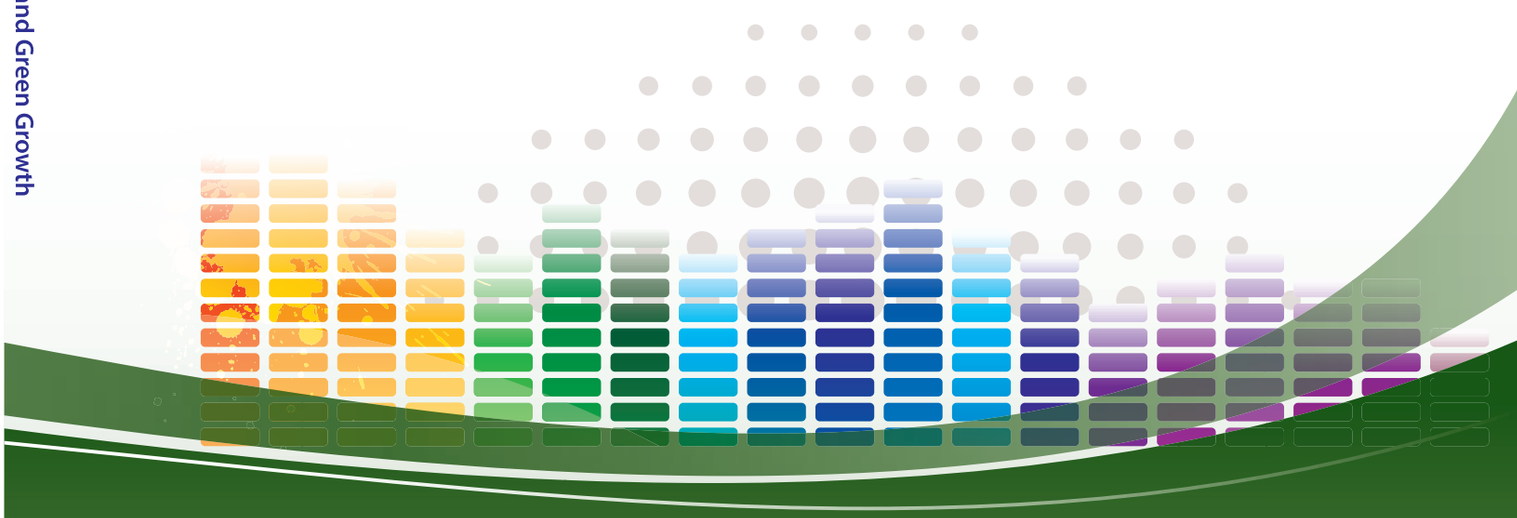
The Primer Series on ICTD for Youth

Primer 4: ICT, Climate Change and Green Growth



UNITED NATIONS
APCICT-ESCAP

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Primer 4: ICT, Climate Change and Green Growth

UNESCAP/APCICT

Primer Series on ICTD for Youth

Primer 4: An Introduction to ICT, Climate Change and Green Growth

A learning resource on ICT for development for institutions of higher education

Lead Author:
Asian Disaster Preparedness Center

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

Primer Series on ICTD for Youth

Primer 4: An Introduction to ICT, Climate Change and Green Growth

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FOREWORD

The importance of youth and its role in helping to build our future society cannot be understated. Every generation comes to a point where it must invest in its youth to lead society into the future. The United Nations clearly understands that only through the enthusiasm and energy of youth will the accomplishments of our generation be sustained and furthered in the next.

The global community, through its shared commitment to sustainable development, has accomplished much over the past decades. Though much work is still to be done to fully meet the Millennium Development Goals (MDGs) by 2015, there are many accomplishments to be acknowledged, achieved through common purpose.

Our world today is moved by the rapid development of information and communications technologies (ICTs). Technologies, best understood as a means of better communication, improved processing and exchange of information, now impact every aspect of our lives, constantly revolutionizing the way we communicate with each other, comprehend our environments, and interact with government.

ICTs have played an important role in fostering improved connectivity as well as socio-economic development throughout the world, including the Asia and Pacific region. ICTs have provided the region's population with new opportunities and resources; e-Government extends the reach of public services, social media provides voices to those social groups most often marginalized, e-Health brings medical practitioners to rural communities and online learning provides access to education for those outside traditional hubs of learning.

However, considerable inequalities in terms of ICT infrastructure, connectivity and know-how still exist and inhibit the potential benefits of ICTs from being adequately leveraged. Access to ICTs is not uniform across regions, countries and communities, with many significant discrepancies existing between neighboring regions and the social groups within them. Indeed, 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 countries within 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 fully bridge the digital divide and realize the full potential of ICTs, a requisite level of human resources and institutional capacity must first exist. Towards this end, the Asia 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 for 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."

Since inception, APCICT has strived tirelessly to develop the requisite set of ICT knowledge and skills among government officials and senior development stakeholders through numerous thematic and programmatic initiatives. APCICT has also indentified the need to build ICT capacity in the next generation of government officials and development stakeholders, if the Asia-Pacific region's development achievements are to be sustained.

However, a gap currently exists in terms of a well designed, instructional sound package for the capacity building of today's youth—the leaders of tomorrow. Understanding the need to bridge this gap, APCICT has developed the *"Turning Today's Youth into Tomorrow's Leaders"* programme, which aims to develop requisite ICT capacity among the leaders and workforce of the next generation.

ESCAP welcomes APCICT's efforts to empower the youth of the Asia-Pacific region and build their ICT for development capacity through the various elements of the programme, and in particular "The Primer Series on ICTD for Youth"; a core curriculum for university students that will provide Twenty-First Century skills for the knowledge society, where ICTs are an intrinsic part of everyday life. With over 56 million students enrolled in institutions of higher learning in Asia and the Pacific alone, the Primer Series is indeed a timely resource, and will support the spirit of the WSIS Declaration of Principles which recognizes that "young people are the future workforce and leading creators and earliest adopters of ICTs. They must therefore be empowered as learners, developers, contributors, entrepreneurs and decision-makers."

Noeleen Heyzer, Ph.D.
Under-Secretary-General of the United Nations
and Executive Secretary of ESCAP
December 2013

PREFACE

The potential of information and communication technologies (ICTs) as a powerful tool to enable inclusive and sustainable development has long been recognized. ICTs can enhance development interventions across all sectors by bridging geographical distance, improving public service delivery and business operations, and increasing access to information and transparency. As important as the role of ICTs is in achieving development goals, it is all the more critical that people know how to put ICTs to the right use to maximize its transformative impact on people's lives.

As today's youth will go on to become leaders in the future, sensitizing the youth to how ICTs can be effectively used to advance development, and empowering them to be able to use the ICTs in their respective fields of career in the future is an investment which will yield long-term dividends. As such, youth should be recognized as one of the key beneficiaries of ICT for development (ICTD) human capacity building. Recognizing this need, APCICT initiated "Turning Today's Youth into Tomorrow's Leaders (TTYTL)", a capacity-building programme for youth on ICTD, and developed the "Primer Series on ICTD for Youth" under the TTYTL as a resource to help enhance coverage of ICTD content in undergraduate and graduate programmes at universities in the Asia-Pacific region.

Since its launch in February 2012, the "Primer Series on ICTD for Youth" has seen a rapid uptake across Asia and the Pacific region. Available in five languages, it has been adopted and utilized in 13 countries and 2 sub-regions, reaching over 90 universities. Building on the success of the first issue of the Primer Series entitled "An Introduction to ICT for Development" which provided a comprehensive understanding on the linkages between ICT and development, APCICT has developed the second (Project Management and ICTD), third (ICT for Disaster Risk Management), and fourth (ICT, Climate Change and Green Growth) issues in 2013 on more specific ICTD topics to meet the growing demand from the member countries for ICTD resources geared towards youth.

The fourth issue of the Primer Series entitled "ICT, Climate Change and Green Growth" focuses on the role of ICT in dealing with climate change and promoting green growth, an issue of increasing importance in recent years. In particular, according to the United Nations Environment Programme (UNEP), Asia-Pacific is one of the most vulnerable regions to climate change and impacts are likely to become more severe in the future. Rising temperatures and extreme weather events have led to loss of crop yield in many countries, while sea level rise is likely to cause significant losses of coastal ecosystems, and put millions of people living in coastal areas at risk.

This Primer introduces students to the role of ICT in climate change adaptation and mitigation with case studies of ICT applications. It also examines how ICTs can be applied to reduce greenhouse gas emissions, and introduces the role of ICTs in promoting Green Growth. This Primer also touches upon the role of ICT in disaster risk management (DRM) focusing on some new ICT-based applications that are not dealt with in Primer 3, providing a more comprehensive overview of the role of ICT in DRM.

A comprehensive and demand-driven approach has marked the entire process of developing this Primer Series. A series of needs assessment surveys, consultation meetings, and workshops have been undertaken with various stakeholders to better understand the needs of the member countries and thus make the Primer Series as relevant as possible. Throughout, APCICT has received generous support from the stakeholders from around the region. I would like to take this opportunity to thank all the participants of the meetings and workshops organized towards developing this fourth issue of the Primer Series for providing their valuable feedback to help strengthen ICTD education in Asia and the Pacific.

I would like to extend my sincere appreciation to the Asian Disaster Preparedness Center (ADPC) for its valuable partnership in bringing out a useful resource for youth on this pertinent topic. I also wish to thank Christine Apikul for editing this Primer Series. I would also like to acknowledge and appreciate APCICT's partners who participated in multiple rounds of the review of the manuscript, and contributed to enhancing the relevance and quality of this publication. Lastly, I would like to thank the Korea International Cooperation Agency for its generous financial support for the development of this Primer Series.

I sincerely hope that the Primer Series will serve as a valuable resource that will enhance the youth's understanding of the role of ICT in addressing climate change and promoting green growth in our region, and contribute to creating a cadre of future leaders with the ability to leverage ICTs for inclusive and sustainable development.

Hyeun-Suk Rhee, Ph.D.
Director
UN-APCICT/ESCAP

PRIMER 4: AN INTRODUCTION TO ICT, CLIMATE CHANGE AND GREEN GROWTH

This Primer addresses the role that information and communication technology (ICT) can play in enhancing the ability and capacity of humans to deal with the impact of climate change and contribute to sustainable development. The principle of sustainable development is an important guide to ensure that the use of ICT to tackle climate change effects is done in a way that does not impact on the ability of future generations to meet their own needs.

There are two main policy responses to climate change: **mitigation and adaptation**. Mitigation addresses the root causes, by reducing greenhouse gas emissions, while adaptation seeks to lower the risks posed by the consequences of climatic change. Both approaches will be necessary, because even if emissions are dramatically decreased in the next decade, adaptation will still be needed to deal with the global changes that have already been set in motion.

Note that climate change mitigation is not the same as disaster mitigation. Climate change mitigation includes actions to reduce greenhouse gas emissions. Disaster risk mitigation is the lessening or limitation of the impact of hazards such as floods and earthquakes. It includes the implementation of structural measures (e.g. flood gates) and non-structural measures (e.g. land-use planning) so that when a disaster strikes, its impact on communities is lessened.

This Primer focuses on the role that ICT can play in climate change adaptation and mitigation. Since climate and the environment are linked, this Primer also considers the role of ICT in helping humans understand the environment that surrounds them, which is a prerequisite for tackling the problems of climate change.

While the Primer also considers the role of ICT in and disaster risk management (DRM), it does so in regards to some new ICT-based applications that are not covered in Primer 3, which provides a comprehensive overview of the role of ICT in DRM.

LEARNING OBJECTIVES

The Primer aims to:

- Introduce the key concepts and issues in climate change, Green Growth and ICT;
- Foster a better understanding of how ICTs can be used to adapt to climate change effects, with case studies of ICT applications;
- Foster a better understanding of how ICTs can be used to achieve reductions in greenhouse gas emissions, with case studies of ICT applications; and
- Provide a Green Growth-oriented approach to development, and discuss the role of the ICT sector in promoting Green Growth.

LEARNING OUTCOMES

After reading this Primer, students will be equipped with the basic awareness of climate change concepts, and exposed to the potential use of ICT for climate change adaptation, climate change mitigation and Green Growth. Students will be able to utilize this as a context and potential in whatever field or profession they decide to pursue.

Specifically, this Primer provides students with:

- Conceptual frameworks to understand the processes of climate change adaptation, climate change mitigation and Green Growth, and the role of information and ICT in these processes.
- Broad knowledge and skills to help in the effective planning, development and implementation of relevant ICT applications.

Something To Do

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

- 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.
- Read 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.
- Read the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) published in 2007.[3]
- 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.

HOW TO USE THIS PRIMER

This primer introduces various aspects and issues in climate change, and explores how ICT applications are helping us to adapt to climate change consequence, reduce greenhouse gases, and go towards better pathways to development.

The primer is divided into five chapters. Each section begins with a set of learning objectives and outcomes against which readers can assess their own progress. Each chapter of the primer contains practical exercises and multiple choice questions to help readers check that they have understood the discussions. The practical exercises are intended to promote an interactive learning process among students and faculty, and encourage readers to think reflectively on the issues presented.

Case studies are also provided throughout the primer. These are intended for discussion and analysis, particularly in terms of the extent to which the key concepts and principles presented in the primer work in real-world projects and programmes. Case study analysis and assignments are intrinsic to the learning process and should be taken with the seriousness they merit.

In addition, the primer contains short “Youth In Action” synopses of what young people have done or can do using ICTs to tackle climate change issues. The intention of these synopses is to inspire students to go beyond classroom learning.

This primer can be used by students as basic material to understand the various aspects and issues in ICT for climate change adaptation and mitigation, and green growth. The faculty can use this primer as materials for teaching. The faculty can also use this primer as materials to incorporate ICT for climate change adaptation and mitigation, and green growth in university curricula.

Educators are invited to enhance and modify the contents provided in this primer, and/or supplement these with case studies, assignments and questions that they think will be more effective and meaningful to the students. All primers are released under the Creative Commons Attribution 3.0 License, which means that we encourage you to copy, distribute and adapt the primer provided you attribute the United Nations Asian and Pacific Training Centre for Information and Communication Technology for Development (UN-APCICT).

Educators may wish to use the template provided below for case study development. Faculties are encouraged to improve on the template or rework it as per their own needs.

Suggested template for case studies on ICT for climate change adaptation and mitigation (maximum 2,000 words)

Title of case study	
Stakeholders in the case study	
Location (community/city/district/province and country)	
Project start date and duration	
Overview	A summary of the case study
Description	• Why was this project developed? • What is the objectives of the project? • What is the project context? (policy environment, economic and social conditions, etc.) • What are the strengths (e.g. resources and capacities available) and weaknesses (e.g. vulnerable conditions) of the project? • What are the external opportunities and threats that affect the project? • What is the expected results of the project? • What are the achievements and impacts • What are the methodologies and tools used in the project? • How were ICTs applied in the project?
Project management	• How was the project managed? By whom? • What were the good practices, lessons learned and recommendations for future actions
Questions that ask readers to reflect on the extent to which the case study applies to their situation and what they will do similarly or differently	
Source and useful references for further information	• Reports and publications related to the case study • Images or videos related to the case study • Website • Contact information (email, phone, address)

Educators are encouraged to explore the subject matter with their students, draw on their own discipline, and identify linkages to climate change adaptation, climate change mitigation, and green growth. Here are some possible ideas: Those in the natural sciences can guide students in the development of field monitoring stations to measure climate variables, the environment, or climate-related hazards. Those in the social sciences can guide students in the use of ICTs to change attitudes, behaviour or cultural norms to address the impact of climate change. Those in the arts and humanities can guide students in the promotion of dialogue about climate change and green growth using electronic media. Those in the applied fields can guide students in the development of inventions, and organizational or industrial processes consistent with green growth principles.

Finally, educators and students alike are encouraged to enlist in the APCICT Virtual Academy (http://e-learning.unapcict.org) and interact with others who have started their journeys to a green and sustainable future.

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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
DRM	Disaster Risk Management
DSSAT	Decision Support System for Agrotechnology Transfer
EPA	Environmental Protection Agency (USA)
ESCAP	Economic and Social Commission for Asia and the Pacific (United Nations)
ESIC	Employee State Insurance Corporation (India)
EWS	Early Warning System
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information System
GLOF	Glacial Lake Outburst Flood
ICIMOD	International Centre for Integrated Mountain Development
ICT	Information and Communication Technology
ICTD	Information and Communication Technology for Development
IEA	International Energy Agency
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
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
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
USB	Universal Serial Bus
WCED	World Commission on Environment and Development
WMO	World Meteorological Organization
WSN	Wireless Sensor Network
WWF	World Wide Fund for Nature

List of Icons

 Case Study

 Points To Remember

 Something To Do

 Questions To Think About

 Test Yourself

 Youth In Action Note

1. AN INTRODUCTION TO CLIMATE CHANGE AND GREEN GROWTH

Objectives:
- **Present an overview of what climate change is and why it is important; and**
- **Explain the concepts of climate change adaptation, climate change mitigation and Green Growth.**

"Climate is what we expect, weather is what we get." – Mark Twain

1.1 Climate Variability and Climate Change

People are generally familiar with the weather, and know it with words such as sunny, rainy, windy, snowing and the like.[4] The weather is a description of the state of the atmosphere at a given time and place. It is measured through its conditions such as temperature, humidity, air pressure, precipitation and wind speed.

In contrast, climate is the average weather conditions for a site measured over a long time period of 30 years. Like the cartoon shows, for something extreme like a desert climate, one can expect the weather to be fairly constant.[5] In other words, climate is the summary of a 30-year story about the weather in a particular place. Climate descriptions can be made specific for a local area, a region or for the whole world.

Areas with consistent climates are grouped together as climate regions based on monthly temperatures, monthly precipitation and precipitation values. The regions are classified into six major zones, described briefly in table 1.

4 Image from http://www.eo.ucar.edu/kids/green/images/page1a_weather_sm.jpg.

5 Image from http://cartoonsy.com/cartoons/forecast-desert-wife-husband-radio-weather-3807.

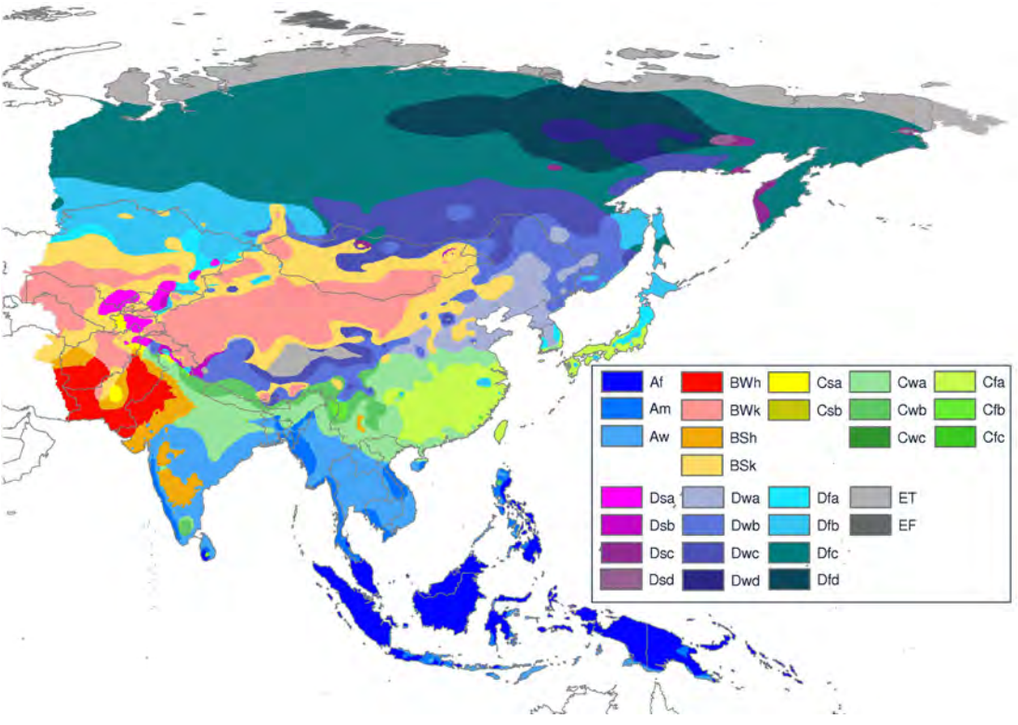
Table 1. Major Köppen climate categories

A – Tropical moist	• Very warm. Monthly average temperatures above 18°C • High precipitation
B – Dry	• Little precipitation during most of the year • Evaporation exceeds precipitation
C – Moist mid-latitude with mild winters	• Summer temperatures are warm to hot and winters are mild • Coldest month has an average temperature between 18°C and -3°C
D – Moist mid-latitude with cold winters	• Summer temperatures are warm and winters are cold • Average temperature of warmest month exceeds 10°C • Average temperature of coldest months is below -3°C
E – Polar	• Very cold winters and summers • No true summer • Warmest month has an average temperature below 10°C
H – Highland	• Strongly influenced by the effects of altitude

Source: Encyclopedia of Earth, "Köppen Climate Classification System", updated 10 November 2011.
Available from http://www.eoearth.org/view/article/162263/. See website for a description of all 24 subcategories.

Figure 1 shows the current climate regions of Asia.

Figure 1. Regional distribution of the Köppen climate classification system types in Asia



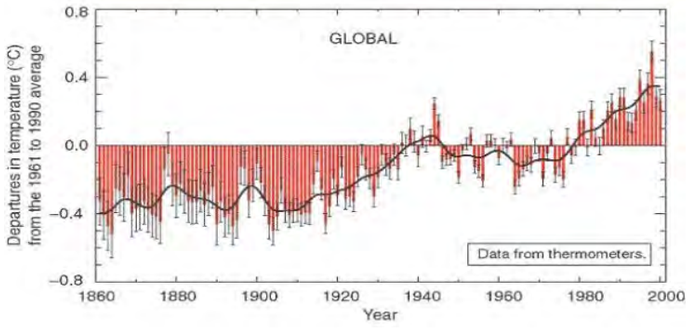
Source: http://people.eng.unimelb.edu.au/mpeel/Koppen/Asia.jpg, downloaded on 23 May 2013.

It is necessary now to highlight an important distinction between two terms—climate variability and climate change.

Climate variability refers to short-term variation in climate, including daily, seasonal and annual fluctuations. For example, a place may have a wetter year than usual, a hotter day than usual, more or less storms than usual, but these may just be part of the current trend and do not represent climate change. It also includes phenomena such as El Niño and La Niña Southern Oscillation—related climate events with multi-year cycles that can cause noticeable climate change in the short term. Natural variability includes extreme weather and climate events, which are by their nature extremely rare.

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."[6] It refers to the longer-term trends in average temperatures, especially the long-term warming trend observed by scientists that is related to increased concentrations of greenhouse gases (GHGs) in the atmosphere. This also encompasses changing trends in climate variability, including changes in the frequency and severity of extreme weather events, and new definitions of "extreme" in any given location. Figure 2 shows how the global temperature has increased over the past 150 years.

Figure 2. Graph showing average global temperature from 1860 to 2000



Source: IPCC, Contribution of Working Group I to the Fourth Assessment Report, 2007.

Over the past decades, climate scientists have developed computer models to predict the future effects of climate change. This is a difficult task due to the immense complexity of the global climate system, but as the models become more sophisticated, more factors are taken into account.

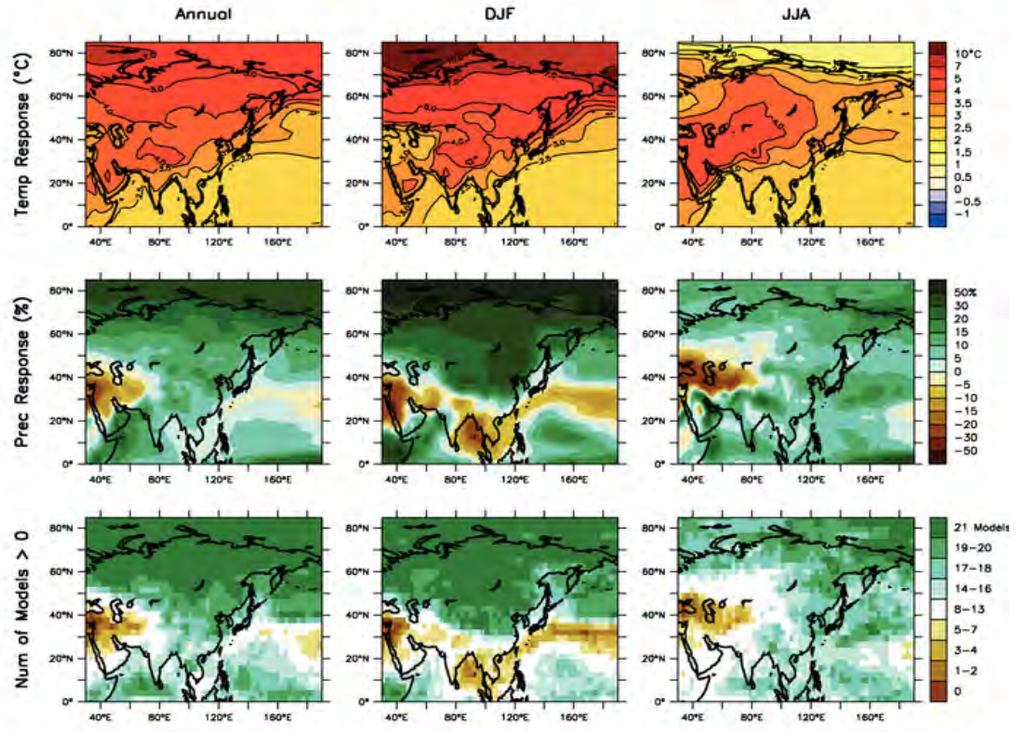
The projections displayed in figure 3 show temperature rises occurring across Asia, particularly in high latitudes and in areas of high altitude (most obviously the Tibetan Plateau). Precipitation projections suggest increased precipitation in the north of the continent during the winter, and significant decreases in South Asia and South-East Asia during the same season.

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 floods and landslides.

6 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/.

Climate change is related to 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).

Figure 3. Projected temperature and precipitation changes in 2080-2099 as compared to the period 1980-1999



Note: From left to right, the graphs show projected annual mean; December, January and February temperatures; June, July and August temperatures.
Source: IPCC, Contribution of Working Group I to the Fourth Assessment Report, 2007.

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 approach to development that has the potential to combine goals for climate change adaptation, climate change mitigation and economic growth.

1.2 Adaptation and Resilience

Climate change is expected to generate impacts, both positive and negative. The negative impacts include the following:

- More people are expected to experience flooding every year due to sea level rise
- Shrinking volumes of mountain snow, glaciers and small ice caps are projected and are expected to reduce water availability for drinking and hydropower
- Illness and death due to diarrhoea are expected to rise

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."[7] 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.

Resilience is defined as "the ability of a system and its component parts to anticipate, absorb accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration or improvement of its essential basic structures and functions."[8] It is a framework being discussed to guide adaptation.

The World Wide Fund for Nature (WWF) has identified two priorities for adaptation. These are the establishment of a "world-wide early warning system (EWS) and development support for poor countries to get access to drought resistant crops."[9] ICTs contribute to achieving both of these priorities.

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 adapt is generally limited.

Climate change adaptation requires the following:

- A sound understanding of the natural environment and how it is challenged and modified by climate change over time and space. ICTs are indispensable for environmental observation, analysis, planning, management and monitoring, which can help policymakers formulate informed decisions on actions for climate change adaptation.
- Assisting vulnerable communities adapt to existing problems 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), and preparedness for more frequent disasters and extreme weather events.
- Forest and biodiversity conservation, sustainable land-use management, early warning, awareness raising and capacity building are central to adaptation. ICTs are used to share and teach these practices.

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

8 IPCC, Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, Special Report of the Intergovernmental Panel on Climate Change, 2012.

9 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.

Something To Do

Go to the United States Environmental Protection Agency website for a fun quiz called “Clues of Climate Change” at http://epa.gov/climatestudents/scientists/clues.html or use the image below.

Instructions: Scientists look in many places to find clues about climate change. For example, they examine historical records, collect measurements, and observe trends in temperature, weather patterns, sea level and other features of the environment. Because there are so many clues from all over the world, scientists say that climate change is already happening today. Eleven signs of climate change are hidden in the landscape below. Can you find them all?

Explore the other pages of the website for ideas on developing a similar learning website for teaching children about climate change adaptation and mitigation.

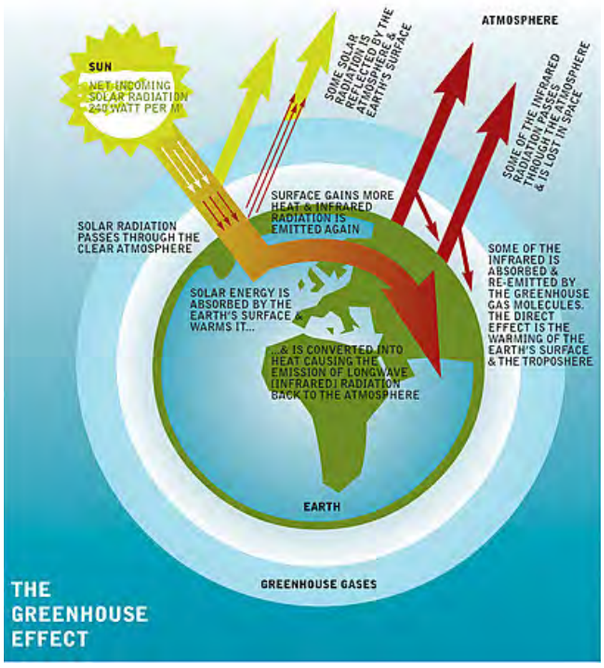
1.3 Greenhouse Gases, their Effects and Mitigation

Certain gases in the atmosphere, called “greenhouse gases” trap energy from the sun and reflect it back down to the surface, warming the planet. The ability of the atmosphere to capture and recycle energy emitted by the Earth surface is known as the greenhouse effect, and without it, the world would be much colder—around -18˚C. There are also human-made GHGs that contribute to global warming.[10] Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and ozone (O_3) are the primary GHGs in the Earth’s atmosphere.

Since the industrial revolution began in Europe around 1750, humans have been burning fossil fuels such as coal, oil and gas for energy, which releases carbon dioxide into the atmosphere. Other industrial processes also release other GHGs such as methane and nitrous dioxide. The presence of higher quantities of these heat-trapping GHGs in the atmosphere is thought to have caused less solar energy to be radiated back into space, more heat being trapped in the atmosphere, and an increase in the average temperature of the earth’s surface. This is referred to as the “enhanced greenhouse effect”.

10 NOAA, “Greenhouse Gases Frequently Asked Questions”. Available from http://www.ncdc.noaa.gov/oa/climate/gases.html.

Figure 4. Illustration of the greenhouse effect



Source: Greenpeace, 2005. Available from http://www.greenpeace.org/international/en/multimedia/photos/greenhouse_effect/.

The most important contributor is carbon dioxide followed (in descending order) by methane, chlorofluorocarbons, ozone and nitrous oxide.[11]

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."[12]

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.

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.

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. A combination of solutions needs to be considered.

11 Marian Koshland Science Museum of the National Academy of Sciences, "Global Warming Facts & Our Future. Causes of Change. CO_2 and Other Greenhouse Gas Variations", 2010. Available from http://www.koshland-science-museum.org/exhibitgcc/causes02.jsp.

12 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.

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)[13] 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[14] shows the significant growth in demand from China, whereas in the OECD countries[15] growth in energy demand is largely static.

Climate change mitigation would require:

- Using more efficient energy generation technologies. ICTs can be utilized to improve the generation, storage and distribution of energy to minimize energy loss.
- 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.
- Replacing fossil fuels with none or low carbon-emitting energy generating technologies such as renewable energy technologies or nuclear energy
- Adopting more sustainable natural resource management, and harvesting or extraction technologies and practices[16]
- Adopting policies and practices that encourage conservation of energy and natural resource

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-polluting 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.).

1.4 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 in 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 for economic development based on the principles of sustainable development: Green Growth.

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

14 Ibid.

15 The Organisation for Economic Co-operation and Development (OECD) is comprised of 34 member countries. They include many of the world's most advanced countries but also emerging countries like Mexico, Chile and Turkey. See http://www.oecd.org.

16 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 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."[17]

Points To Remember

- Climate change refers to the shifts in the longer-term trends in temperature, humidity and precipitation.
- Climate change adaptation is about preparing for changing environmental and climatic conditions before their full impacts are felt.
- The volume of GHGs has increased since the industrial revolution and is thought to contribute to climate change. Climate change mitigation is about using appropriate technology to reduce and absorb emissions.
- Green growth is about pursuing economic progress in ways that are sustainable, low-carbon and socially inclusive.

Something To Do

Go to http://globalfloodmap.org/ and zoom in on Bangladesh, Viet Nam and Papua New Guinea. Use the application to see the proportion of its cities that are under water if the sea level were to rise.

Instructions:

1. Type in the capital city name (Dhaka, Hue, Port Moresby) in the box titled "Find Your City" to quickly zoom into the country. Each city is represented as a dot, and the color represents its flood risk.
2. Change the projected sea level rise using buttons marked 6, 18, 100 and 1000 inches.
3. See how the number of blue dots increases as you go from 6 to 1000 inches.

17 United Nations and Asian Development Bank, *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.

Test Yourself

1. Look at the map in figure 1. Locate Russia and identify its major climate region. Choices:

   A – Tropical moist
   B – Dry
   C – Mild mid-latitude
   D – Severe mid-latitude
   E – Polar
   H – Highland

Hints for all questions:
1. Match the country's colour to the legend. The first letter corresponds to the choices.
2. Compare the two periods as to whether their temperatures tended to be above or below the average represented by the horizontal black line.
3. See the definition in Section 1.3.

2. Look at the graph in figure 2. Is it correct to say that the global temperature in the period 1860 to 1910 was cooler than the period 1940 to 2000?

3. Climate change mitigation is about reducing vulnerability to the effects of climate change. Is the statement true or false?

Questions To Think About

1. Why is it important to study climate?

2. Do you personally worry about polluting the air with GHGs?

3. What are the ways in which your school could be using ICTs to monitor energy use?

2. ICT TRENDS AND THEIR IMPLICATIONS FOR TACKLING CLIMATE CHANGE

Objectives:
- **Identify the information needs for climate change adaptation and mitigation**
- **Identify the communication needs for climate change adaptation and mitigation**
- **Be familiar with important ICTs for climate change adaptation and mitigation, and Green Growth**
- **Appreciate the trends in the ICT industry and how these may promote climate change mitigation and Green Growth**

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.

2.1 Information Needs in Adaptation and Mitigation

ICTs can be used to collect and store information on the climate, on emissions, and on climate change impacts on people and the environment. Information can then be shared among networks (academic, professional and the general public) to inspire creativity in the devising of solutions and initiatives to adapt and mitigate. Solutions can be about tapping the beneficial opportunities of climate change (such as wine-growing in Britain), moderating harm from the negative impacts, modifying energy production and consumption, optimizing gas-emitting transportation, and the like.

Information needs identified for such solutions and initiatives are:

- Data about the climate (temperature, humidity rainfall and snowfall) and sea levels
- Data about the environment in general, and GHG emission levels of particular activities
- Data about energy production and consumption
- Characterization of climate change into the future, particularly capturing variables that affect climate parameters at local scale (such as precipitation and the effects of orography[18])
- Characterization of the vulnerability of people, communities and economic sectors to the negative impacts of climate change and shocks in development
- Analyses of data to discover trends in climate patterns and the environment, so that targets can be set for adaptation, mitigation and Green Growth
- Skills and knowledge sets required for adapting to climate change and mitigating GHG emissions

Chapters 3 to 5 will be providing discussion and examples of how ICTs can help to collect data, and how the datasets may be utilized for adaptation, mitigation and Green Growth initiatives.

18 Orography is the study of mountain ranges and elevated land masses.

2.2 Communication on Climate Change

"What we've got here is a failure to communicate." Frank R. Pierson

The information producers are usually a specialized group of meteorologists, hydrologists, climatologists and social scientists who study hydro-meteorological processes, modeling, data collection and analysis of how climate changes might influence human systems. End users are those who need climate information for operational and strategic purposes. These include city planners, water and sanitation engineers, disaster managers, service providers, business owners, urban dwellers rich and poor, and children. The understanding of the same phenomena by the two groups may be very different.

Communication of the impacts of climate change is important to create and sustain awareness among the information end users, support adaptation and decisions, and build capacity for action based on this information.

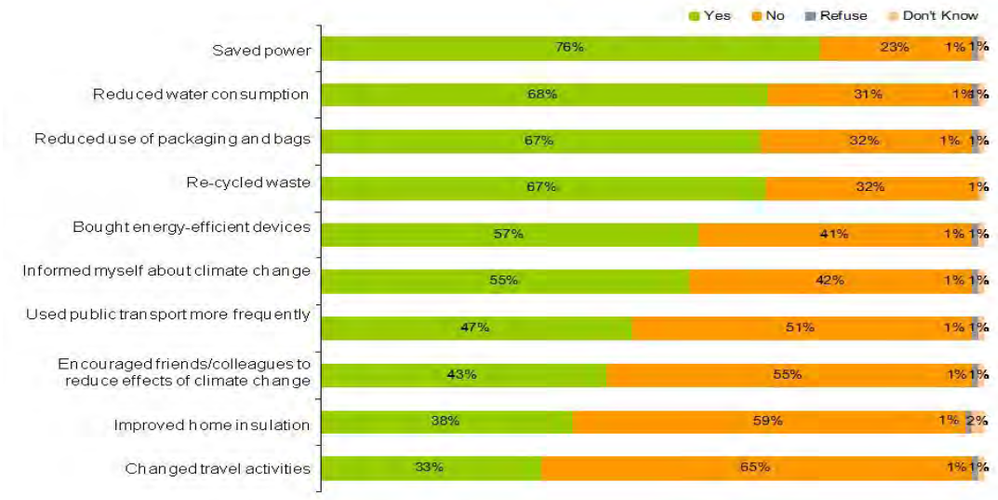
The "Hierarchy of Effects" model describes that behavioral change can be caused at three stages:

- **Knowledge** refers to what people learn, believe, are aware of, remember and recognize.
- **Attitude** refers to how people feel about something, whether something is liked or disliked, and whether something is evaluated positively or negatively.
- **Practice** refers to behaviour, and is the observable or tangible part of the model.

Knowledge is theorized to provide the building blocks for attitude, and attitude in turn is the building block for action. Implicit here is the assumption that people are rational: each person first learns, then forms an attitude, then acts or not.

What then do people know and do about climate change? The 2010 global survey by Synovate (a global market research firm) conducted with over 13,000 respondents in 18 countries had some interesting findings (see figure 5):

Figure 5. Responses to 2010 global survey question on personal actions to reduce the effects of climate change



Source: Synovate.

- Only 30% of the respondents were “very concerned” about climate change, while 39% were “somewhat concerned”.
- When asked what they have personally done to help reduce the effects of climate change, the most frequent answers were: saved electricity (76%), reduced water consumption (69%), reduced use of packaging (67%), recycled waste (67%), bought energy-efficient devices (57%), and informed themselves about climate change (55%).
- In most countries, more women than men buy ecological products, and more elderly than youth would recycle and buy ecological products.

Synovate also annually ran the Young Asians study from 2007 to 2010 and found the following percentage of youth who believe that they have the biggest say and are able to influence household purchase decisions for specific items:

- 84% for snack food, candy, chocolates and soft drinks
- 72% for clothing and apparel
- 70% for choice of venues among fast-food outlets and quick service restaurants

When asked how they felt regarding the effects of climate change, young people answered as follows:

- 67% of Asia’s 8-24 year olds said that they were concerned about the effects of climate change.
- Most concerned are the Filipinos (87%), Thais (81%), Hong Kongers (78%), and Koreans (75%).
- Less conscious were youth from India (38%), Indonesia (14%) and Malaysia (13%) who said that they do not believe that the climate is changing.

And have the youth personally taken steps to reduce the effects of climate change?

- 38% had recycled waste and reduced the consumption of plastic bags, electricity, water and gas.
- 26% purchased green products.

Something To Do

Answer this: *What have you personally done to reduce the effects of climate change in the past year?* Tick all that apply to you.

Action	Yes	No	Don't know
Saved power			
Reduced water consumption			
Reduced use of packaging and bags			
Re-cycled waste			
Bought energy-efficient devices			
Informed myself about climate change			
Used public transport more frequently			
Encouraged friends/colleagues to reduce effects of climate change			
Improved home insulation			
Changed travel activities			

2.3 Scope and Definition of ICTs

The United Nations Development Programme (UNDP) defines ICTs as follows:[19]

> ICTs are basically information handling tools—a varied set of goods, applications and services that are used to produce, store, process, distribute and exchange information. They include the "old" ICTS of radio, television and telephone, and the "new" ICTs of computers, satellites and wireless technology and the Internet. These different tools are now able to work together, and combine to form our "networked world", a massive infrastructure of interconnected telephone services, standardized computer hardware, the Internet, radio and television, which reaches into every corner of the globe.

This networked world is bringing data and information closer to the communities who need and may benefit most from them.

2.4 ICT Trends and their Implications for Tackling Climate Change

There are two trends that are important for tackling climate change – digitization and dematerialization.

Digitization refers to the changing of manual processes to digital ones. 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.

19 UNDP Evaluation Office, *Information Communications Technology for Development, UNDP Essentials: Synthesis of Lessons Learned* (New York, 2001), p. 2.

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 videoconferencing to replace attendance at meetings and events such as conferences.

The following are examples of specific technologies that support digitization and dematerialization.

Virtualization technologies. Desktop virtualization is a fancy word 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 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 hardier 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, mobile 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.

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. With the miniaturization of devices, 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.

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.[20] Here are some specific examples:

20 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.

- 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.[21]
- Use of a network of wireless sensors in a rainforest to monitor the recovery of regenerating rainforest from previous agricultural grassland.[22]

Cloud computing. Cloud computing refers to applications and digital services that reside exclusively on the Internet, located on server systems (i.e. 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. Services include a full IT department, server facilities, human resources and payroll functions online, as well as sales and customer relationship management. 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 and the cost of that energy.[23]

Videoconferencing. Telepresence is a form of high definition videoconferencing using dedicated Internet connections. It allows the replacement of travel in favour of network-based videoconferences. Existing videoconferencing 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[24] in its daily operations for 158 weeks. These savings were equivalent to 201.7 metric tons of CO_2 saved, 36,546 cars off the road, and 97,543 meetings that took place without the requirement for travel.[25] Many developing countries have established high-end telepresence facilities on a commercial basis and some hotel chains now offer access to telepresence facilities.[26]

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 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.

21 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.

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

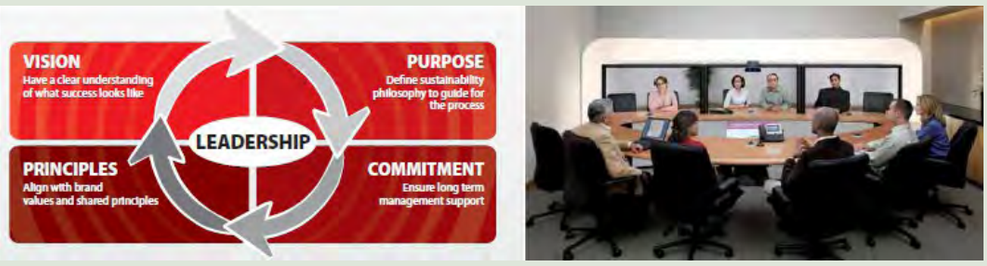
23 James Harris and Steven Nunn, “Cloud Computing’s Great Promise”, Forbes.com, 30 June 2010. Available from http://www.forbes.com/2010/06/30/pharmaceuticals-mobile-salesforcecom-technology-cloud-computing.html?boxes=Homepagetoprated.

24 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.

25 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.

26 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.

Case Study 1. 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-eventsustainability_REPORT.pdf.

During the 15th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC COP15) 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 the organization of COP15, and telepresence continued to play a part during COP16 in Cancun, and COP 17 in Durban.

Key points

- Participants from around the world were able to participate "virtually" in COP15 side events clocking over 250 hours of telepresence meetings held over 149 sessions.
- 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.
- 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, *COP15 United Nations Climate Conference, Copenhagen: Event Sustainability Report* (2009). Available from http://www.sustainableeventsdenmark.org/assets/2011/11/cop15-event-sustainability_REPORT.pdf.

Question To Think About

The photo on the right shows a lot of the media and communication devices that were used in the 1980s. (If you cannot recognize some of them, show the photo to your parents and ask them if they know what they are.)

These have progressively grown smaller due to digitization of image and sound, and can now be found together in the same electronic device like a mobile phone.

The technologies shown in the photo plus a computer can now be combined into a tablet or smartphone.

What could all this mean in terms of saving energy and resource materials for these products?

Images source: Techi, http://www.techi.com/2012/05/all-of-this-now-fits-in-your-pocket/.

2.5 e-Waste and Recycling

One negative aspect of processor design is associated with the energy and resources required to produce microprocessors. Electronics are major consumers of many precious and special metals and contribute to the global demand for metals. The embedded energy cost and resources (water, purified air, metals and other materials) required for the production of microprocessors is very high.[27] The other downside of the pervasiveness of ICTs comes from the massive amounts of electronic waste (e-waste) associated with discarded devices.

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 PCs in 2006, while China had roughly 14 million PCs in 2005. 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. Toxic and hazardous elements are also present in e-waste, and are generated during e-waste processing (e.g. mercury in gold amalgamation or dioxins from inappropriate incineration).

27 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.

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

- The collection of e-waste is of crucial importance as this determines the amount of material that may be recovered. In addition, the 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.

- 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 in 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.

- Specific technologies are required to treat the chemical and other hazards they contain, and recover the recyclable materials such as aluminum, 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.

Case Study 2. WEEE Recycle in India

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

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.

The WEEE Recycle Project is developing the capacity of SMEs to recycle e-waste safely using environmentally sound technologies. Focused on four cities (Bangalore, Delhi, Kolkata and Pune), 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 can be undertaken to improve recycling techniques and promote green products.

Further reading and contact information

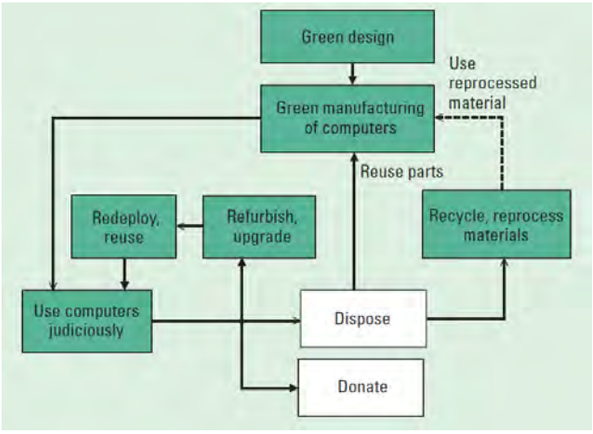
WEEE Recycle website, http://www.weeerecycle.in/index.php.
Contact: Advisory Services in Environmental Management, GIZ, contact@asemindia.com.

2.6 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; and each stage generates hazardous waste, and directly or indirectly increases carbon emissions.[28] Green computing ensures the sustainable design, manufacture, use and disposal of computers, servers, and associated devices (monitors, printers, storage devices, etc.).

Figure 6. 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.

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.[29] 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.

28 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.

29 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.

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.[30] Data centres consume large amount 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.

Points To Remember

- ICTs can enable societies to adapt to the consequences of climate change and mitigate GHG emissions.
- ICTs can help communicate the information on what may be done to adapt to climate change or reduce GHG emissions, to convince end users to take appropriate actions.
- Digitization and dematerialization are important ICT trends that promote efficiency in the use of energy and resources, as well as reduce GHG emissions.
- We should be conscious about how ICTs can generate e-waste and the need to recycle electronics.

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

Something To Do

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

- Use a screen-saver to minimize the energy used by your monitor.
- Turn off your computer before going to class or lunch.
- Before going home, switch off all computers, monitors, printers, facsimile machines, scanners and photocopiers.
- Check to see if your electronic devices have a power-saving feature. If yes, make sure that it is enabled. If no, look for products with power-saving features when acquiring your next device.
- 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?
- See Ohio University's Green Computing Guide at http://www.ohio.edu/facilities/recycle/erecycling.htm.

Test Yourself

Match the ICT trend with the letter corresponding to its example.

ICT Trend	Answer	Example
Virtualization		A. 4 Gigabytes of data used to be stored in several compact disks, and are now contained in a tiny thumb drive. B. A world-renowned researcher in climate change impacts on forests can deliver a short lecture to students in five countries simultaneously, as well as answer their questions using computers, video-cameras and microphones. C. Fans of Angelina Jolie can be alerted by tweets on their computers and smartphones that she is coming to their country to campaign for mitigating GHG emissions in order to preserve children's future. D. Students can search for references from an electronic catalogue at access points within a library building. E. A motion detector is used to switch lights on and off.
Miniaturization		
Sensor		
Social networking		
Videoconferencing		

3. ICT APPLICATIONS FOR ADAPTING TO CLIMATE CHANGE

Objectives:
- **Appreciate the need to adapt to climate change**
- **Be familiar with major types of ICT applications for climate change adaptation**
- **Develop a simple ICT application to help raise awareness for climate change adaptation**

ICTs have the potential to inform and enhance the processes for formulating policies and making decision 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 The Need to Adapt to Climate Change

- There are impacts of climate change on ecosystems and humans that are expected to be detrimental. Some findings are presented below:[31]

- By the 2080s, many million 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.

- 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's population currently lives.

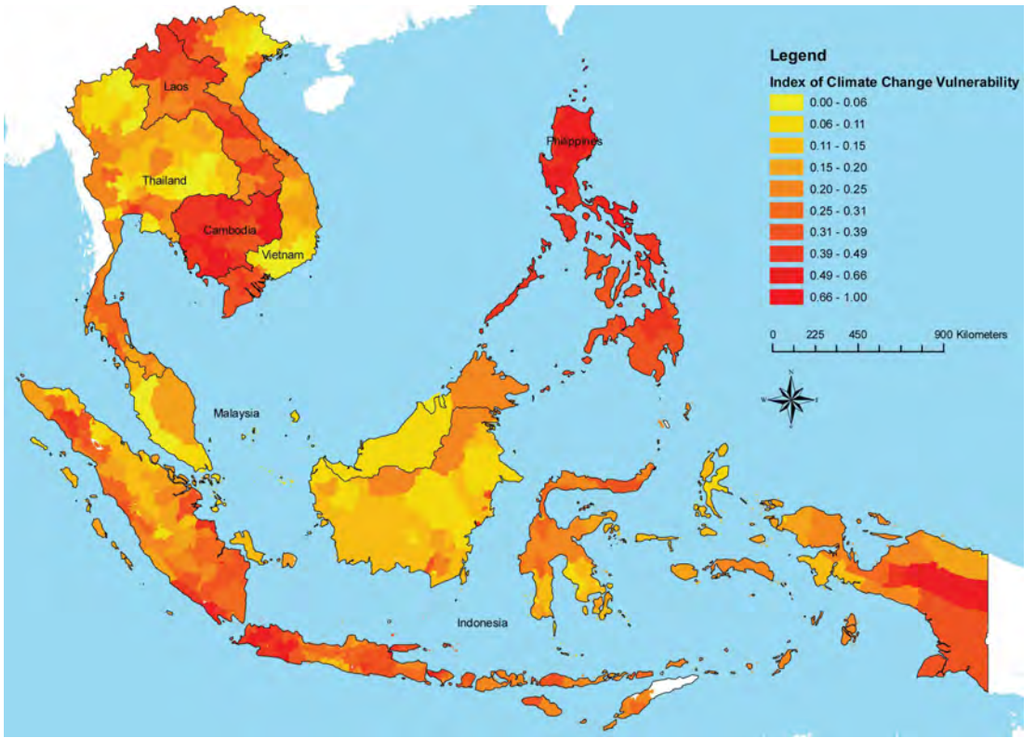
- Runoff is projected with high confidence to increase by 10 to 40 per cent by mid-century at higher latitudes and in some wet tropical areas, including populous areas in East and South-East Asia. On the other hand, runoff is projected to decrease by 10 to 30 per cent over some dry regions at mid-latitudes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

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

- 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.

31 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 7. South-East Asia's vulnerability to extreme climate hazards



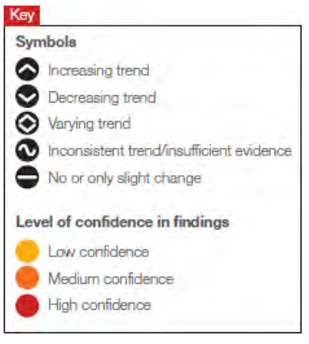
Source: IDRC, "Show and Tell: Plotting Climate Change Hot Spots", 2009. Available from http://www.idrc.ca/eepsea/ev-148556-201-1-DO_TOPIC.html.

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

- 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.
- Deterioration in coastal conditions, for example through erosion of beaches and coral bleaching, is expected to affect local resources.
- 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.
- With higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands.

Figure 8. 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.

Figure 8 summarizes the projected changes in climate for the sub-regions of Asia. Information about all these impacts, however, is still generalized over large areas and therefore is not specific enough to be used for local planning and decision-making.[32] In addition, several potential ICT applications such as those in table 2 are needed for generating information for adaptation planning.

32 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).

Table 2. Climate change adaptation and ICT applications

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

There are 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. A process of dialogue between the climate scientists and the local communities or sectors can help specify the potential climate change impacts on livelihood and welfare, both positive and negative.

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:

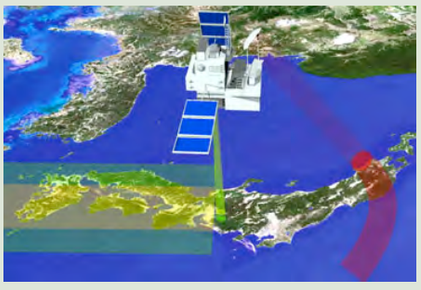
- Some national meteorological institutes are investing in automated meteorological stations to improve the frequency and reliability of climate data.
- Remote sensing refers to the process of recording information from sensors mounted either on satellites or aircrafts. It has contributed to climate modelling of the globe and its regions through the monitoring of precipitation using radar. It also contributed to monitoring sea levels with specific satellites altimetry (the measurement of elevation).

Case Study 3. Global precipitation measurement

Satellites can play an important part in collecting precipitation measurements needed for climate change adaptation due to their capability to scan large parts of the atmosphere. The Japan Aerospace Exploration Agency (JAXA), the National Aeronautics and Space Administration (NASA), among others, have been working to monitor and measure global precipitation in an effort to support climate change related research.

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

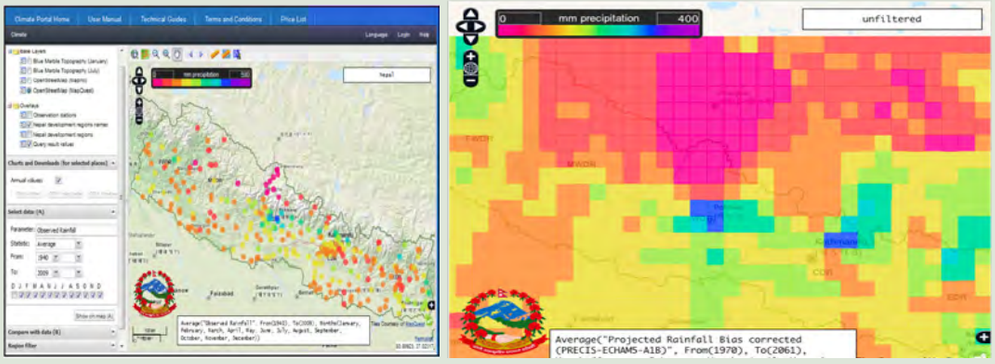
JAXA, “Global Precipitation Measurement”, http://www.jaxa.jp/projects/sat/gpm/index_e.html.

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

3.3 Modelling Climate Change

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. The climate science community developed techniques and methods, mostly using supercomputers, to perform a set of climate models and emissions scenarios for a range of possible future climate conditions. Downscaling is another set of modelling done to improve the level of detail at the scale of a country or local area.

Case Study 4. 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, downscaling of future climate change projections, and public access through the Nepal Climate Data Portal (http://www.dhm.np/dpc). Users may generate the following products: printable maps, time-series charts, data download and purchase, data filter and queries, data comparison and aggregation, multiple colour 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

Department of Hydrology and Meteorology dg@dhm.gov.np.
Asian Disaster Preparedness Center adpc@adpc.net or www.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*[33] by focusing projects on reducing vulnerability and raising capacity for adaptation (see case study 5).

The IPCC Fourth Assessment Report gives the following projected general impacts on various sectors:[34]

Climate change and water. Climate change is expected to add to the stresses on water resources. Focused climate impact studies are needed to determine significant impacts in the near future on water availability and water quality, and whether water utilities can still meet the needs of citizens at desired levels of reliability and affordability.

- 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 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. This results in increased flood risk in the future.

Case Study 5. CRiSTAL, the community-based risk screening tool

Project planners and managers can use the 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. It aims 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.

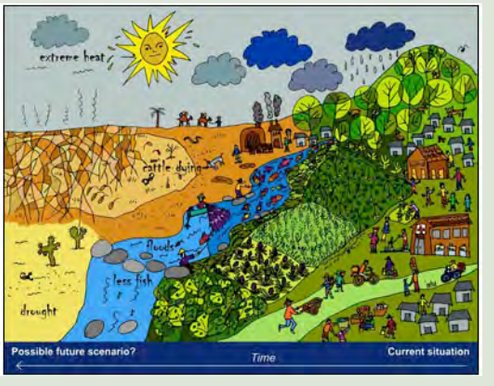


Image source: http://www.iisd.org/cristaltool.

Further reading

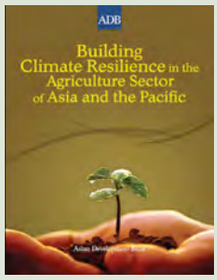
CRiSTAL website, http://www.iisd.org/cristaltool.

33 Maladaptation is an adaptation process that results in increased vulnerability to climate change and/or undermines capacity for future adaptation (http://www.apmen.iom.int/en/m/editorials/item/102-avoiding-maladaptation-to-better-manage-climate-induced-migration-in-asia-pacific).

34 IPCC, *Climate Change 2007: Synthesis Report* (2007).

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.[35] ICTs can be used to model how climate change may affect future food production in Asia (see case study 6).

Case Study 6. 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 report asserts that agriculture is a sector most vulnerable to climate change. 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. 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, such as:

- Results from three general circulation models of the global climate
- The International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) partial equilibrium partial equilibrium model of world agriculture, 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 – e.g. land, soil, daily weather values and 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 website, http://dssat.net/.

35 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.

Climate change and human health. 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. The health status of millions of people is projected to be affected through different drivers of health:[36]

- 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.

ICTs may be used to monitor factors that affect human health, as shown in case study 7.

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, and overexploitation of resources). 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.

Climate change and DRM. The vulnerable industries, settlements and societies are generally those in densely populated and low-lying deltas of Asia, 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[37] 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 8). 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.

36 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.

37 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/.

Case Study 7. Urban Services Monitoring Systems

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.

Surat Municipal Corporation in India developed the Urban Service Monitoring System to improve the monitoring and handling of complaints related to health, water supply, sewerage and solid waste services. A text messaging system 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.

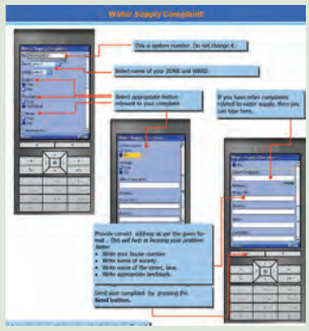


Image source: UrSMS Brochure, http://www.acccrn.org/sites/default/files/documents/URSMS_booklet.pdf.

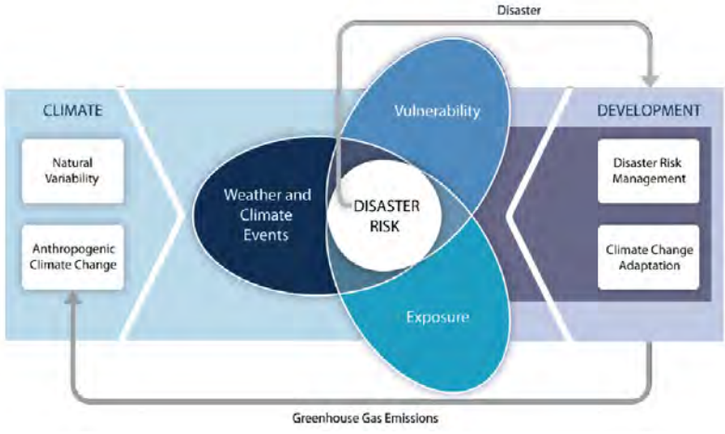
Key points

- 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.

Figure 9. 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 SREX 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. Recommendation for the way forward includes integrating DRM, climate change adaptation and sustainable development.

Case study 8 describes how ICTs can help identify the short-term variations in the climate, possibly related to the ongoing climate change process, that may lead to disasters. Case study 9 gives a specific example of hazard monitoring and early warning and useful ICTs. Primer 3 has another example on monitoring glacial lake outburst flood (GLOF) in Nepal (see case study 1 in Primer 3).

Case Study 8. 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 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, vulnerabilities are identified, preparedness measures can be developed, contingency plans can be updated and capacity building needs can 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.

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

Key points

- 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.
- Seasonal forecasting using ICT and modelling tools is increasingly playing an important role in climate change adaptation.

Further reading

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

Case Study 9. Monitoring and early warning of GLOF from Lake Sarez

In 1911, a massive earthquake triggered a landslide that buried the village of Usoi and dammed the Murghab River in Tajikistan. Now it is known as the Usoi Natural Dam in the Pamir range. This dam created a 60 km-long lake containing over 17 km³ of water called Lake Sarez, and since that year has been the subject of scientific inquiry as to the stability of the new dam and risk of a catastrophic flood. Part of the risk stems from a possible landslide at a point called the Right-Bank Slope. Climate change is expected to lead to melting of snow-caps and glaciers in Central Asia, and increase the flow of water to Lake Sarez in the near future, and therefore increase the risk of glacial lake outburst floods.

The Lake Sarez Risk Mitigation Project was undertaken to establish a systematic hydrological, hydro-geological and geological monitoring of Lake Sarez and Usoi Dam. An emergency communication system was installed for the settlements located in close proximity to the lake, accompanied by disaster preparedness measures. A monitoring and EWS was installed in 2004 to detect the imminent possibility of an outburst flood, and send a signal that will trigger alarms in the most vulnerable villages found downstream. GIS and remote sensing are being used to develop flood scenarios, and to analyse information to determine the risk and potential socio-economic impacts of a catastrophic flood for downstream communities.

Key points

- ICTs are useful for monitoring potential GLOF
- Emergency communication equipment is needed to relay warnings
- Data from remote sensing can be used for developing flood scenarios
- GIS provides analytical tools for developing hazard and impact scenarios

Image source: UNISDR, Sarez Lake: The latest achievements and unsolved problems, December 2007. Available from http://www.unisdr.org/files/10896_SarezBrochureengreduced%5B1%5D.pdf.

Further reading

UNISDR, Sarez Lake: The latest achievements and unsolved problems, December 2007. Available from http://www.unisdr.org/files/10896_SarezBrochureengreduced%5B1%5D.pdf.

3.5 Facilitating Adaptive Learning

ICTs have the potential to raise awareness, build capacity, and transform how organizations deliver goods and services to be better adapted to 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

- UN-APCICT's ICTD for Youth, an online distance learning programme on ICTs for achieving development goals, and includes this Primer. It is for students in undergraduate and graduate programmes at universities in the Asia-Pacific region (http://www.unapcict.org/pr).
- EPA's Student's Guide to Global Climate Change (http://epa.gov/climatestudents/index.html).
- UNESCO-IHE Institute for Water Education offers an online course for a fee. It is entitled, "Integrated Water Resources Management as a Tool for Adaptation to Climate Change" (http://www.unesco-ihe.org/online-course-iwrm-tool-adaption-climate-change).

Online resources

- UNFCCC Adaptation webpage (http://unfccc.int/adaptation/) contains national adaptation plans and programmes and other official documents. UNFCCC also manages an online community, "Adaptation Exchange" on Facebook (https://www.facebook.com/The.Adaptation.Exchange) that aims to stimulate collaboration, sharing and networking on adaptation.
- The Asia Pacific Adaptation Network (http://www.asiapacificadapt.net) is a regional programme for managing and applying adaptation knowledge in the region. The website provides a platform for holding online discussions on climate change adaptation issues. It also shares news, events, documents and project information related to climate change adaptation in the region.
- weADAPT (http://www.weadapt.org) is an online knowledge sharing platform that allows practitioners, researchers and policymakers to access credible, high quality information and to share experiences and lessons learnt on climate adaptation issues.
- Adaptation Learning Mechanism (http://www.adaptationlearning.net) is an online knowledge sharing and discussion platform facilitated by UNDP.
- Adaptation Atlas (http://www.adaptationatlas.org) is a web-based application that enables user-driven, dynamically generated maps of climate impacts and adaptation activities. It includes a database of peer reviewed climate studies and adaptation projects.
- World Bank makes available climate change data of specific countries (http://data.worldbank.org/topic/climate-change).

Points To Remember

- 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).
- ICTs can enhance our ability to create, manage and exchange climate adaptation information for more informed decision-making.
- Downscaling is a form of climate modelling that achieves greater precision and less uncertainty over projections of what the climate may be in the future.
- Other computer modelling techniques can assist to determine possible impacts for cities, towns, small islands, small climate phenomena such as cyclones, and for areas with complex features such as mountains and valleys.
- Investment can be made in gathering and digitizing socio-economic data, earth observation data, and analysing these using GIS platforms.

Youth in Action

The Development Reality Institute, a youth-based organization in Zimbabwe, designed the first virtual school on climate change. Run and managed by youths and targeting the youth, its interactive online course aims to raise awareness on the effects of climate change to development. Utilizing Internet and SMS technology to communicate with participants, the project won the World Summit Youth Award 2010 as the best innovative and creative e-content addressing the Millennium Development Goals,[39] and is recognized in the UNFCCC Youth Portal. See its website at: http://www.driafrica.org.

Something To Do

Use social media to spread awareness among your school friends about your country's projected climate in the near future and the climate change adaptation needs, and start generating ideas about how to fulfill those needs.

The goal: To create a Facebook page for promoting climate change adaptation actions by people who are about your age.

This project should take two weeks to accomplish.

1. Form a team to work on your project with no more than seven members. Assign yourselves roles—have one team leader, and divide the rest into researchers and designers.

   The role of the team leader is to organize the group, keep everyone focused, plan the project and the amount of time it takes to fulfill each task, and motivate everyone to finish.

   The role of the research group is to be responsible for the research on your country's future climate and adaptation needs. This group will develop the content and write short articles for the Facebook page.

   The role of the design group is to lead the brainstorming of a concept and design for the Facebook page, and then make choices of what applications will go into the page. This group will also look for images, photos, videos and other audio-visual materials that will be linked or uploaded on the page.

   It is important that the entire team meet regularly to update each other on progress, obtain inputs from the team members and ensure that everyone has a common vision for the way forward that will guide the work of the research and design groups.

38 The Millennium Development Goals are eight international development goals that were established following the Millennium Summit of the United Nations in 2000, following the adoption of the United Nations Millennium Declaration. All 189 United Nations member states and at least 23 international organizations committed to help achieve these goals by the year 2015 (http://en.wikipedia.org/wiki/Millennium_Development_Goals).

2. For the research group:

   The project requires some research about the projected impacts of climate change on your country. Your research should fall into three categories—(1) climate projections; (2) vulnerable sectors (such as those in table 2); and (3) adaptation needs.

   Check out the online resources listed in section 3.5. You could also use an online search engine such as Google or Yahoo! to generate searches using the keywords of your country's name and "national adaptation plan" or "national adaptation programme of action".

   Be careful in selecting the materials that you will use. Prioritize official documents from the government and research findings from reputed institutions.

   Do the research for a maximum of two days, then describe the findings to the rest of the group. As a group, talk about the future impacts that may happen around 20 or 30 years later, and identify an adaptation need that you feel will be most important for your well-being. For example, your future may have less precipitation and so your agriculture sector will have to switch to crops that can handle less rain. What can you do as a student to help farmers and farming corporations adapt?

3. For the entire team:

   Select the key adaptation message that you want to make. This message should be about what other students can do to help, and what they will need to know in order to help. Identify the pieces of evidence from among the official documents and research papers already gathered.

   Set an appointment with your teacher for this course, or with a faculty member who has done related research. Present your ideas to the teacher, explaining your logic and the research you had undertaken to come to your ideas. Be open to feedback on how to improve your ideas. Based on the feedback from the teacher, review your ideas for adaptation and finalize your key message. Some additional research may be necessary, if the teacher pointed out some holes in the logic, or missing pieces of evidence.

4. For the design group:

   While the research group is doing their work in step 2, open a Facebook account and study how to make a Page for your campaign for adaptation. Study the features and applications that you can utilize. For example, the page can contain:

   - Images
   - Links to videos
   - Links to publications
   - Opinion polls
   - Text that can contain your messages to the students reading your page
   - Links to other Facebook pages

After the key message is finalized, design and create your page. Make sure that your key message is clearly visible at the top of the page. The page should contain at least the following:

- A page title, which should be your message for adaptation phrased in a catchy or interesting way
- An image or picture that symbolizes or depicts your message
- A short description under the title that explains why other students should be concerned about their future, and what kind of future this will be
- Space for visitors to your page to give comments or messages on what they intend or promise to do to promote adaptation
- Links to videos about the topic
- A reading list of the important documents and research papers you gathered, with links to where they may be downloaded

5. Further action:

- After creating your page, share it with other students in your network. Ask them to "Like" your page.
- Consider a strategy for maintaining the Facebook page with updated posts on latest news, events and research related to climate change adaptation.
- Take the time to send us an email at info@unapcict.org to let us know that you have created the page, and we can share it with other students in other countries who are also taking this course.

Test Yourself

1. How can ICTs be used to improve climate change adaptation? Look at the listed ICT applications in table 2 to arrive at the answer.
   a. Identify areas exposed to climate change impacts such as sea level rise and temperature changes
   b. Identify sectors within exposed areas that will be affected by climate change impacts
   c. Model how the climate will change at different points of time in the future
   d. All of the above

2. Downscaling is performed to adequately characterize and manage the _____ associated with projections of climate change. Fill in the blank. Hint: read section 3.3.

3. What are the sectors that can be affected by climate change? Name at least two, and describe one potential ICT application for each. (See table 2 for the answers.)

4. ICT APPLICATIONS FOR MITIGATING CLIMATE CHANGE

Objectives:
- **Appreciate the need to reduce greenhouse gases**
- **Appreciate the need to reduce energy consumption**
- **Be familiar with major types of ICT applications for climate change mitigation**
- **Develop a simple ICT application to help track energy consumption or GHG use**

4.1 The Need to Mitigate Climate Change

Most of the global average warming over the past 50 years is very likely due to GHG increases from anthropogenic sources (human action) 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.

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[39] 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.

What has already happened cannot be changed, but will reducing our potential CO_2 emissions into the atmosphere make a difference? There are arguments that human emissions need to be kept below 450 ppm (parts per millilitre) by the year 2100, while others advocate for as much as 1350 ppm. But what is the best way to achieve any of these targets? There are three options: (1) do nothing and keep letting emissions increase; (2) keep emissions at the current level; and (3) reduce emissions.

4.2 Facilitating Environmental Observation

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.

39 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.

Remote sensing 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.[40]

Case Study 10. 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. Initiated by various international agencies including the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), the Global Climate Observing System aims to overcome these barriers 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 for research and planning the following data: CO_2 and methane levels, ozone and aerosol properties, temperature, wind, water vapour 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.

Contact information

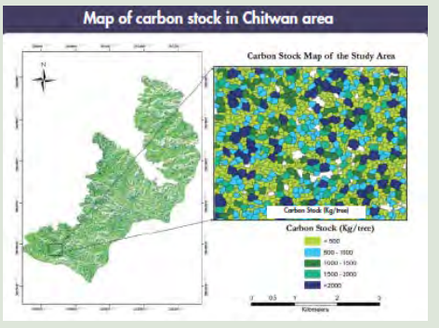
Global Climate Observing System website: www.wmo.int/pages/prog/gcos/index.php.

40 The use of remote sensing for DRM is discussed in more detail in Primer 3: ICT for Disaster Risk Management. Case studies on the use of remote sensing for 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.

Case Study 11. 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. 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.

Researchers from the International Centre for Integrated Mountain Development (ICIMOD) used high-resolution satellite imagery together with object-based image analysis techniques to delineate and classify crown projection area of individual trees for above-ground biomass estimation. This technique is a way of quantifying carbon stocks in forests, using an equation based on diameter at breast height of trees combined with information from remote sensing satellites on the spatial distribution of forest biomass.



Images source: Eak Bahadur Rana.

Key points

- Using remote sensing, carbon stored in forests can be calculated at reasonable costs within acceptable accuracy ranges.
- Satellite-borne sensors make it possible to monitor areas that are not readily accessible and to carry out cost effective measurements in vast areas.

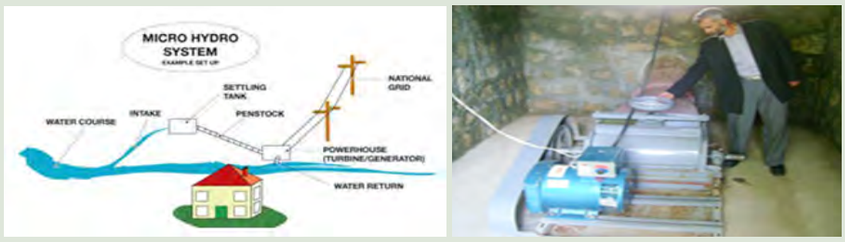
Further reading

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 waste of energy is a critical issue for developed and developing countries alike, occurring when producing, distributing or consuming electricity. Centralized energy infrastructure can waste more than two-thirds of produced energy.[41] In many countries, the energy generation and distribution system is outdated or inadequate; ICTs can enable countries to leapfrog to the smart grid electrical power system by enhancing efficiency in energy generation, transmission or distribution (see case study 12).[42]

Case Study 12. 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. Already used in rural parts of Afghanistan and Thailand, these systems are applicable as newly built power plants or for improving the performance of old power plants.

Key points

- Automatic control systems are effective at reducing costs 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/.

ACTED, "Afghanistan 10 years later: Community development as a priority", 7 October 2011, http://www.acted.org/en/afghanistan-10-years-later-community-development-priority.

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

42 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 Clean Technologies and Dematerialization

In the last decade, some investors have considered that the development of clean technologies (cleantech) 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 issues and global environmental problems such as climate change. Cleantech includes a diverse range of products, services and processes that harness renewable materials and energy sources, dramatically reduce the use of natural resources, and cut or eliminate emissions and wastes.[43] 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.[44]

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 cleantech to reduce energy consumption and/or increase the efficiency of energy use.

Dematerialization. According to the Climate Group Smart 2020 Report,[45] 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."

Figure 10. Dematerialization: Using less to produce more

Image source: http://www.cato.org/blog/dematerialization-update.

43 Wikipedia, "Clean Technology". Available from http://en.wikipedia.org/wiki/Clean_technology.

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

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

Dematerialization includes:

- Digitization of materials such as paper, CDs, video tapes, etc. so that content is manipulated using strictly digital technologies
- Travel replacement technologies such as telepresence technologies and other high definition high bandwidth videoconferencing systems
- Replacement of brick-and-mortar retail outlets with digital malls and shops and store fronts.
- e-Government – online government services replaces need for physical presence across a country or jurisdiction
- e-Commerce – online purchasing of goods and services replaces need for 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.

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.

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. Digitizing can be done to certain goods such as music, reading materials, and film. Benefits from dematerializing include reduced: raw materials and energy from reproduction; GHG emissions by downloading the digital product instead of postage; warehouses to store inventories of products, and the energy to 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[46] 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.

46 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.

Case Study 13. High-level government officials in Orissa use videoconferencing for meetings

Image source: eOdisha.com, 2011

An e-government project provided telepresence capabilities in 32 locations in the Indian state of Orissa. Videoconferencing studios were set up in each district headquarters, office of the Chief Minister, and the State Assembly**.** These studios are connected to the network of the 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 became apparent.

Key points

- Telepresence and videoconference 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.

Case Study 14. Project Panchdeep, India

Image source: Project Panchdeep website, http://esic.nic.in/panchdeep.htm.

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.

Case Study 15. The Philippines is leading the way in call centres

Reflecting maturation in business process outsourcing (BPO), the Philippines has overtaken India in providing call centre services to large multinational firms located in countries such as USA. The Filipino's high level of spoken English makes it ideal for providing call centre services in the Philippines. This shows that efficiency can be achieved using ICTs 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.

As of 2012, increases in the government's foreign currency reserves and assets, as well as higher demand for commercial offices spaces in the Philippines were both attributed to growth in 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.

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

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.

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:[47]

- **S**how energy consumption and emissions information, traced across different processes, including those beyond the ICT sector's own products and services.
- **M**onitor energy consumption and emissions across the economy in real time, and thus provide the data needed to optimize for energy efficiency.
- **A**ccount for energy consumption and emissions alongside other key business priorities by developing appropriate tools.
- **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.
- **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

Renewable energy is 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.

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.

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

Some of the advantages of the smart grid are as follows:[48]

- 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
- Better monitoring and control of energy and grid components
- Improved data capture and thus, improved outage management
- 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
- 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.
- 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.[49] 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."[50] 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.[51]

IBM estimates that 40 per cent of the world's current output of raw materials goes into buildings.[52] 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."[53] This amount will be higher in the developing regions of the world as more new construction is taking place in these countries.

48 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.

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

50 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.

51 Ibid.

52 IBM, *Smarter Cities Challenge Report*, June 2011. Available from https://www-static.bouldercolorado.gov/docs/IBM_SmrtCity_SGC_Report-1-201306171551.pdf.

53 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.

Case Study 16. The Shanghai Tower

The Shanghai Tower, scheduled for completion in 2014, will be the second tallest building in China. It will measure 682 metres in height, and have 128 storeys. The tower was designed and is being built using building information modelling.[55] It will be the first super-tall double-skin building in the world, insulated like a "thermos bottle" and saving energy.

Organized as nine cylindrical buildings stacked atop each other, it is enclosed by a glass façade that is designed to be able to reduce wind loads on the building by 24 per cent. This means that less construction materials are needed. The outer layer twists as it rises, and will collect rainwater to be used for the tower's air conditioning and heating systems. Wind turbines will generate power for the building.

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.

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

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."[55] 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.

Smart building applications include the following:

- 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.
- The integration of sensors within a building provide information on energy usage and occupancy patterns
- Home energy management or building management system can automatically manage and reduce energy consumption, as well as manage distributed energy resources
- 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.

54 Wikipedia, "Shanghai Tower", Available from http://en.wikipedia.org/wiki/Shanghai_Tower.

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

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%).[56]

To help reduce emissions, intelligent transportation systems 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."[57]

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. Applications include:[58]

- Advanced traveller information systems that provide drivers with real-time information about road and weather conditions, and other related information.
- Advanced transportation management systems that include traffic signals, ramp meters, variable message signs, and traffic operation centres.
- 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.
- 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).

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.[59] ICTs can enhance the efficiency of logistics by improving:[60]

- Tracking of materials, processes, goods, and inventory
- Optimizing fuel consumption, length and timing of travel, frequency of deliveries
- Navigation of new routes using onboard navigation systems

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

57 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.

58 Ibid.

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

60 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.

Case Study 17. Kuala Lumpur's integrated transport information system

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

A comprehensive traffic information system was developed to monitor traffic flow and analyse the data on road conditions in the Klang Valley,[62] and to provide useful traffic information to road users. ICTs used include networked computer systems, databases, closed-circuit TV cameras, and other sensors. The Transport Management Centre processes images from closed-circuit television cameras combined with automated information from an incident detection system and a vehicle location system. All services are available free of charge for users through a range of media. The benefits include:

- Improved trip planning, reduced travel time and increased safety for commuters
- Long-term planning for transport, security and emergency response by authorities
- Reduced traffic congestion and reduced pollution due to less time spent idling

Key points

- Road users can enjoy reduced congestion and easier travel, and less GHG emissions.
- Experts analyse real-time video and images, congestion maps, and incident maps.
- Information is shared using message sign boards, websites, and mobile devices.
- A call centre is available for people to call in for information.

Further reading

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

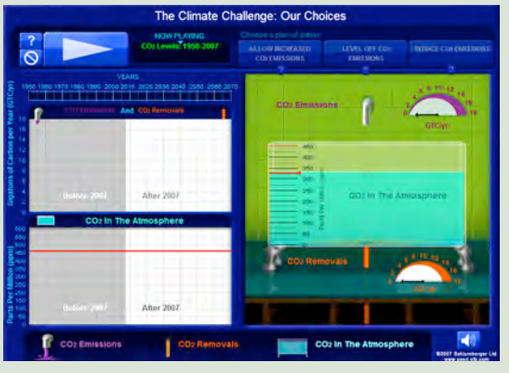
61 Klang Valley is an area in Malaysia comprising Kuala Lumpur and its suburbs, and adjoining cities and towns in the state of Selangor. See http://en.wikipedia.org/wiki/Klang_Valley.

Points To Remember

- Climate change mitigation is undertaken to reduce CO_2 and other GHGs. The goal is to minimize the negative impacts on the natural environment and abate climate change.
- Societies can explore technologies for climate change mitigation and assess their potential to adopt or adapt these technologies in their jurisdictions. These technologies can facilitate environmental observation, enhance the efficient use of energy, and reduce GHG emissions through dematerialization. Some limited applications could have a very large impact in the amount of energy saved.
- The greatest inefficiencies in energy use come from producing, distributing and consuming electricity. In developing countries, smart grid projects are an opportunity to leapfrog other countries in modernizing the electrical grid.
- 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.
- Smart transformation is a set of ICT-enabled technologies that can help to better understand and monitor energy consumption and emissions, optimize efficiency, and promote a low-carbon economy.

Something To Do

The Climate Challenge Simulation
http://www.planetseed.com/files/flash/science/features/earth/climate/en/challenge/index.htm?width=835&height=680&popup=true



The **challenge**: choose the right option to keep CO_2 in the atmosphere below the level of 450 ppm.

Let's assume that countries are targeting to keep emissions below 450 ppm. The next question is how do we achieve this? This simulation presents the earth's atmosphere as a bathtub. Using the principle of "stock and flow", the simulation allows CO_2 to accumulate like water filling the bathtub, while carbon removal is the drain at the bottom. The "flow" is how much CO_2 goes in and how much goes out. Read more about the simulation and the science behind it at:
http://www.planetseed.com/relatedarticle/climate-challenge-our-choices.

Youth in Action

Today's young people are exploring earth observation on their own initiative, utilizing readily available ICTs to help satisfy their curiosity.

Matthijs Tissen, a 16-year-old Dutch boy, took 6,000 photos of the Netherlands from 35 km in near space (see photo above). His set-up consisted of a helium-filled weather balloon, a digital camera that took a photo every two seconds, and a GPS tracker that transmitted coordinates to a website. On his own, he planned "Flight Level 1200," looked for sponsors, and then launched his camera. Visit the project website here: http://www.fl1200.nl/. Read more at: http://www.gim-international.com/news/remote_sensing/aerial_photography/id7344-dutch_schoolboy_photographs_earth_from_35_kilometres_up.html?utm_source=20130423+GIM+333&utm_medium=email&utm_campaign=20130423+GIM+333.

Some kids have sent toys into space as well. Lauren Rojas, a 7th-grade girl from the United States launched a Hello Kitty doll 28.5 km into near space. Watch Hello Kitty's journey here: http://www.youtube.com/watch?feature=player_embedded&v=5REsCTG4-Gg and see the view from up there. Read more about the project and others at: http://www.space.com/19740-girl-sends-hello-kitty-into-stratosphere.html.

Test Yourself

1. Climate change mitigation refers to actions that reduce the impacts of greenhouse gases upon societies and the environment. *True* or *False*?
   (Hint: This may be a tricky question; re-read section 4.1 for the answer)

2. Which of the following can be used to observe the environment? Select the best answer.

   a. Sensors that measure greenhouse gas emissions
   b. Sensors that measure sea surface temperature
   c. Satellite images that can indicate biomass
   d. All of the above

3. Which of the following statements is correct? (See section 4.3 for the answer)

   a. ICTs can promote efficient energy production
   b. ICTs can promote efficient energy distribution
   c. ICTs can promote efficient energy consumption
   d. All of the above

A CHALLENGE!

Guided by your teacher, design a spreadsheet to calculate household carbon footprints. It should assign points for specific actions. At the end, it calculates how many planets just like Earth that would be needed if every household has the same lifestyle.[62]

1. Create a spreadsheet file and name it **CarbonCalc**.
2. Make six columns for: Category, Question, Answers, Choice, Value, and Points. Put the headers in Row 1.
3. Type up the data found after these instructions. Put each possible answer on its own row. Finish typing in all the questions and possible answers before continuing. Including the header, you should reach Row 126.
4. Put a default value of zero "0" at each row under the column "Choice".
5. Put the value of each possible answer under the column "Value".
6. At Row 2 under "Points" type in the equation **=D2*E2**.
7. Copy the equation and paste it for all the rows with a possible answer (see example).
8. At the very bottom, go to the cell just beneath the cell with the last entry containing the equation. Click on the Autosum sign ∑ to add up all the values above it (at this point, it should add up to 0).
9. Go to the cell to the right of the one containing the Autosum. Type in **=F127/350** to find out how many planet Earths would be needed to sustain humanity if everyone had the same lifestyle as you.
10. How to use the calculator: Answer all questions by choosing just one from all possible answers. In the "Choice" column, change the value from 0 to 1 in the row corresponding to your selected answer.

    In the example below, answer to question 1 "My shower on a typical day" is "Short shower once a day", with a value of 50 points. The answer to question 4 "We use water-saving toilets" is "Yes", with a value of -20 points.

    Example of spreadsheet entries:

	A	B	C	D	E	F
1	**Category**	**Question**	**Answers**	**Choice**	**Value**	**Point**
2	Water	1. My shower (or bath) on a typical day is:	No shower / no bath (0)	0	0	0
3			Short shower 3-4 time a week (25)	0	25	0
4			Short shower once a day (50)	1	50	50
5			Long shower once a day (70)	0	70	0
6			More than one shower per day (90)	0	90	0
7		2. I flush the toilet:	Every time I use it (40)	1	40	40
8			Sometimes (20)	0	20	0
9		3. When I brush my teeth:	I let the water run (40)	0	40	0
10			I don't let the water run (0)	1	0	0
11		4. We use water-saving toilets	Yes (-20)	1	-20	-20
12			No (0)	0	0	0
13		5. We use low-flow showerheads	Yes (-20)	1	-20	-20
14			No (0)	0	0	0

62 This is taken from the Ecological Footprint Calculator developed by Conneticut Energy Education. Download the tool and learning resources at: http://www.ctenergyeducation.com/lesson.htm?id=fqe4v3ol.

Data entries for the spreadsheet

Categories and Questions		Answers and Equivalent Points
Water	1. My shower (or bath) on a typical day is:	No shower / no bath (0) Short shower 3-4 time a week (25) Short shower once a day (50) Long shower once a day (70) More than one shower per day (90)
	2. I flush the toilet:	Every time I use it (40) Sometimes (20)
	3. When I brush my teeth:	I let the water run (40) I don't let the water run (0)
	4. We use water-saving toilets	Yes (-20) No (0)
	5. We use low-flow shower-heads	Yes (-20) No (0)
Food	1. On a typical day, I eat:	Meat more than once per day (600) Meat once per day (400) Meat a couple times a week (300) Vegetarian (200) Vegan (150)
	2. All of my food is grown locally or is organic	Yes (-20) No (0)
	3. I compost my fruit/vegetable scraps and peels.	Yes (-10) No (0)
	4. Most of my food is processed.	Yes (20) No (20)
	5. Little of my food has packaging.	Yes (20) No (0)
	6. On a typical day, I waste:	None of my food (0) One-fourth of my food (25) One-third of my food (50) Half of my food (100)

Categories and Questions		Answers and Equivalent Points
Transport	1. On a typical day, I travel by:	Foot or bike (0) Public transit / school bus (30) Private vehicle; carpool (100) Private vehicle; 1 person (200)
	2. Our vehicle's fuel efficiency is: **For efficiency values, see:** http://www.fueleconomy.gov/feg/findacar.shtml	More than 13 km/litre (-50) 10-13 km/litre (50) 7-10 km/litre (100) Less than 7 km/litre (200)
	3. The time I spend in vehicles on a typical day is:	No time (0) Less than half an hour (40) Half an hour to 1 hour (100) More than 1 hour (200)
	4. How big is the car in which I travel on a typical day?	No car (-20) Small (50) Medium (100) Large (SUV) (200)
	5. Number of cars in our drive-way?	No car (-20) Less than 1 car per driver (0) One car per driver (50) More than 1 car per driver (100) More than 2 cars per driver (200)
	6. Number of flights I take per year?	0 (0) 1-2 (50) More than 2 (100)
Shelter	1. My house is:	Single house on large lot (50) Single house on small lot (city) (0) Townhouse/ attached house (0) Apartment (-50)
	2. Divide number of rooms in the home (no baths) by the number of people living at home.	1 room per person or less (-50) 1-2 rooms per person (0) 2-3 rooms per person (100) more than 3 rooms per person (200)
	3. We own a second, or vacation home that is often empty.	Yes (200) No (0)

Categories and Questions		Answers and Equivalent Points
Energy	1. In cold months, our house temperature is: **Or if you don't have cold months** In summer, our house air conditioning is set to:	Under 15°C (-20) 15 to 18°C (50) 19 to 22°C (100) 22°C or more (150) We don't use one (-20) 27°C or more (50) 22°C to 27°C (100) Under 22°C (150)
	2. We dry clothes outdoors or on an indoor rack.	Always (-50) Sometimes (20) Never (60)
	3. We use an energy-efficient refrigerator.	Yes (-50) No (50)
	4. We have a second refrigerator / freezer.	Yes (100) No (0)
	5. We use 5 or more compact fluorescent light bulbs.	Yes (-50) No (100)
	6. I turn off lights, computer, and television when they're not in use.	Yes (0) No (50)
	7. To cool off, I use:	Air conditioning: car (50) Air conditioning: home (100) Electric fan (-10) Nothing (-50)
	8. My clothes washer is a:	Top load (100) Front load (50) Laundromat (25)
Clothing	1. I change my outfit every day and put it in the laundry.	Yes (80) No (0)
	2. I am wearing clothes that have been mended or fixed.	Yes (-20) No (0)
	3. One-fourth (or more) of my clothes are handmade or secondhand.	Yes (-20) No (0)
	4. Most of my clothes are purchased new each year.	Yes (200) No (0)
	5. I donate clothes that I no longer wear.	Yes (-50) No (100)
	6. I never wear _____ % of the clothes in my closet.	Less than 25% (25) 50% (50) 75% (75) More than 75% (100)
	7. I buy_____ new pairs of shoes every year.	0-1 (0) 2 to 3 (20) 4 to 6 (60) 7 or more (90)

Categories and Questions		Answers and Equivalent Points
Waste	1. All my garbage from today could fit into a:	Shoebox (20) Small garbage can (60) Kitchen garbage can (200) No garbage created today! (-50)
	2. I recycle all my paper, cans, glass and plastic.	Yes (-100) No (0)
	3. I reuse items rather than throw them out.	Yes (-20) No (0)
	4. I repair items rather than throw them out	Yes (-20) No (0)
	5. I avoid disposable items as often as possible.	Yes (-50) No (60)
	6. I use rechargeable batteries whenever I can.	Yes (-30) No (0)
	7. In my home we have __ number of Electronics? (Computer, TV, Stereo, VCR, DVD, X box, Game boy, etc.)	0-5 (25) 5-10 (75) 10-15 (100) more than 15 (200)
	8. How much equipment is needed for typical activities? A lot =boat, snowmobiles, dirt bikes ,Very little soccer, bicycling)	None (0) Very little (20) Some (60) A lot (80)

5. ICT FOR GREEN GROWTH AND SUSTAINABLE DEVELOPMENT

Objectives:
- **Be familiar with the Green Growth concept**
- **Appreciate the potential for the ICT industry to be part of Green Growth**
- **Develop a short essay or think piece on how to personally contribute to 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.[63]

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."[64] 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.[65]

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. 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.

63 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.

64 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.

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

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. Here are some facts about the Asia Pacific region that drive support for Green Growth:[66]

- By the start of the 21st 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.
- As of 2005, to produce one unit of GDP the region required three times the input of resources as the rest of the world.
- During most of the last four decades, the region's energy use grew faster than global energy use.
- In 2008, the region used 45 per cent of global primary energy.
- From 1990 to 2005, regional GHG emissions rose from 14.5 billion to 19.5 billion tons.
- 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.
- 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.

During the 5th Ministerial Conference on Environment and Development in Seoul in 2005, UNESCAP received a mandate to promote Green Growth as a strategy to achieve sustainable development while at the same time achieving Millennium Development Goals Target 1 on poverty reduction and Target 7 on environmentally sustainability.[67] The conference resulted in a regional implementation plan for sustainable development in the Asia Pacific region with the objectives of: improving eco-efficiency for environmental sustainability; enhancing environmental performance; environmental protection for sustainable growth; and integrating disaster risk management and preparedness in socio-economic development policies and planning.

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:

- 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.
- UNESCAP's Green Growth online e-learning facility offers a set of interactive modules to learn about the fundamentals of Green Growth, liveable 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.[68]
- UNESCAP developed the *Low-Carbon Green Growth Roadmap for Asia and the Pacific*[69] as a guide for policymakers in the region on overcoming the challenges from resource constraints and the climate crisis. The Roadmap identifies five main tracks on which to drive the system change for low carbon Green Growth, with factsheets and case studies for each track available online:[70]

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

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

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

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

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

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

5.3 Role of ICTs in Achieving Green Growth

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

- 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.
- Smart buildings, because of the importance of buildings and the rapid rate of urbanization worldwide.
- Smart transportation and logistics systems, including smart supply chains. These ICT driven innovations will make business more energy efficient.
- 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.
- 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.

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

The ITU e-Environment Report[71] recommends strengthening the capacity of developing countries to use ICTs for environmental action: management, conservation and sustainable development. To do this, the report recommends 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.[72] The goals of the strategy could include measures to reduce environmental impact, energy use and the emission of GHGs while at the same time promote economic, human and social development.

71 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.

72 Ibid.

Case Study 18. Thimpu Tech Park

Image 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.

Case Study 19. 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.

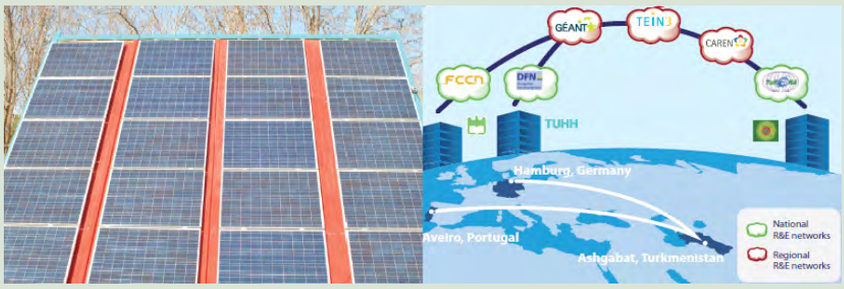
Key points

- 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.

Case Study 20. 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 CAREN and pan-European GÉANT research networks, the required engineering skills and technology needs are being acquired.

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, videoconferencing 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.

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Case Study 21. 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. 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.

Image 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.

Case Study 22. Jeju's renewable energy micro-grid

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, it is a model for a planned nationwide roll-out by 2030.

Key points

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

Image 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.

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Case Study 23. 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.

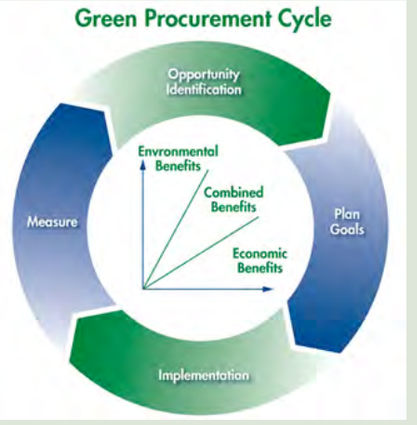

Image source: http://www.shafferdesignworks.com/CUQuarterly/Q22008/NetworkingMidAtlMeeting.html.

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.

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

Case Study 24. Integrated stormwater management system in Cebu

Image 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).

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.

The system's components included 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. Using computing simulation modelling, the system resulted in 75 per cent reduction in dependency on the main aquifer. It replenished water supply, enabled sound flood management, and is 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 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.

Points To Remember

- Green Growth is a way to pursue economic growth and development, while preventing environmental degradation, biodiversity loss and unsustainable natural resource use.
- The inefficient use of resources and energy within the Asia Pacific region is expected to lead to unsustainable growth, and drives the move to promote Green Growth as a strategy for sustainable and equitable development.
- ICTs could be utilized to reduce environmental impact, energy use and the emission of GHGs while at the same time promoting social and economic development.

Something To Do

As a student, you have now an opportunity to think about the direction in life that you would like to pursue. While we would rather anticipate employment and a successful career after graduation, we should also add considerations of whether we are working in a way that is not harmful to other people or to the environment now and in the future. Have you thought about working in a green job?

The International Labour Organization defines a job as green when it helps reduce negative environmental impact ultimately leading to environmentally, economically and socially sustainable enterprises and economies. Think about the job or profession that you are currently interested in, and see if it is listed in any of these green jobs websites:

- http://greenjobs.com
- http://www.greenjobs.co.uk
- http://www.greenjobs.ie
- http://www.goodwork.ca
- http://www.sustainablebusiness.com/index.cfm/go/greendreamjobs.main/?CFID=3843046&CFTOKEN=33356893

Is your job interest found in any of these sites? If no, are there any listed jobs that you are willing to consider instead of your original preferred profession?

Write down a three- to five-sentence essay for yourself, describing a green job that you could like, and why this job can be personally satisfying.

CONCLUSION

The mainstreaming of ICTs in all aspects of human endeavour has enabled significant transformations in the way we work and live. This Primer 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 Primer, 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 in both the developed and 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 students of this Primer have an important role to play.

This Primer 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. Primer 4 users (teachers and students) need to explore the knowledge resources identified in this Primer and ask themselves to what extent they are appropriate to their own needs and circumstances. They need to continue with the research work that this Primer has started. They need to undertake their own enquiries and do their own discovery work to adapt this knowledge and experience to their own needs.

A local needs assessment should be undertaken before the Primer is taught. This will help identify priority areas that need to be emphasized during the course, and the course content be adapted accordingly to meet demands. In particular, local case studies and teacher-generated exercises would be most useful.

Users of this Primer are encouraged to contribute their own experience and knowledge by sharing them on e-Co Hub (http://www.unapcict.org/ecohub) that UN-APCICT has established for this purpose. In this way, the work that has gone into Primer 4 can continue and be shared.

SUMMARY

The following key points were discussed in this Primer:

1. Climate change is a worldwide challenge. While most decision makers are aware of the threats posed by climate change, awareness of the options for abating climate change using smart technologies and ICTs is only now becoming apparent. This Primer provides details on a wide range of ICT-based solutions that are being used to address the challenges of climate change.

2. The Primer 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 adaptation and mitigation.

3. As governments 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 Primer 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 Primer will help students understand the issues and build their capacity to identify opportunities for using ICTs to tackle climate change effects.

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 tonnes (or kg) of CO_2 equivalent.
Cleantech	Clean technologies to reduce energy use 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. 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	Terrestial, 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 can access the geothermal energy by drilling, and then uses the heat or hot water to create power.
Global positioning systems	A system consisting of 25 satellites in 6 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 greenhouse gas emissions.
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 videoconferencing 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.

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About the Author

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 sub-regional 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) and the WMO with funding from the UNDP. ADPC has in turn established new regional mechanisms such as the Regional Consultative Committee on Disaster Management 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 sub-regional 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 DRR. 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 as the core training courses:

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

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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 regional institute 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 with the focus on the following 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 members 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

Additional UN-APCICT/ESCAP Programmes and Resources

The Academy of ICT Essentials for Government Leaders
http://www.unapcict.org/academy

The Academy is a comprehensive ICT for development training curriculum with currently ten modules that aims 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.

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 are also been translated into different languages. To ensure that the programme stays relevant and addresses emerging trends in the 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 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

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