

# **A Study of Impact of Information and Communication Technologies on Environment: In context of Opportunities and Development as well as Challenges**

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**Abstract:** Development of Information and Communication Technologies (ICT) has changed the world. Every day hundreds of information communication devices and apps are manufactured and make our living easier. These days development of any country based on technologies development and in the field of development of ICT plays a vital role. Today, both developed and developing countries face many issues and challenges related to environment such as climate change, waste management, improving energy efficiency, air pollution, loss of natural habitats, issues and challenges related to transport and areas of urban and rural system. In fact, ICTs play optimization role in which people living and working. All the process of innovation, development and consumption are needed for any country but is a challenge for environment. In context of development different elements of information and communication technologies such as database system, Geographic Information Systems (GISs), remote sensing and multimedia etc. helping to dealing with different environmental problems. Therefore, smart ICT and their application have both negative and positive impact on environment but in the context of green growth strategies, ICTs become a broader part of environment policies. Green information and communication technologies refer to smart application of technologies which have positive impact on environmental presentation and ecosystems. This paper

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\* The author participated in the Professor Radha Kamal Mukerjee Young Social Scientist Award Contest held during the Conference: Science, Technology and Society at Indore Christian College, Indore on January 6-7, 2018.

explores how ICTs help to tackle environmental related issues and challenges. This study aims to know how smart ICT and their applications recognize all environmental problems and make people aware before hand to take early action.

**Key Words:** Environment, Information, Technologies, Development, Communication, Innovation, Challenges.

## **Introduction**

Environment refers to living and non-living things around us. In the environmental domain, ICTs can foster sustainable development by enabling better use of resources and energy and by dematerializing transactions (GeSI, 2008a; Harter, Sabbagh, Shehadi and Karam, 2010; Jitsuzumi, Mitomo, and Oniki, 2001). Development of ICTs has changed the world. Every day hundreds of information/communication devices and apps are manufactured which make our living easier. Today, both the developed and developing countries face many issues and challenges related to environment such as climate change, waste management, improving energy efficiency, air pollution, loss of natural habitats, issues and challenges related to transport and areas of urban rural system. The purpose of this paper is to examine the potentially transformational role of ICTs in sustainable development of environment. For example, information and communication technology can improve transportation because of the awareness of the use of smart meters to examine traffic and release of energy and consumption more efficient with the use of thermostats. “Tele- and video-conferencing can reduce travel needs, leading to reduced carbon emissions for the environment. Distance and online learning technologies can reduce the need for brick and mortar buildings as well as the need for transportation in delivering education. Finally, telemedicine, e-health, and m-health have the potential to make delivery of public health more efficient. ICTs thus have the potential to promote sustainability” (Raghupathi, W, Wu, S.J and Raghupathi, V, 2014).

Information and Communication Technology is developing rapidly and is playing an increasingly important role in society (Plepys 2002; Berkhout and Hertin 2004; OECD 2011; Hilty and Aebischer 2015b). The contemporary society is facing a number of sustainability

problems and in this context rather high expectations are being placed on ICT in relation to sustainable development, claiming that ICT could play a crucial role supporting various sustainability strategies and may enable transition to a less material-intensive economy (Hilty et al. 2011; Höjer et al. 2015). A number of studies have been carried out by industry, organizations and researchers, exploring the idea of ICT contribution to solving environmental problems (e.g. Mingay (2007); Buttazoni (2008); Coroama and Hilty (2009); Mickoleit (2010); GeSi (2012)). ICT is suggested to be able to contribute to sustainable development and reduction of environmental impacts in a number of ways, such as replacing products, intensifying use of products/space/transport, increasing efficiency of processes/activities, informing consumption choices (Höjer et al. 2015). In fact, ICTs play an optimization role in which people are living and working. Innovation, development and consumption are needed for any country but is a challenge for environment. In the context of development, different elements of ICTs such as database system, Geographic Information Systems (GISs), remote sensing and multimedia etc helping to dealing with different environmental problems. “Except for life cycle environmental impacts of specific ICT solutions it is important to consider the role of ICT in a context of a whole society in order to take into account different kinds of indirect effects as well. For example, many studies claim that there is a high potential of improved energy efficiency with the help of ICT, however, it is not usually considered that”(Arushanvan, Y. 2016) “as technological improvements increase the efficiency with which a resource is used, total consumption of that resource may increase rather than decrease” (Polimeni 2008).

### **Information and Communication Technologies and Environment**

The term, information and communication technology refers to the transportation and components that enable modern computing. It is networking components, applications and systems that are combined allow people and organisations to interact in the digital world. Basically, ICT encompasses both the internet enabled sphere as well as the mobile motorized by wireless networks. It also includes antiquated technologies, such as landline telephones, radio and television broadcast all of which are still widely used today alongside cutting-edge ICT

pieces such as artificial intelligence and robotics. The UN defines ICTs in broad terms, calling them “tools that facilitate communication and the processing and transmission of information and the sharing of knowledge by electronic means.” The definition allows scope for the full range of electronic digital and analogue ICTs from radio and television to fixed and mobile telephones, computers and electronic-based media such as digital text, audio-video recording, the Internet (including Web 2.0 and 3.0), social networking, and web-based communities” (Raghupathi, W., Wu, S.J and Raghupathi, V, 2014). According to Houghton, J. (2009) the relationship between ICTs and the environment is composite and versatile, as ICTs can play equally positive and negative roles. Positive impacts can come from dematerialization and online delivery, transport and travel substitution, a mass of monitoring and management applications, greater energy competence in production and use, and product stewardship and recycling. Negative impacts can come from energy use and the materials used in the production and sharing of ICT tools, energy consumption in use straight and for cooling, small product life cycles and e-waste, and exploitative applications.

The impacts of ICT can be direct on the environment in the form of energy consumption and e-waste, indirectly it can be in the form of intelligent transport systems, buildings and smart grids. According to Houghton, (2009) estimates of the direct impacts of the ICT industries differ with the definition of the industry and coverage of ICT associated energy uses, but the production and use of ICT equipment is estimated to be equivalent to 1 to 3 percent of global CO<sub>2</sub> emissions (including embedded energy) and a higher and growing share of electricity use. In 2006, it was estimated that ICT tools (excluding broadcasting) contributed around 2 to 2.5 percent of worldwide Greenhouse Gas (GHG) emissions - 40 percent of this was reported to be due to the energy requirements of PCs and monitors, 23 percent to data centres, 24 percent to fixed and mobile telecommunications, and 6 percent to printers (Kumar and Mieritz 2007). More recent life cycle assessments produce broadly similar results (Malmodin 2009). Data centres are a particular focus, and Koomey (2007) estimated that worldwide electricity use for servers

doubled between 2000 and 2005, and he recommended that consumption would increase by a further 40 percent by 2010. The Climate Group (2008) identified key areas of enabling impacts potentially primary to global emissions reductions by 2020 that were five times the ICT sector's direct footprint.

“ICT and the Internet are enabling an increasing number of products and services to be delivered online (i.e. de-materialisation). This affects scientific journals, books, music CDs, film and videos, software, etc., with fewer taking a physical form and less energy and potentially fewer resources being used in their production, storage and delivery. E-commerce and online shopping can save time and travel in searching and pricing, and centralised fulfilment and delivery can replace many thousands of individual trips, not only saving energy directly but also through potential reductions in traffic congestion. E-mail has replaced many millions of letters, written on paper, collected, sorted and delivered worldwide, with almost instantaneous communication that has a very small environmental footprint” (Schmidt and Kloverpris 2009).

There are different types of ICTs tools dealing with different type of environment challenges. According to ITU 2008 Report ICTs dealing with environmental challenges of developing and new emerging country at six level

- 1) Environmental observation: monitoring, recording and collecting information of earth, land, soil, water, ocean, climate etc. related issues and data through ICTs equipments.
- 2) Environmental analysis: when environmental data have been collected and stored ICT having various computational and processing tools to analyze it.
- 3) Environmental planning: includes classification of various environmental conditions for use in agriculture and forestry and other applied environmental sectors, and is often focused on specific issues such as protected areas, biodiversity, and industrial pollution or GHG emissions.
- 4) Environmental management and protection: information and communication technologies have different tools to manage and

protect the environment. In this involves managing and mitigating impacts on the environment as well as helping adapt to given environmental conditions.

- 5) Impact and mitigating effects of ICT utilization: “ICT use can mitigate the environmental impacts directly by increasing process efficiency and as a result of dematerialization and indirectly by virtue of the secondary and tertiary effects resulting from ICT use on human activities, which in turn reduce the impact of humans on the environment” (Houghton, 2009).
- 6) Environmental capacity building: ITC providing us different types of medium to aware public to environment related issues and challenges.

### **Review of Literature**

The review of the literature has been classified and presented on the basis of the time period, country of the study, the methodology used, the issue covered, techniques used and conclusions.

Houghton, J. (2009) conducted research on “ICT and the environment in developing countries: opportunities and developments”. This study analyzed the environmental challenges which faced developed and developing countries regarding climate change, improving energy efficiency and waste management, addressing air pollution, water quality and scarcity, and loss of natural habitats and biodiversity and explores how the internet and the ICT can help tackle environmental challenges in developing countries through environmentally sustainable models of economic development, and examines the status of current and emerging environmentally friendly technologies, equipment and applications in supporting programmes aimed at addressing climate change and improving energy efficiency.

Mushi, R. and Maharaj, M. (2013) studied “The potential of ICTs to enhance environmental sustainability in Tanzania”. In this research they evaluate the environmental crisis the world facing today and an innovative approach to ensure sustainability. This paper also explores the role ICTs can play in promoting environmental sustainability in Tanzania and focused the environmental crisis in Tanzania and discusses ICT policies in relation to environmental sustainability and finally highlights the potential of ICTs in promoting environmental sustainability.

Raghupathi, W., Wu, S.J and Raghupathi, V. (2014) research on “The role of information and communication technologies in global sustainability: A review”. In this study they focus on contribution of ICTs at several levels in global sustainability. They identify the key challenges to be addressed in bringing about a ICTs-based sustainable world. They also study that the macro impacts of ICT investments can also guide countries in setting policy and making selective investments in ICTs that will promote global sustainability.

Ahola, J. et al. (2010) conducted a research on “ICT for environmental sustainability: Green ICT roadmap”. In this research they focused on VTT roadmap on ICT for environmental sustainability, based on the assessments and evaluations made by VTT technology experts. This roadmap is divided into three themes. 1) Empowering people means using ICT to raise people’s awareness of the environmental impact of their actions and to channel their behaviour in a more environmentally-friendly direction. 2) Extending natural resources involves reducing the use of diverse environmentally unsustainable re-sources through ICT-based solutions. 3) Optimising systems refers to minimising the environmental load of diverse systems by optimising their operation.

Mungai, W. (2005) research on “Using ICTs for poverty reduction and environmental protection in Kenya: The M-vironment approach”. In this paper, Mungai recommends a more significant consideration of environmental issues in the regional and national poverty reduction and ICT discussions in Kenya. Specifically, he recommends addressing poverty reduction as proposed in the MDGs and resolutions of the WSSD. Opportunities for quick gains for Kenya lie in e-environment and e-agriculture initiatives. He presents the “M-vironment framework,” a mobile telephony platform which can help enable financial sustainability for environmental protection efforts; facilitate awareness-raising and exchange of information; strengthen early warning systems; raise environmental consciousness among ICT solutions providers; create employment and protect livelihoods.

Arushanyan, Y. (2016) conducted a research on “Environmental Impacts of ICT: Present and future”. In this thesis he analyzes the

negative and positive, direct and indirect impacts of ICTs on environment. In this, he focused to understand the life cycle environmental impacts of individual ICT solutions and to study ICT in a context of a whole society, identifying the potential risks and opportunities for environmental consequences. Moreover, the potential role of ICT in supporting those opportunities for improvements and counteracting the potential risks needs to be explored. This research also provided the new knowledge on the environmental impacts related to ICT, to explore the potential of ICT to contribute to environmental sustainability and discuss ways of assessing environmental impacts of ICT and challenges related to such assessments.

### **Objectives**

The study is primarily undertaken

1. to study different type of tools of ICTs which help to tackle environmental related several issues and challenges; and
2. to examine all applications and medium of smart ICTs which recognize environmental problems and make people aware to take timely action.

### **Methodology**

In this study, the researcher has used primary and secondary data to explore its objectives. To explore the first objective of this study, review of literature was done on the base of Impact of ICT on Environment. For this, secondary data was collected from various research papers, newspapers, journals and websites.

To explore the second objective of this study, primary data was collected through questionnaire. The methodology that has been used for this study was survey method and sampling of this study was purposive sampling which is non-probability sampling method. The sample area of this study was Babasaheb Bhimrao Ambedkar University, U.P. The sample of this study was all higher education students from the Department of Mass Communication and Journalism, Babasaheb Bhimrao Ambedkar University, Lucknow. 50 respondents were selected by convenient sampling technique from the Department of Mass Communication and Journalism students because they have

the knowledge about ICTs through awareness campaigns. They were also familiar with campaigns, advertisements and posts. Close-ended Likert scale based questionnaires have been used for data collection.

## Results

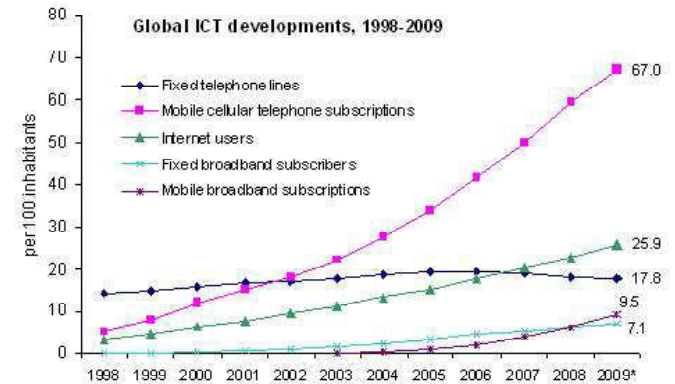
Information and Communication Technology (ICT) is “an umbrella term that includes any communication device or application, encompassing radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as video-conferencing and distance learning” (Tech Target 2016). In this paper ICT as defined in Arushanyan (2013) “cover ICT products, services and society where ICT plays a crucial role in societal life and development. In case of ICT society all ICT solutions are considered”. A number of scientific studies advocate that ICT can be a means of enabling the transition of society to a less material-intensive economy, and therewith sustainability (Hilty et al. 2011). The Smarter 2020 report (GeSi 2012) defined a potential role of ICT in reducing future energy use and climate change impact through digitalization and dematerialization, data collection and communication, systems integration, and process, activity and functional optimizations. These are suggested to be applied on such sectors as power, transportation, manufacturing, consumer and service, agriculture and land use, and buildings. Mitchell (2000) discusses the way ICT can contribute to the reduction of energy use in cities. He defines the opportunities as follows: dematerialization, demobilization, mass customization, intelligent operation, and soft transformation.

Results show that trends in ICTs and ICT Applications has been growing number and types of remote sensing technologies and platforms, miniaturization and digitalization, Growing processing power, efficiency, storage capacity and intelligent algorithms, Broadband and wireless connectivity such as GRIDs and Clouds.

Trends in ITCs for e-environment significantly help reduce climate change by promoting the development of more energy efficient devices, applications and networks. Wireless technologies are particularly useful to connect remote and especially for environmental applications.

Wireless sensor networks have been successfully used in flood and drought monitoring. Earth observation satellite systems provide data for damage assessment and planning relief operation. Radio communications, in many cases are the only communication means in relief operations because the “wired” infrastructure is destroyed.

Figure - 1: Global ICT Development, 1998-2009



Source: ITU world telecommunication ICT Indicators 2009

On the other side in the environmental awareness campaign ICTs play vital role and give us chance to be a part of any campaigns, protects etc by clicktivism. Environmental awareness campaigns have the ability to provide individuals with the knowledge, skills and attitude required to reduce environmental impact. Information and communication Technologies have been used by environmental activists to conduct environmental awareness campaigns. There are various environmental issues that are increasingly becoming of concern to all countries. Therefore, there is a societal pressure to create environmental awareness which is essential for informing people about the effects of environmental hazards. The intention of environment awareness is to maintain and protect natural resources. For the environmental issues two key concepts are important which are awareness and environmental responsibility. For this social media platforms such as Face book, Twitter and You Tube create some of the largest networks of people across all professions, cultures and countries. Messages transmitted across these platforms

have the power to go viral or spread to other social media fore within seconds. During the deepwater horizon oil spill (2010), Gulf coast residents used Face book and Twitter as platforms to share their personal stories. Social media can be used as a pressure point to prompt and encourage support during Greenpeace targeted Shell oil operations in the Arctic Circle. ITCs play a vital role in creating people awareness about environment and conservation of natural resources. It contributes to dialogue and social actions. It helps to build local capacities and allows people to share their experiences.

Result of second objective of this study is obtained by calculating through SPSS. Content study was also done by researcher to calculate its results. 50 respondents were taken by researcher to analyse its objectives and aims of this study.

In this study, the respondents were asked which ICTs platform they use for information and communication and the responses are recorded in table 1. It indicates that out of 50 respondents, 55 percent total cumulative percentage respondents used all ITCs (radio, television and social media) for information and communication. Further, 74 percent respondents answered that they used all media for information and communication. 20 percent respondents answered they used only social media for information and only 6 percent respondents answered they used television for information.

**Table-1: Type of ICTs Used**

ITCs Used	Frequency	Percent
Television	3	6
Social media	10	20
All of the above	37	74
Total	50	100

Further, the respondents were asked whether ITCs (social media) are providing opportunities to make their own opinion. Out of 50 respondents 47 (94%) answered “Yes” that ICTs provides opportunities to make their own opinion on burning issues pertaining to environment and the remaining 3 (6%) said is does not provide any opportunities to make their own opinion.

Next, the researcher asked how much time they have been a part of environment awareness campaigns through social media and the responses are recorded in table 2. Out of 50 respondents, 17 (34%) answered “None of one”, but 15 (30%) respondents answered “More than five times” that they are a part of environment awareness campaign through ITCs. 12 (24%) respondents answered “1 to 2 times” and 6 (12%) answered “3 to 5 times”.

**Table-2: Time spent on environment awareness campaigns through social media**

Time spent	Frequency	Percent
1 to 2 times	12	24.0
3 to 5 times	6	12.0
More than 5 times	15	30.0
None of One	17	34.0
Total	50	100.0

When researcher asked general question that, ICTs helps to tackle environment related challenges and issues on the time, out of 50 respondents 32(64%) respondents answered “Yes” it helps to tackle challenges and issues related to environment. On the other side 18 (36%) respondents answered “No”, meaning it cannot help to tackle environments related problems. Further, researcher asked whether ITCs recognize environmental related harmful problems and whether people are aware to take action before time. Out of 50 respondents 40 (80%) respondents answered “Yes” that it is aware people to take action before time when situation is dangerous. Only 10 (20%) respondents answered that “No” it is not aware people to take action on the time in dangerous situation.

## Conclusions

ICTs are all but ubiquitous and the possible uses and impacts of ICTs on the environment are several and varied such as earth observation, monitoring and remote sensing, grid and cloud computing, data collection, communication networks, analysis and modelling. Some time it works like decision support system and database management. ICT provide facility to geographic information systems and earth browsers through Google and other search engine. Its provides web-based clearing house sites for communicating technology and learning,

education and capability building facilities. ITC have different types of network and medium for detection and early warning regarding storm, flood, earthquake and tsunami related challenges. “Fundamentally, ICTs are about information and communication, and it is these roles that are vital. Data must be collected, analysed and interpreted, transformed into information that enables individuals to make smarter greener choices, and communicated to individuals in such a way as to inform and educate, influence and change behaviours. It is not simply a matter of price signals shaping behaviour, even if it were possible to get those signals right, but also about informing, monitoring performance and providing non-price feedback in such a way as to motivate and reward individuals and communities for creating sustainable livelihoods” (Houghton, 2009).

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