Role of Information Technology for the Improvement of Climate Change in the Context of Nepal

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ROLE OF INFORMATION TECHNOLOGY FOR THE IMPROVEMENT OF CLIMATE CHANGE IN THE CONTEXT OF NEPAL

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Abstract

Climate change refers to the alteration in the climate over a period often arising from the activities of humans as well as some naturally stirring events such as earthquakes, explosions, etc. Climate change is caused due to different factors such as atmospheric carbon dioxide (CO2) and other greenhouse gases (GHGs) viz., methane (CH4), nitrous oxide (N2O) and chlorofluorocarbons (CFC) due to fossil fuel burning, rapid industrialization, deforestation and increased agricultural activities. Climate is changing at an unprecedented rate and this is highly impacting many fields like melting of glacial, livestock production, hydroelectricity, livelihood, agriculture and so on.

The problem of climate change can be solved with the help of information technology. India is tackling the problem of air pollution by installing Wind Augmentation Purifying Unit (WAYU) in different cities of India. US government is doing research about Methane (Greenhouse gas) by using sensor technology, drones, etc. Nigeria approved space technology program to save environment from climate change. But the development of IT fields lacks in Nepal due to lack of enough budget and infrastructures. Many Nepalese people are deprived of education and under poverty line. So, they cannot afford technologies. Although urban areas have enough facility to use mobile banking and digital wallet, people prefer ongoing system rather than the new ones. Digital wallets like eSewa, Khalti and other mobile banking services are representing

themselves as something that can reduce printed money from Nepalese market which ultimately decreases the production of money in industry which leads to decrease in pollution. Contaminated water leads to many hazardous problems in living beings and also contaminates soil. So, to tackle this problem water quality monitoring system based on GPRS technology was invented. Information technology improves climate change by strengthening agricultural field i.e. it shares information about pest, disease control, irrigation applications, etc. Remote sensing (product of IT) helps to monitor the natural disasters and improve communication to help the people deal with natural disasters more effectively. Powering vehicles with electricity helps to control pollution which cause climate change. Online exams help to control deforestation as well as pollution caused by industry for the production of paper.

But there are some challenges faced by Nepal to implement IT in different fields with a goal to minimize climate change but those challenges can be solved. The major part of the Nepal consists of high mountains and rolling hills. And for the development of IT field, wireless internet connection might be relatively feasible than the fiber. Banking apps should focus on privacy policy and data encryption, so that the risk of data leakage should be eliminated which ultimately makes the brand trustworthy and people would go for information technology.

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Abbreviations

GHG	Greenhouse Gas
GIS	Geographical Information System
ICT	Information and Communication Technology
IT	Information Technology
KU	Kathmandu University
MI	Mobile Technology
RS	Remote sensing
WAYU	Wind Augmentation Purifying Unit
WSN	Wireless Sensor Network

Chapter 1 Introduction

1.1 Background

Climate change refers to any alteration in climate overtime, whether due to natural discrepancy or as a result of human dexterity. [1] Due to climate change the country has to face many problems. The climate change causes the melting of glacier and the water added into the rivers, ocean, etc. causes many natural calamities such as flood, tides, etc., impact living beings and environment. There are several ways to control climate change such as stopping deforestation and starting afforestation, using alternative source of energy, adopting sustainable developmental strategies, adopting 3R policy and so on. [2] Information technology based applications can also help in reducing climate changes impacts on environment because using it in climate monitoring provides real time observation, reduce cost, decrease power consumption, lively tracking, real time data processing and analysis etc. [3]

Information is a process of transmission and transfer of knowledge: forms, data, and concepts, studies with the aim of making it accessible to another person, institution or society. The term information technology is any activity that involves information processing and integrated communication through electronic equipment. [4] Information technology can be used to reduce the problem of climate change. With advancement of information technology and development of applications such as Digital wallet, online classes and so on, the deforestation and the production of paper can be reduced which ultimately reduces the pollutants from

industrial sector. Advancement of IT such as remote sensing for monitoring of natural disasters improves communications to help deal with natural disasters more effectively, or satellite and surface-based remote sensors for environmental observation can also be used to predict and reduce the risks of climate change. [5] Alternative ways of powering vehicles, such as with electricity, can help a lot to control CO_2 footprints if done in wide range. [6]

Human influence has been the dominant cause of the climate change and its consequences which indeed, threatens human health and well-being in a numerous ways. [7] Since, small groups with the power to respond to, negotiate with, and change the strategic future of the organization is called a stakeholder. So, civil society, made up of non-governmental organizations, private citizens, and informal groups who can make a decision and implement plans to use IT applications to control climate change are considered to be the stakeholders. Governmental bodies also have the power and the strength to enforce the decision related to climate change so arguably, everyone is a stakeholder of climate change. [8] Mahabir Pun has started wireless internet services in rural communities which helps a lot to increase the use of IT in rural areas too that ultimately decrease climate change.

Nepal government held its cabinet meeting at the foothills of Mt Everest at Kala Patthar (5,242m) on 4 December 2009, drawing the attention of the world towards the impact of climate change on the Himalayas. United States Environmental Protection Agency is also doing

research about climate change. The research focused on problems of climate change and the ways to tackle those problems. Many researches have been conducted regarding the effects of climate change around the glove. However, the study to reduce climate change with the application of information technology has not been conducted in detail in the context of Nepal.

1.2 Objectives

1. To study climate change, information technology and their interconnection.
2. To study the effects of climate change in the world briefly and the ways implemented to reduce them.
3. To study the positive aspect of information technology regarding climate change.
4. To study climate change in context of Nepal and ways to reduce it using information technology.
5. The challenges faced by information technology while reducing climate change and the ways to overcome them.

1.3 Scope

1. The scope of the research is limited to the study of information technology in order to reduce climate change.

2. The report is focused on interconnection between climate change and information technology.

3. The study is conducted in the context of Nepal rather than of the world (the latter is done briefly).

4. The scope is limited to solving the problems of climate change through information technology.

Chapter 2 Literature Review

2.1 Climate change

Climate change refers to the alteration in the climate over a period often arising from the activities of humans as well as some naturally stirring events such as earthquakes, explosions, etc. [9] Increase in atmospheric carbon dioxide (CO2) and other greenhouse gases (GHGs) viz., methane (CH4), nitrous oxide (N2O) and chlorofluorocarbons (CFC) due to fossil fuel burning, rapid industrialization, deforestation and increased agricultural activities results in warming of earth. [10]

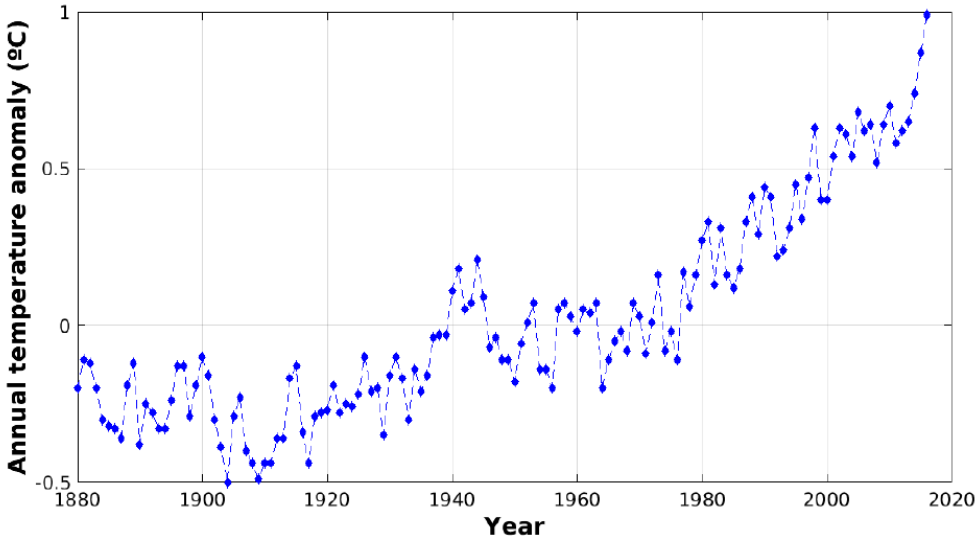

Figure 2.1 Annual mean global air temperature near surface. [11]

The graph in figure 2.1 shows the time evolution of the annual mean global air temperature near surface done by thermometers of National Weather Service meteorological stations and more recently by satellite thermal sensors.

Climate system has changed notably on both global and regional scales since the pre-industrial era. At least some of these changes are directly and indirectly attribute-able to human activities. Climate change includes global warming, changing weather patterns, heavy monsoon, unexpected rainfall, rapid urbanization, pollution and industrialization, losses of crops due to drought, glacier melting resulting in rise of water level in rivers causing flash floods. [3] According to the "United Nations Framework Convention on Climate Change (2007)" major climate changes are Global Warming (increase in average global temperature) resulting in heat waves, bush fire, extreme temperature, droughts.

2.2 Information technology

Information Technology is advancing our understanding of the threatening environmental hazards and also providing some new insights on mitigation and management techniques. Information and Communication Technology plays a pivotal role in monitoring, mitigation and adaptation of Climate changes challenges. It can help vulnerable communities to reduce the risk related to climate changes by education and awareness at the lowest level of community, sharing practical and theoretical knowledge, empowering communities to access the knowledge and relevant information applicable locally to save lives. [12] Information technology includes Geographical Information System (GIS), Wireless Sensor Networks (WSN), Mobile Technology (MT), Web based applications, Satellite Technology, Remote

Sensing (RS). [13] Developing countries are facing GHG emission problems due to rapid industrialization and transportation. Information technology can be used in designing smart buildings, using smart grids which can be implemented in energy generation and power consumption. It can also control transmission and distribution of energy. [14]

Presently, through information technology, there have been novel techniques for measuring and reducing emissions of methane which is a powerful GHG that has generated over eighty times the near-term warming power of carbon dioxide. It is reported that man-made methane emissions are responsible for about 25% of all global warming presently experience. Artificial intelligence, analytics, and machine learning are some of the various tools that are being applied to climatology studies in climate adaptation projects. Right from creation, climate inconsistency has continued to cause severe harm to man and his environment and countless scientific cum technological mechanisms have been put in place for its mitigation and management. [9]

2.3 Climate change and its control around the world

In this era of technology, without modern tech input we can't imagine our life. Lots of software are very much useful to collect climate change and pollution data. For example, online pollution detector device which is placed in different places of India such as Delhi. Two devices capable of filtering particular matter in area of 500 sq. meters have been installed in ITO and

Mukarba chowk in Delhi called WAYU (Wind Augmentation Purifying Unit). The device generates wind in order to dilute the air pollutants like carbon with the help of one fan and filter. The device runs at a cost of just Rs. 1500 per month. [15] In Beijing of China, smog-sucking vacuum has been invented with the help of information technology to control air pollution.

We're deploying advanced sensor technologies to help create a healthier environment in other ways, too – from Google cars mapping air pollution and its health effects to wearable bracelets that track your daily chemical exposure. Sensors can help farmers reduce the amount of chemicals on their fields. A research was done in California with the help of information technology. Five years ago, Environmental Defense Fund set out to measure methane emissions from the US oil and gas sector, launching an unprecedented scientific research effort involving more than 140 researchers from 40 institutions, along with four dozen oil and gas companies that provided site access and technical advice. Researchers used a range of technologies — including sensors mounted on drones, airplanes, and even Google Street View cars — to measure emissions at every link in the supply chain, from remote wellheads to pipes under the local street. And with the help of IT, it is found that the US oil and gas industry emits 13 million metric tons of methane each year—nearly 60% more than current Environmental Protection Agency estimates. Then, US government knew about it and they are controlling Methane emission. [16]

Nigeria's Federal Government took a bold step by putting in place a space policy and space science and technology program. Subsequently, in 1999, an institutional framework, the National Space Research and Development Agency (NASRDA), was established. The approval of the National Space Policy in 2001 and the execution of the program enunciated in it climaxed in the launching in September 2003 of an earth observation satellite. Space technologies have led to several inventions that benefit the environment and save energy. Vehicles carbon dioxide emissions are being reduced by satellite-based systems, wind turbines are more efficient as a result of remote sensing technology and solar cells produce more energy based on information from weather satellite. These are just some examples of how spin-offs from space technology and satellite service can make a difference. [17]

The strategic approaches were followed in different environments of six countries located in four continents viz. Asia (India, Japan), America (USA), Europe (United Kingdom, the Netherlands) and Australia. Geographical Information System (GIS) and satellite remote sensing tools have helped study and understand better each and every aspect of our planet. Geospatial technologies that visualize and use information collected from ground, airborne and satellite platforms alert people about natural hazards and climate change. Geospatial technology has proved to be an important tool to examine the changes and to suggest adaptation and mitigation, locally, regionally and globally. [18]

In Australia, there is 3.2% hike in carbon emissions from fossil fuel and cement production. And the country has been cited for its environmental achievements, including its plastic bag ban, its strategy to halve food waste, and the construction of the world's largest lithium battery and the charging device with the help of information technology to more effectively store wild energy. [19]

Chapter 3 Discussion

3.1 Climate change in context of Nepal

Nepal is a land-locked country located in South Asia between India and China, at 28° North latitude and 84° east longitude. It has an extremely varied and complex climate, driven by the uneven terrain and regional weather systems. Within a few hundred kilometers, the country's elevation changes from the lowland of 70 m in the Terai to the top of the world, Mount Everest (8,848m). [20] Nepal is considered as one of the top ten countries most likely to be impacted by global climate change but is one of the least contributors to the emissions of greenhouse gases (GHGs), emits only 0.027% of global share. [21]

Day by day temperature of Nepal is rising due to many factors such as Carbon dioxide (CO_2, produced mainly by fossil fuel combustion and non-retired from the atmosphere due to deforestation and other areas with lack of vegetation), Methane (CH_4, generated mainly during cattle digestion, rice production, and emissions from open air urban landfills), Carbon monoxide (CO, a short-lived gas in the atmosphere), Halocarbons (HCFC, included mainly in the new refrigeration systems, that replace the old ones, the CFC, that were responsible of the Ozone layer destruction), Nitrous oxide (produced mainly by land fertilization for increasing vegetables growing for food production), NMVOC (non-methane volatile organic compounds, mainly produced by vegetation), Solar irradiance change, etc. [11]

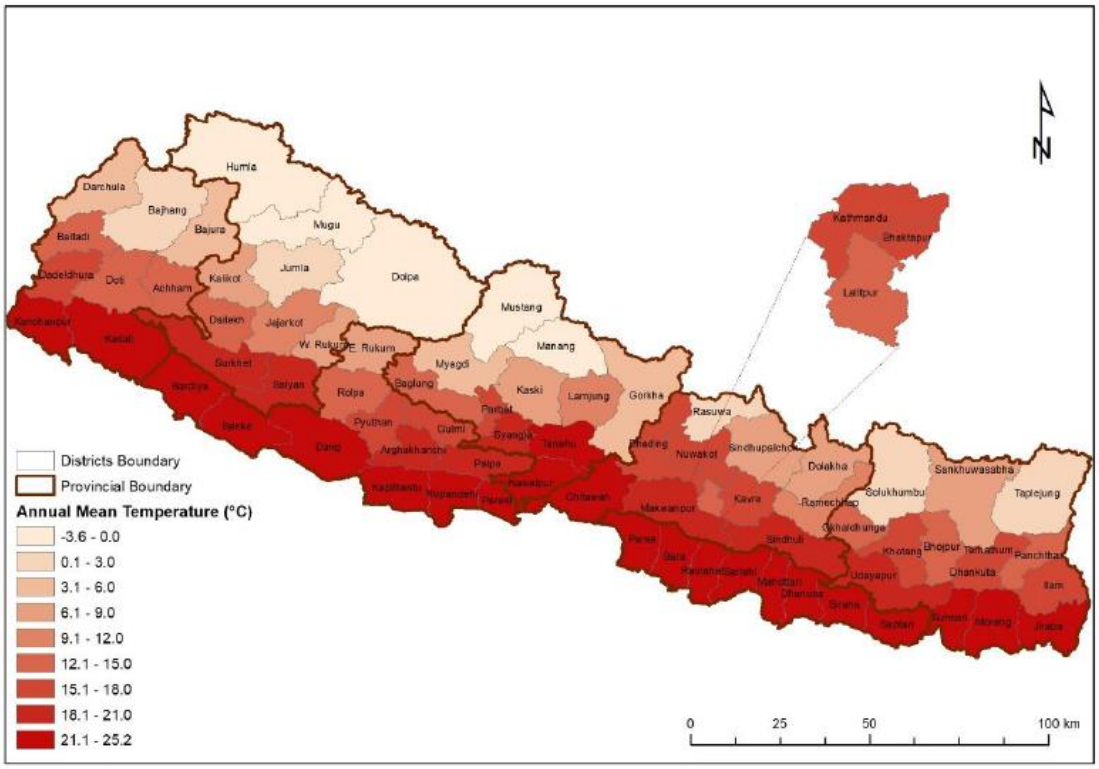

Figure 3.1 Annual Mean Temperature (°C) for districts [22]

The figure 3.1 shows annual mean temperature for all districts of Nepal in Celsius scale. The climate change poses risks for both living being and natural resources. Least developing countries like Nepal are becoming more vulnerable due to their limited capacity to adapt it. Thus, the risk of climate change is assessed in this study by considering the eleven climate extremes indices that suggested by Government of Nepal. Where, changes in the indices has been standardized and identified the composite indexes. Result shows that Province 5 will have a higher risk and Province 2 will have a lower risk of climate change among all other provinces. [22]

Table 3.1 Risk of climate change in different Provinces [22]

S.N.	Province	RCP4.5				RCP8.5			
		2030s		2050s		2030s		2050s	
		Average	Likely	Average	Likely	Average	Likely	Average	Likely
1.	Province 1	L	H	L	M	L	H	H	VH
2.	Province 2	L	M	L	M	M	M	L	M
3.	Bagmati	M	H	M	H	M	H	M	VH
4.	Gandaki	L	H	M	VH	L	H	M	H
5.	Province 5	H	VH	H	VH	H	VH	H	VH
6.	Karnali	L	M	M	VH	M	H	M	H
7.	Sudurpashchim	M	M	M	H	M	H	L	H

Table 3.1 shows the risk of climate change in average and maximum likelihood in provinces. Climate change risks are categorized into four classes using a statistical approach; which are 'Low (L)', 'Moderate (M)', 'High (H)' and 'Very High (VH)'. Where, 'Low' class means that there will be a lesser risk in comparison to other geographical location.

3.2 Problems faced due to climate change

Climate is changing at an unprecedented rate and this is highly impacting people of Nepal as well as the economy of the country. Nepal's low resilient capacity, lack of adequate funds for adaptation makes Nepal and its people very vulnerable to climate change. Adding to this, it is observed that climate change impacts largely on agriculture, tourism, economy, hydroelectricity, economy, livelihood and might cause many climate induced disaster like GLOFs, landslide, flood, drought, epidemic. [20] Some of the impacts of climate change that Nepal is facing and might be facing in future are discussed below:

Impact on glacial

Nepal's Initial National Communication Report on Climate Change to UNFCCC mentions increased seasonal and annual air temperature over the last few decades. Observed annual trend of temperature rise per decade is 0.41°C while seasonal rising trend for temperature during pre-monsoon, monsoon and winter periods are 0.43°C, 0.43°C and 0.37°C per decade respectively. [23] This is much higher than the global average. As a result, in Himalayas, Glaciers melt at a faster rate. New glacial lakes have formed and those already existing have grown rapidly; therefore, it is possible to project future scenarios of water discharge in snow-fed rivers. Also, the occasional bursting of glacial lakes in the past has seriously damaged the lives and livelihoods of mountain communities. So, effects of temperature rise are embedded in ongoing

complex dynamic processes such as weather, season, vegetation and hydrologic patterns. [24]

Impacts on Livestock Production

There is a growing concern on the effects of climate change on livestock production. Climate change also increases mortality and morbidity of animals particularly from the climate sensitive infectious diseases. [25] Increases in zoonotic diseases among the animals also increase the risks of transmission of such diseases in human beings. [20] Increased temperature and relative humidity increase the risks of aflatoxin development in feedstuffs whereby increasing the risks of poisoning among animals. [26] Moreover, it is said that climate change increases the costs of veterinary medicines in livestock and poultry production. [20]

Impact on hydroelectricity

For the country like Nepal which is highly dependent on hydroelectricity for power generation, climate change is considered a curse in the long run. Many reports say that, due to glacier melting the discharge in the river will increase for certain periods of time and that particular time might be fruitful for the electricity generation. But, if we consider the long run, the water discharge level is supposed to decrease after 2050, thus it will be hard for Nepal to extract high amounts of electricity from running water. [20] Many other climate induced disasters like GLOF, flood, drought, landslides, and erosions are also supposed to cause negative impacts on

hydroelectricity generation. [27]

Impact on livelihood

Climate change has affected Nepalese people through a number of pathways, including disasters, hydropower, irrigation, and domestic water usage. Few case studies done by IDS Nepal shows that, there is increase in the frequency of occurrence of hailstorms in Kaski district while on the other hand, west Rapti river side has witnessed high number of floods in the last decade. Meanwhile, in Mustang a decline in the productivity of buckwheat over the last decade was seen. Nepalese suffered from the impacts of increased frequency of extreme weather events, such as landslides, floods and droughts resulting in the loss of human lives as well as high economic costs and social disputes. The way of living has been changed by the impacts of climate change. [20]

Impact on Agriculture

The agricultural sector accounts for around three quarters of employment and around one-third of Gross Domestic Product (GDP) in Nepal. [20] Due to climate change, farmers are facing and will be facing three types of costs namely, direct impact costs, indirect impact costs, and adaptation costs. [26]

- Direct impacts costs include the cost of effects of climate change on crop production,

livestock production, and risks of natural hazards.

- Indirect impacts costs include the cost of effect of climate change on socio-economic conditions and lost opportunities.

- Adaptation cost includes the cost incurred to keep themselves away from or minimize the negative effects of climate change.

Thus, climate change has affected production, processing, consumption and distribution of food either directly or indirectly. [26]

3.3 Information technology in context of Nepal

Information technology is not so well developed in Nepal. Remote places of Nepal don't even have facility of electricity. Due to this people are facing great loss. People cannot get education through online course. Nepal is an agricultural country. Farmers could get the knowledge about pest, seasonal vegetables and how to tackle climate change to grow crops in effective way through information technology. But due to lack of information technology farmers are planting and growing crops in traditional way. Not only this people could use eSewa for paying utility bills such as the electric bill but people don't use information technology as they don't feel it trustworthy. So, the people of rural areas have to walk long distance to pay bills.

3.4 Information technology's answer to climate change

Climate induced disasters such as floods, forest fire, landslide which contaminate water and brings water-borne diseases such as cholera and typhoid, putting lives of Nepalese at risk. [20] Impure water is harmful for soil, habitat, birds, trees as well as human beings so water quality monitoring system based on GPRS technology for measurement and transmitting data of different parameter required for monitoring water quality can be used in Nepal to solve water contamination problem. [3] So, in this way IT could make a contribution in the improvement of water resource management techniques, monitoring of water resources and awareness raising. [28] It can help in agricultural field by strengthening of agricultural and livestock production systems (i.e. through information about pest and disease control, planting dates, seed varieties and irrigation applications, and early warning systems), by improving market access (through information on prices and consumer trends) and capacity building opportunities for local farmers in Nepal as well. It has the potential to enable information sharing and capacity building on the main health threats related to climate change, enabling effective prevention and response. [28] Online courses and exams help to control deforestation as well as pollution caused by industry for the production of paper. Also, advancement of IT such as remote sensing for monitoring of natural disasters such as floods and tidal waves, improved communications to help deal with natural disasters more effectively, or satellite and surface-based remote sensors for environmental observation can also be used to reduce risks

of climate change.

Alternative ways of powering vehicles, such as with electricity, can help a lot to control pollution but in order to do it on a wide scale. For example, Yatri motorcycles is working on to launch electric motorcycles in Nepal. Pollution meter is placed in different cities of Nepal. It indicates the level of pollution in the air with the help of different color indicators. When the level of pollution rises in the air, the device changes its color from lighter to the darker ones which instantly aware people.

Digital wallets like eSewa, Khalti and other mobile banking services are representing themselves as something that can reduce printed money from Nepalese market. Since rapid use of such application increases the lifetime of printed money. This ultimately decreases the production of money in industry which leads to decrease in pollution. Instead of burning the fuel in one's car or motorcycle to get to the destination, one can use the communication networks (powered by IT equipment) to do the work as if he/she was "there". Teleconferences can be considered as "work from home". This reduces the CO_2 footprint which ultimately reduces pollution. Even in the present context of lockdown around the glove due to COVID-19, it's a relief to some extend that we have been able to perform work/study from home which is made possible by the platforms created by information technology.

3.5 Challenges along the way

Various fields like Education, health, media, etc. are working to control climate change in Nepal. Applications of IT has been applied in various sectors like agriculture, livestock farming, health sector, etc. in order to control pollution, GHGs leads to climate change but there are some challenges faced by Nepal to implement IT in different fields with a goal to minimize climate change:

- The new technology must be accepted by the society but most of the people of Nepal are deprived of education and under the poverty line. So, they cannot afford technologies, electricity let alone internet service. Furthermore, the price of internet service is much higher than other countries.

- Although urban areas have enough facility to use mobile banking and digital wallet, people prefer old ongoing system rather than the new one.

- In a small landlocked country like Nepal, where the major part of the country consists of high mountains and rolling hills and has an ethnically complex society, there have been major obstructions for information technology development and its wider application. [29] IT field is not so developed due to low budget allocation to create official software professionals who can actually work in different fields including climate change.

- There are alternative ways of powering vehicles, such as with electricity, but in order to do it on a wide scale, much more efficient batteries and battery-charging technology are required which is challenging for a developing country like Nepal to implement in real.

3.6 Solving those challenges

- The implementation of technology does not end with installation of the machinery and explanation of how to use it. It should be accompanied, therefore, by transfers in education, organization, administration, employment strategy, and research etc. [29]

- The major part of the Nepal consists of high mountains and rolling hills. And for the development of IT field, wireless internet connection might be relatively feasible than the fiber.

- Banking apps should focus on privacy policy and data encryption, so that the risk of data leakage should be eliminated which ultimately makes the brand trustworthy.

- Local NGOs, INGOs along with government should work together to uplift people from poverty line and provide them education. However, this is not enough, the high price of internet should be reduced to make it minimum or free.

Chapter 4 Result

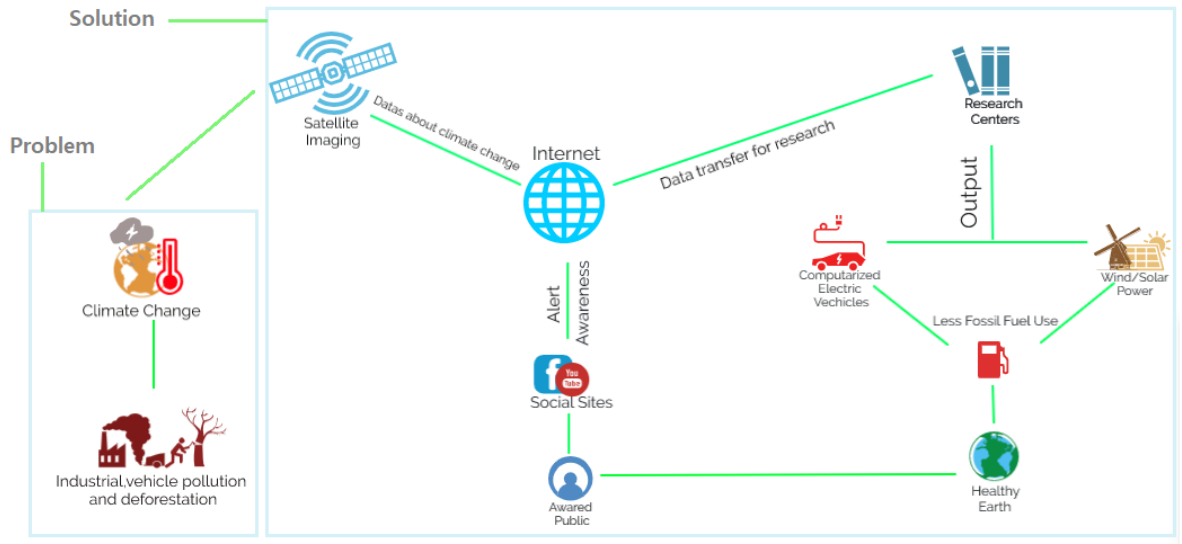

Figure 4.1 Architecture diagram of connection between IT & climate change

The architectural diagram shows the interconnection between information technology and climate change. The main cause of climate change in Nepal is emission of greenhouse gases from vehicles, industries and factories. Deforestation also leads to climate change. It can be solved by using applications of information technology. The applications of information technology such as Digital wallet and online course and so on can decrease deforestation and pollutants from paper industries as well. Using space technologies like satellites, images of areas with high greenhouse gases and deforestation can be located and the collected data can be sent to different climate change research centers who can analyze the data and find an appropriate solution to it. Drones also help a lot to see the areas with high waste material which motivates local people to clean the surrounding.

To control emission of harmful gases, fuel vehicles can be replaced with computerized electric

vehicles. Alternative sources of energy like solar, wind energy can be used instead of fossil fuels which ultimately reduces the use of bio fuels indeed decreases climate change. Also, awareness can be provided to people through different social website platforms about changes in climate so that they can stay alert and contribute from their side to control it. Ultimately, awareness and environmentally friendly technologies will make healthy earth**.**

Chapter 5 Conclusion

The study of effects of climate change and role of information technology to reduce it was done. The study of the positive aspect of information technology in context of Nepal and the ways to reduce climate change was done. The research showed that with the help of advancement of information technology such as Digital wallet, online classes and so on, the deforestation and the production of paper can be reduced which ultimately reduces the pollutants from industrial sector. The research is about challenges faced by information technology while reducing climate change and the ways to overcome them are done. Internet facility is not available in remote areas which is huge barrier in context of Nepal. However, with the work started by Mahabir Pun to provide wireless internet service in rural communities, the situation is improving daily. Many agencies and telecommunication services such as Namaste are figuring out different ways to provide internet service in each community of rural areas of Nepal. After the installing at Everest by Chinese company Huawei, nothing seems impossible in Nepal in the field of IT. Hence, after the advancement of information technology in Nepal, within few years, climate change can be reduced significantly.

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