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Full Length Research Paper

Applications and Effective Utilization of Information & Communication Technology for Addressing Environmental Issues

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ABSTRACT
The paper focused on how information and communication technology is used to address environmental issues. Information and communication technologies (ICTs) are acting as integrating and enabling technologies and with the usage of this new technologies, the global community can be supported in their collaboration to preserve the environment in the long term. This includes ethical aspects of protecting human life as well as preservation of our natural environment. The application areas of the ICTs are Energy Consumption/Efficiency, Climate Change, Sustainable Use of Natural Resources, Biodiversity, Eco-industrial Applications and Industrial Ecology, Agriculture, Landscape Ecology, Personal Information Systems and Quality of Life, Sustainable Urban Development, Health Care, Environmental Risk Management, Further reading, etc. Information and communication technology has tremendous potential in the field of environmental studies as in any other field like education, health, business, economics, politics, culture, etc. Development of Internet facilities, World Wide Web (WWW), remote sensing and geographical information system (RS&GIS) and information through web based online resources and satellites has generated a wealth of up-to-date information on various aspects of environment studies, education and research.

Key words: *Information & Communication Technology, Environmental Studies, Remote Sensing, Geographical Information System, Environmental Information System*

INTRODUCTION
Environmental technology or green technology is the application of one or more of environmental science, green chemistry, environmental monitoring and electronic devices to monitor, model and conserve the natural environment and resources, and to curb the negative impacts of human involvement. Sustainable development is the core of environmental technologies. The term environmental technologies is also used to describe a class of electronic devices that can promote sustainable management of resources. Technology has played a key role in the development of human society. Modern technologies such as information & communication technology have changed the human lifestyle. Development of sophisticated instruments like computers, satellites, telecommunication instruments etc have resulted in total revolution in almost all spheres of life.

Information and Communication Technology can improve environmental performance and address climate change across all sectors of the economy. Smarter and cleaner environmental and economic strategies will tackle the challenge of global warming and contribute to "Green Growth" and clean innovation in the economic crisis and recovery. ICTs and Computer have key roles in increasing energy efficiency, reducing energy use and managing scarce resources. Smart ICT applications and the Internet can enable energy efficiency improvements in areas as diverse as buildings, transport and logistics, electricity generation, distribution and consumption. Sensor-based broadband applications can foster effective responses to environmental change as well as improving efficiency of current systems. As products and services become "digital", online delivery can also reduce environmental impacts across all sectors of the economy.

APPLICATIONS AND BENEFITS OF INFORMATION AND COMMUNICATION TECHNOLOGY
Database Access: Among the most significant benefits of ICT is ready access to data and information at any time and any where. Database is the collection of inter-related data on various subjects including environmental sciences. It is usually in computerized form and can be retrieved whenever required. In the computer, the information of database is arranged in a systematic manner that is easily manageable and can be very quickly retrieved. Data and information that, just a decade ago, was the province of specialized agencies or laboratories are now publicly available with near immediate access through the computer technology and World Wide Web. The Ministry of Environment and Forests, Govt. of India has taken up the task of compiling a database on various biotic communities which includes Environment, Ecology, Wildlife, Conservation, Forest cover etc. The National Science and Technology Management Information System (NSTMIS) of the Department of Science and Technology, Govt. of India has been entrusted with the task of building the information base on a

continuous basis on resources devoted to scientific and technological activities along with information about research scientists and personnel involved for policy planning in the country.

Communications: Electronic mail and network communications are enabling interaction and collaboration that were impractical not long ago. Users are able to interact with colleagues and other departments worldwide. Visualizations of results, even with animations, can be available to various users as they are derived, whether from instruments, field or earth observations, or by evaluating mathematical models. Computer networks are enabling a variety of virtual institutions.

Distribution of Research Materials: The World Wide Web interface to networks has replaced photocopy as the primary means of distributing research materials to various researchers. Web based electronic material on various aspect is available online through the World Wide Web. Increasingly, researchers turn to the World Wide Web as a primary information source. This interface can appear more attractive than reading books and journals.

ICT Trainings to Researchers: Presently, most of the research and development organizations rush to provide ICT trainings in the access and distribution of information through the World Wide Web interface, short courses in programming, operating systems and various other ICT courses that enable researcher most aware about the application and use of information and communication technologies which helps them in the environmental studies and statistical computations.

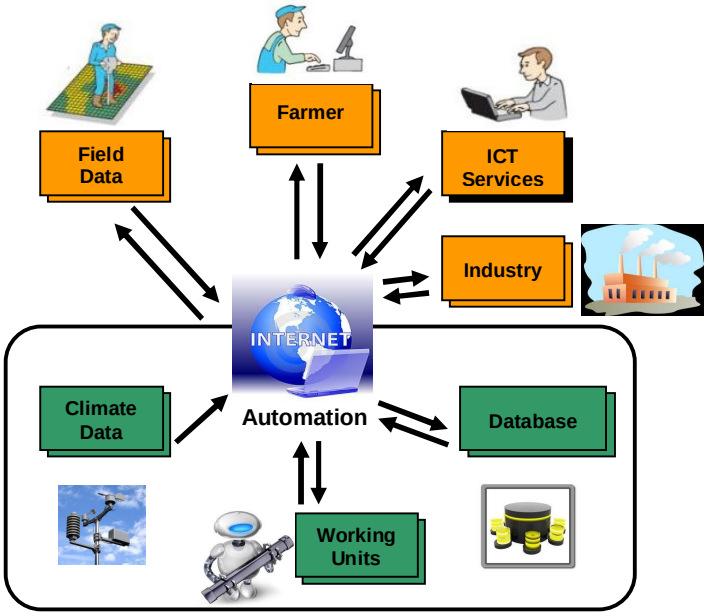

Fig.1. Key components of Information and Communication Technology.

DISTRIBUTED AND NETWORK COMPUTING CONCERNS

The distribution and processing of environmental data and information on networked computers is expanding so rapidly as to distract from traditional methods of research and analysis. The focus on distributed computing in various research Institutions also distracts attention from the critical contributions of large high-performance computational facilities. Computer networks can provide access to high-performance computers independent of their locations. But the development and operation of distributed systems is demanding, and the maintenance of links to super-computers is easily assigned low priority by systems managers and engineers chosen for their interest and skill in distributed computing and information technology. Network computing has literally revolutionized the way in which we do our science. It has vastly broadened our access to information, improved our ability to interact with colleagues globally, and provided us easy access to the data we need to do our research. Science is discovery, and computing has become instrumental in that discovery process.

Networking enables access to information and computational resources on a variety of technologies. This versatility is particularly important to meeting the needs of the diverse research community. But network efficiency and simplified system administration argue for hardware and software standards including personal computers, workstations, operating systems, and application software. Such trends toward a common denominator can seriously erode the quality of computational resources available to the many disciplines including environmental technology of the research Institution. Furthermore, any move toward standardization of desktop computing, hardware or software runs counter to current national trends and developing technologies that allow for information retrieval that is completely independent of the computational platforms being used.

ENVIRONMENTAL INFORMATION SYSTEM (ENVIS)

The Ministry of Environment and Forests, Government of India has created an information system called Environmental Information System (ENVIS) by end of 6th Five Year Plan as a Plan Scheme for environmental information collection, collation, storage, retrieval and dissemination to policy planners, decision makers, scientists and environmentalists, researchers, academicians and other stakeholders. ENVIS is a decentralized computerized network database system consisting of the focal point located in the Ministry at New Delhi and a chain of network partners, known as ENVIS Centres located in the potential organizations/institutions throughout the country.

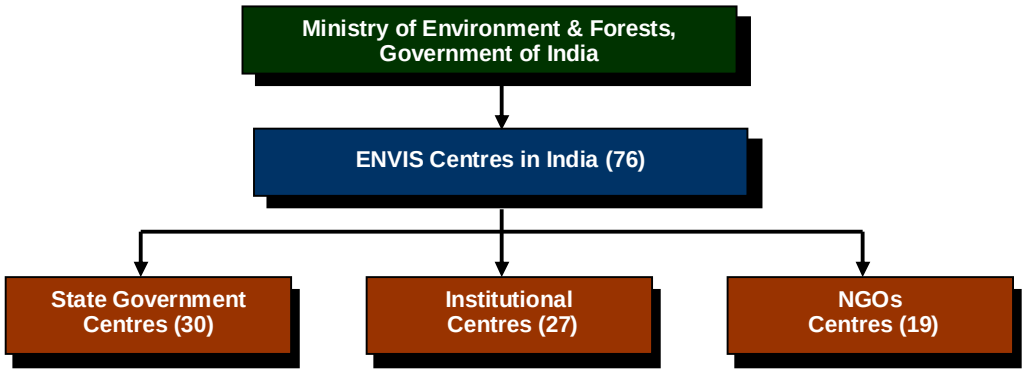

Fig.2. Organisational structure of the Environmental Information System (ENVIS).

ENVIS's mission is to provide access to and enhance the use of environment related information in India as well as the rest of the world, advancing understanding of different environment related issues and indirectly serving the needs of public and private decision making. Presently, the ENVIS network consist of 76 ENVIS centres apart from the ENVIS Focal Point, out of which, 30 ENVIS Centres are on State Government Departments dealing with the Status of Environment and related issues of the concerned State Government and the remaining 46 have been set up on various environmental disciplines covering from Himalayan ecology, Conservation, Forests, Pollution control, Biodiversity, Solid waste management, Ecology and Ecosystems, Environmental education, Wildlife, Remote sensing, Renewable energy, Desertification, Mangroves, Mining, Western Ghats and Eastern environmental management, NGOs, Media and even Environmental parliament, Coastal ecosystem, Clean technology, etc.

Table 1. Subject wise distribution of ENVIS Centres

Subject Areas	Numbers	Related Web Link
Ecology and Ecosystems	11	http://envis.nic.in/ecology_ecosystem.asp
Status of Environment	30	http://envis.nic.in/soer.asp
Chemicals, Wastes and Toxicology	12	http://envis.nic.in/cwt.asp
Environment Law and Trade	05	http://envis.nic.in/tl.asp
Media, Environment Education and Sustainable Development	04	http://envis.nic.in/meesd.asp

Flora, Fauna and Conservation	10	http://envis.nic.in/ffc.asp
Environment & Energy Management	04	http://envis.nic.in/eem.asp

ENVIS due to its comprehensive network has been designed as the National Focal Point (NFP) for INFOTERRA, a global environmental information network of the United Nations Environment Programme (UNEP). ENVIS exists solely to act as an information broker for environmental information in India. ENVIS network offers a mother portal which acts as a platform for inter nodal interaction. The entire portal has been designed and organized to provide with easy access to the multitude of environment related information available with the ENVIS Centres. Both the Focal Point as well as the ENVIS Centres has been assigned various responsibilities to achieve the Long-term & Short-term objectives. The website i.e. http://envis.nic.in may be explored for the more information about the ENVIS network in India and related online database.

APPLICATIONS OF REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM (RS&GIS)

Remote Sensing is the acquisition of information about an object or phenomenon, without making physical contact with the object. Remote sensing has proved to be very effective tool in environment studies and management. Now, the ongoing changes in the environment can be assessed easily through satellites by remote sensing techniques.

The occurrence of a number of natural calamities like droughts, floods, volcanic erruptions etc., can also be predicted well in advance. Such assessments help the environmentalists and planners to take ameliorative measure to minimize the effects of these extreme natural events. Satellite imageries provide us actual information about various physical and biological resources and also to some extent about their state of degradation in a digital form through remote sensing. We are able to gather digital information on environmental aspects Eke water logging, desertification, deforestation, urban sprawl, river and canal network, mineral and energy reserves and so on. Satellite data also helps in providing correct, reliable and verifiable information about forest cover, success of conservation efforts etc. They also provide information of atmospheric phenomena like approach of monsoon, ozone layer depletion, inversion phenomena, smog etc. We are able to discover many new reserves of oils, minerals etc. with the help of information generated by remote sensing satellites. Remote Sensing softwares includes ERDAS Imagine, ERMapper, ESRI, ITT Visual Information Solutions ENVI, MapInfo, AutoDesk, TNTmips, PCI Geomatica, RemoteView and Open source remote sensing software includes GRASS GIS, ILWIS, QGIS, OSSIM, Opticks and Orfeo toolbox, etc.

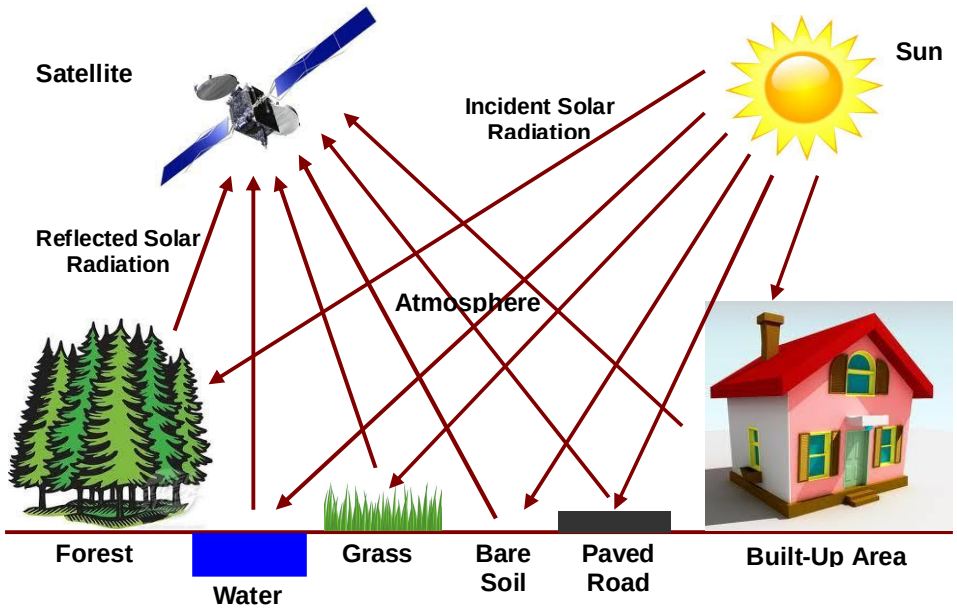

Fig.3. Optical and Infrared Remote Sensing – A working cycle.

A Geographical Information System (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographically referenced data. Geographical Information System is a technique of

superimposing various thematic maps using digital data on a large number of inter-related or inter-dependent aspects several useful software's have been developed for working in the field of GIS. Different thematic maps containing digital information on a number of aspects like water resources, industrial growth, human settlements, biodiversity, road network, soil type, forest land, crop land or grass land etc. are superimposed in a layered form in computer using software. Such information is very useful for future land vise planning. Even interpretations of polluted zones, degraded lands or diseased cropland can be made on GIS. Planning for locating suitable areas for industrial growth is now being done using GIS by preparing Zoning Atlas. GIS serves to check unplanned growth and related environmental problems. Geographic Information Systems softwares includes Desktop GIS, gvSIG, GRASS-GIS, Capaware-rc1, SAGA-GIS, Whitebox GAT, IDRISI Taiga, QGIS, MapWindow GIS, ILWIS, uDig, JUMP GIS, Kalypso, TerraView, Capaware, FalconView, GeoServer, MapServer, PostGIS, SpatiaLite, VMDS, DB2, Informix, Microsoft SQL Server, Oracle Spatial, PostGIS, etc.

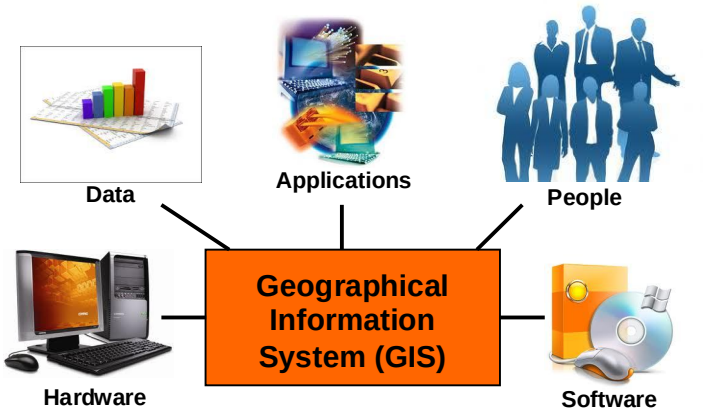

Fig.4. Components of Geographical Information System (GIS) Services.

INTEGRATED USE OF ICT AND GIS IN GEOMATIC,SURVEYINGAND ENVIRONMENT STUDIES

Information and communication technology has also been applied in surveying and geomatics as these help in environmental analysis. Geomatics is the science and technology of acquiring and managing information about our world and its environment. Surveying is the art and science of determining the position of natural and artificial features on, above or below the earth surface and representing the information on paper plans as figures in report tables or on computer based maps. Environmental studies, geomatics and surveying are all linked as they all view the aspects of geography. Geomatics, surveying and environmental studies integrate into geography, information and communication technology are widely used in this area and this is mainly through the use of geographical information systems (GIS) which is described as a computer-based technology that combines geographic data and other types of information to generate visual maps and reports. Geomatics professionals use an integrated approach to measure, analyze and manage spatial data by employing GIS, the global positioning system (GPS), digital photogrammetry, digital total station, satellite and terrestrial remote sensing to create a detailed but understandable picture of the earth's natural and man-made features. Environmental modeling has become critical to the understanding and resolution of environmental problems and issues of sustainable and natural resource management.

The specific objectives include identifying the available information and communication technology in use, analyzing the importance of ICT in the fields of geography, environmental studies, surveying and geomatics and to come up with recommendations of improving the utilization of ICT. Digitizers, multispectral scanners, color printers, total stations, GPS receivers and the internet are important in supporting GIS use in mapping environmental issues. Scanners are important in obtaining digital information through scanning of aerial photographs or hard copy maps. GIS software performs a variety of functions including data input, database management, data analysis, graphic presentations, data query and transformation. Educational institutions can now use GIS in research in surveying, geomatics and environmental management. GIS is also used in automated digital landscape analysis, digital photogrammetry and in cartography to produce automated maps. GIS can be used in water resource management courses such as deformation and hydro graphic surveying and one can use remotely sensed data obtained by GPS receivers to find out areas with illegal dams or to analyze land cover changes in catchment areas so as to monitor siltation rates.

EFFECTIVE UTILIZATION OF GIS TECHNOLOGY IN ENVIRONMENTAL STUDIES AND RESEARCH

GIS is an available spatial analysis tool, which is to give insights into the natural and man-made environments due to its strength to link the generic information with its location. It is a powerful tool, which not only analyses the present environmental scenario, but also helps in projecting the future that is, GIS can be used for past, present and future studies on the environment, its protection for generations to come in future. GIS is used to store spatial data in a digital mapping environment. A digital base map can be overlaid with data or other layers of information onto a map in order to view spatial information and relationships. It thus allows for viewing and understanding physical features and the relationships that influence a given critical environmental condition. Factors such as steepness of slopes, aspect and vegetation can be viewed and overlaid to determine various environmental parameters and impact analysis.

Apart from data analysis in the laboratory, GIS has the power to analyze attribute data and geographic information, and can also help the analyst in the field by giving the exact location of devastation and amount of devastation and hence an environmental scientist can rapidly map waste storage sites, describe the volume, content and state of waste containers, retrieve previous inspection records to compare with the existing environmental conditions, view environmental data in relation to adjacent geographic features such as waterways, neighborhoods or other sensitive areas such as high risk zones for landslides water pollution. GIS is used in mapping tectonic activity in earthquake prone regions for the purpose of both public safety and commercial interests. Commercially, tectonic activity would be of great interest for the decision making process of insurance companies in setting earthquake insurance premiums. GIS maps are useful for the purpose of studying past earthquake events in order to improve and perfect prediction techniques with a view of creating early warning systems which would predict earthquake and allow emergency response teams and organizations to react more quickly to natural disasters.

TECHNOLOGICAL TRENDS IN ICT FOR ENVIRONMENTAL STUDIES BY USE OF GPS

Technological advances that are transforming the traditional surveying activities include global position system (GPS) receivers and computers. The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather, anywhere on or near the Earth, where there is an unobstructed line of sight to four or more GPS satellites. A GPS receiver calculates its position by precisely timing the signals sent by GPS satellites high above the Earth. Each satellite continually transmits messages that include the time the message was transmitted, precise orbital information, the general system health and rough orbits of all GPS satellites. The GPS receiver is currently one of the preferred equipment for surveying activities involving large areas. With advancement in digital photogrammetry and remote sensing, multiple layers of images in digital format are extracted and processed and the required information is generated and transmitted in the appropriate format for dissemination. Digital photogrammetry has also enabled aerial triangulation, orthophotos, digital terrain modeling (DTM) and also enabled easy interaction with GIS database with digital images, especially color photographs from softcopy photogrammetry as input data for GIS displays and related presentations. Environmentalists and surveyors together use satellites to image the earth's environment, use different satellites for navigation and precise position fixing, use computer visualization techniques for mapping, microcomputer controlled equipment for measuring the earth's surface and information systems to present and analyze data about land and land usage. Due to advances in information and communication technology and space technologies, surveying and mapping have been totally revolutionized.

CONCLUSION

Information & communication technology is expanding rapidly with increasing applications and new avenues are being opened with effective role in environment studies and research, education, management and planning in the field of environment studies, etc. Thus, information and communication technology tools like RS&GIS, GPS, resource online web database, environmental information network can play a very vital and crucial role in environment management, resolving the environmental issues and problems, environment studies and research.

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