, mitigation and Green Growth.

Intended target audience

This module is aimed at planners, policy analysts, as well as policy and decision makers working on broad-based development policies and actions. The intended target audience includes development actors in government including ministers, parliamentarians, political actors, senior government officials, strategic planners and analysts, as well as private sector operators, investors and other key actors in the public and private sectors. The module is also relevant to civil society, i.e., academia, education, research, non-governmental organizations as well as other development actors working at the local and community levels.

Urban planners, members of professional associations or organizations such as engineers, architects and other members of the AEC sector, land-use planner and managers, including farmers and extension agents, as well as others will all benefit from taking this module. This module will be of special relevance to individuals and organizations that are involved in research and/or directly in the negotiations of the UNFCCC.

Module 10 is adaptable. The rate and extent of innovations in the use of ICTs to address environmental as well as climate related issues is so rich, as we can see in this module, that there are elements of information and expertise that can inform and support development workers in most sectors. Not all of this information is to be found in the present edition of Module 10, but with a bit of research and consultation, variations of the module for application to different sectors can be developed.

Structuring the sessions

Depending on the audience, time available, and local settings and conditions, the content of the module can be presented in different structured time capsules. What could be covered in sessions of different durations is outlined below. Trainers are invited to modify the session structure based on their own understanding of the country and audience.

Module 10 is best made an interactive learning experience. Participants are expected to engage and contribute to the discussions. Because of the novelty of the topic, participation is essential for gathering information about case studies and user experience.

For a 90-minute session

Provide an overview of the module. Refer to the "Summary" and introductory parts of each section to build your workshop content, and emphasize issues of most relevance to the participants. You may also choose to focus on an issue in a sub-section, for example, computer modelling of climate impacts in section 3.4, or the positive and negative impacts of the SMART approach in section 4.5, depending on the interests of the participants.

For a three-hour session

This would be an expansion of the 90-minute session structured to provide greater focus on certain sections. Depending on the background of participants, you may wish to run through the module overview and then focus on particular sections or sub-sections, such as some of the ICT trends and their implications for tackling climate change in section 2, or an overview of Green Growth strategies and initiatives from section 5.

A three-hour session may also be divided into two 90-minute sessions. The first session can cover a summary of a relevant section and a case study discussion, and the next session can be spent on a group exercise. Please see the "Something To Do" boxes for ideas for a group exercise.

For a full day session (6 hours duration)

For the morning session, provide an overview of each section and focus on issues in selected sections (because there will not be time to cover all), for example on selected smart systems. For the afternoon session, focus on just one or two sections of the module, for example on the use of ICTs for climate change adaptation and mitigation (sections 3 and 4). Encourage group discussions and assign practical exercises in between PowerPoint presentations.

For a three-day session

Dedicate day one to providing an overview. For instance, section 2 can be presented in the morning, followed by a discussion session on e-waste and policy measures for e-recycling in the afternoon. For day two, present section 3 in the morning with a focus on the adaptation needs of the country(-ies) of the participants and relevant ICTs, and in the afternoon present section 4 with a workshop to discuss a case study on an ICT application for either adaptation or mitigation. For day three present section 5 in the morning, and if possible there can be a field visit in the afternoon. Allocate the last 10 minutes of each session for an open discussion and sharing of experiences related to the module content.

For a five-day session

This time frame should, for the most part, allow you to cover the module fully. Begin with a high-level overview of the module, and then expand into each section. To sustain audience interest throughout the five days, ensure plenty of audience interaction and use the practical exercises as both a break from content presentation and as a means for making the subject matter more interesting. Refer to the "Something To Do" and "Questions To Think About" boxes for ideas. A field visit could also be arranged on the third or fourth day.

Participation in Module 10

The module is designed for self-study as well as for "classroom" delivery. Thus, each section of the module begins with a statement of learning objectives and ends with a summary of key points. Readers may use the objectives and summary of key points as a basis for assessing their progress through the module. Each section also contains discussion questions and practical exercises that may be accomplished by individual readers or used by trainers. These questions and exercises are designed to enable readers to draw on their own experience to benchmark the content and to think reflectively on the issues presented.

Many of the issues, ideas and innovations presented here are still in the very early stages of research, development and implementation. Furthermore, where there are case studies, they are drawn mostly from industrialized and emerging countries and not necessarily from developing countries or from the small island developing states. Module 10 participants and readers are encouraged to share case studies in training sessions or online on the e-Collaborative Hub (http://www.unapcict.org/ecohub).

About the Authors

The Asian Disaster Preparedness Center (ADPC) is a leading regional resource centre working towards the realization of disaster reduction for safer communities and sustainable development in Asia and the Pacific. Its mission is to reduce the impact of disasters on communities and countries in Asia and the Pacific by raising awareness, helping to establish and strengthen sustainable institutional mechanisms, enhancing knowledge and skills, and facilitating the exchange of information, experience and expertise.

ADPC's roles in the Asia Pacific region can be broadly categorized as the following:

• Development of capacities and promotion of learning	• Preparations and follow up of global and regional mechanisms
• Establishment of new regional mechanisms	• Dissemination of information and knowledge management
• Provision of technical and advisory services	• Support for inter-agency coherence and coordination
• Implementation of pioneering regional programmes	• Catalytic facilitator and partner of subregional mechanisms

ADPC was established in January 1986 after a feasibility study by the Office of the United Nations Disaster Relief Coordinator (now the United Nations Office for the Coordination of Humanitarian Affairs [OCHA]) and the World Meteorological Organization (WMO), with funding from the United Nations Development Programme (UNDP). ADPC has in turn established new regional mechanisms such as the Regional Consultative Committee on Disaster Management (RCC) in 2000, with the aim to identify the disaster-related needs and priorities of Asia Pacific countries, develop action strategies and promote cooperative programmes on a regional and subregional basis, and provide strategic guidance to ADPC.

Providing intensive training on various aspects of DRM has been the foundation for ADPC's establishment and the primary focus of its activities during its first five years. The pioneering training courses became ADPC's flagship courses on Disaster Management and Community-based Disaster Risk Reduction. Additional specialized training courses on various aspects of DRM with both single and multiple hazard emphasis have remained part of our portfolio throughout the past 25 years, with the following core courses:

• Climate Risk Management	• Flood Disaster Risk Management
• Community-based Disaster Risk Reduction	• Hospital Emergency Preparedness and Response
• Disaster Management Course	• Mainstreaming Disaster Risk Reduction in Local Governance
• Disaster Risk Communication	• Public Health and Emergency Management in Asia and the Pacific
• Earthquake Vulnerability Reduction Course	• Use of Geographical Information Systems and Remote Sensing in Disaster Risk Management
• End-to-End Multi-Hazard Early Warning Systems	

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Richard Labelle is an independent consultant based in Canada. He has almost 30 years of experience in institutional strengthening and information and knowledge management in developing countries. He also has extensive experience in research and analysis, training, and project management. Since 1992, he has undertaken missions to over 58 developing countries on behalf of UNDP and other organizations working in international development.

Labelle's work focuses on using ICTs and related technologies and management practices for poverty reduction, economic development, economic inclusiveness, trade enhancement, capacity building, governance and empowerment, sustainability, the greening of business and Green Growth.

He specializes in introducing modern management practices and technologies, particularly ICTs and cleantech, for poverty reduction, inclusive development, Green Growth, and for environmental and climate action.

His research and fieldwork focuses on the use and impact of ICTs, especially the newer ICT applications such as social media and networks, cloud computing, unified communications, video conferencing, collaboration and knowledge sharing platforms, virtualization, Web 2.0 and Web 3.0 apps., etc. His most recent fieldwork is on assessing how ICTs can be used for climate action in some of the poorest countries.

Labelle comments extensively and on an ongoing basis on the use of ICTs for climate action and for development, and as a tool for sustainability, and can be followed via the links below:
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UN-APCICT/ESCAP

The United Nations Asian and Pacific Training Centre for Information and Communication Technology for Development (UN-APCICT/ESCAP) is a subsidiary body of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP). UN-APCICT/ESCAP aims to strengthen the efforts of the member countries of ESCAP to use ICT in their socio-economic development through human and institutional capacity building. UN-APCICT/ESCAP's work is focused on three pillars:

1. Training. To enhance the ICT knowledge and skills of policymakers and ICT professionals, and strengthen the capacity of ICT trainers and ICT training institutions;
2. Research. To undertake analytical studies related to human resource development in ICT; and
3. Advisory. To provide advisory services on human resource development programmes to ESCAP member and associate members.

UN-APCICT/ESCAP is located at Incheon, Republic of Korea.

http://www.unapcict.org

ESCAP

ESCAP is the regional development arm of the United Nations and serves as the main economic and social development centre for the United Nations in Asia and the Pacific. Its mandate is to foster cooperation between its 53 members and nine associate members. ESCAP provides the strategic link between global and country-level programmes and issues. It supports governments of countries in the region in consolidating regional positions and advocates regional approaches to meeting the region's unique socio-economic challenges in a globalizing world. The ESCAP office is located at Bangkok, Thailand.

http://www.unescap.org

The Academy of ICT Essentials for Government Leaders (Academy)

http://www.unapcict.org/academy

The *Academy* is a comprehensive ICT for development (ICTD) training curriculum with currently 11 modules that aim to equip policymakers with the essential knowledge and skills to fully leverage opportunities presented by ICTs to achieve national development goals and bridge the digital divide. Below are the short descriptions of the eleven modules of the *Academy*.

Module 1 - The Linkage between ICT Applications and Meaningful Development

Highlights key issues and decision points, from policy to implementation, in the use of ICTs for achieving the MDGs.

Module 2 - ICT for Development Policy, Process and Governance

Focuses on ICTD policymaking and governance, and provides critical information about aspects of national policies, strategies and frameworks that promote ICTD.

Module 3 - e-Government Applications

Examines e-government concepts, principles and types of applications. It also discusses how an e-government system is built and identifies design considerations.

Module 4 - ICT Trends for Government Leaders

Provides insights into current trends in ICT and its future directions. It also looks at key technical and policy considerations when making decisions for ICTD.

Module 5 - Internet Governance

Discusses the ongoing development of international policies and procedures that govern the use and operation of the Internet.

Module 6 - Information Security and Privacy

Presents information on security issues and trends, and the process of formulating an information security strategy.

Module 7 - ICT Project Management in Theory and Practice

Introduces project management concepts that are relevant to ICTD projects, including the methods, processes and project management disciplines commonly used.

Module 8 - Options for Funding ICT for Development

Explores funding options for ICTD and e-government projects. Public-private partnerships are highlighted as a particularly useful funding option in developing countries.

Module 9 - ICT for Disaster Risk Management

Provides an overview of DRM and its information needs while identifying the technology available to reduce disaster risks and respond to disasters.

Module 10 - ICT, Climate Change and Green Growth

Presents the role that ICTs play in observing and monitoring the environment, sharing information, mobilizing action, promoting environmental sustainability and abating climate change.

Module 11 - Social Media for Development

Provides a development-oriented perspective on social media and describes innovative ways for governments and development stakeholders to leverage them in national development strategies and programmes.

These modules are being customized with local case studies by national *Academy* partners to ensure that the modules are relevant and meet the needs of policymakers in different countries. The modules have also been translated into different languages. To ensure that the programme stays relevant and addresses emerging trends in ICTD, APCICT regularly revises the modules and develops new modules.

APCICT Virtual Academy (http://e-learning.unapcict.org)

The *APCICT Virtual Academy* is part of the multi-channel delivery mechanism that APCICT employs in the implementation of its flagship ICTD capacity building programme, the *Academy of ICT Essentials for Government Leaders*.

The *APCICT Virtual Academy* allows learners to access online courses designed to enhance their knowledge in a number of key areas of ICTD including utilizing the potential of ICTs for reaching out to remote communities, increasing access to information, improving delivery of services, promoting lifelong learning, and ultimately, bridging the digital divide and achieving the MDGs.

All *APCICT Virtual Academy* courses are characterized by easy-to-follow virtual lectures and quizzes, and users are rewarded with APCICT's certificate of participation upon successful completion of the courses. All *Academy* modules in English and localized versions in Bahasa and Russian are available via the Internet. In addition, plans for more content development and further localization are underway.

e-Collaborative Hub (http://www.unapcict.org/ecohub)

The e-Collaborative Hub (e-Co Hub) is APCICT's dedicated online platform for knowledge sharing on ICTD. It aims to enhance the learning and training experience by providing easy access to relevant resources, and by making available an interactive space for sharing best practices and lessons on ICTD. e-Co Hub provides:

- A resources portal and knowledge sharing network for ICTD
- Easy access to resources by module
- Opportunities to engage in online discussions and become part of the e-Co Hub's online community of practice that serves to share and expand the knowledge base of ICTD