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Highlights

Nile Rivers Basin Dispute

Development and Environment

Discovering Thoughts, Inventing Future

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By Yohannes Yihdego, Alamgir Khalil & Hilmi S. Salem
Snowy Mountains Engineering Corporation

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Abstract- Transboundary river basins are under increasing pressure due to population growth, agricultural and industrial developments, and climate change, as well as river pollution. Water scarcity is on the increase due to the increasing gap between water demands and supply. This will result in more tensions, disputes, conflicts, and deadlocks in negotiations over water distribution, length of time it takes to fill the reservoir, and allocation. Ethiopia is building the Grand Ethiopian Renaissance Dam (GERD) on the Blue Nile River with a hydropower capacity of 6,000 MW. The total estimated cost of the project is US$ 4.8 Billion and will be the largest dam in Africa, which is much larger than the Aswan Dam in Egypt. Regional controversies have risen over the construction of the dam between Ethiopia and the downstream countries (Sudan and Egypt). The Blue Nile River is a source of around 85% of the Nile River water. Egypt claims that GERD will reduce flow of water in the Nile River between 11 and 19 billion m^3(BCM) which will affect 2 million people and will also interrupt electricity supplies 25 to 40%. The real scale of the environmental impacts of GERD, under construction upstream of the Nile River, together with the rising sea levels, due to climate change, leading to saltwater intrusion downstream, are still not clear. But for Ethiopians GERD is empowering development and contribution to their future. With the Nile, no longer Egyptian birthright, and the Nile Delta gradually disappearing into the Mediterranean sea, millions of Egypt's people will inevitably need to look elsewhere for a livable future. The crises, therefore, necessities the adaptation of a more effective institutional arrangement, such as through Rowland-Ostrom Framework, for common pool shared water resource management and cooperative approach to address and resolve present and future problems, including on other common transboundary resources (forest, oil/gas and minerals).The need for expanding traditional integrated water resources management to better include the cultural, social and political complexity of the GERD is the key factor to reconcile the contrasting concepts of "nationalism" and "regional hydro solidarity". Connecting Nile and Congo water system, through diverting water by digging a 600-km canal together with pumping stations and other massive infrastructure to transport water from the Congo Basin to the Nile Basin has been suggested as an alternative way of ensuring Egypt's water security. As part of mitigation measures, Egypt needs to invest in desalinization for fresh water, water-saving drip irrigation, and come up with an Aquifer Storage Recovery (ASR) scheme, artificial recharge and scheduled water extraction, to minimize the cumulative effect of the Grand Ethiopian Renaissance Dam and seawater intrusion downstream along the Mediterranean coast.

Keywords: Ethiopia, Egypt, Sudan, Nile Basin, Millennium Dam, Grand Ethiopian Renaissance Dam (GERD), Hidase Dam, Aswan dam.

I. Introduction

When water quantity or quality degrades, it leads to more competition among water users for meeting the rising water demands (Yihdego and Al-Weshah, 2016). The situation is more destabilizing in the transboundary river basins (the Great Lakes of the United States and Canada; Lake Victoria of Africa, Lake Malawi, Lake Tanganyika, and the rivers: Nile, Amazon, Rhine, Congo, Danube, Mekong, Indus, Jordan, Tigris-Euphrates, and the Brahmaputra, to name a few). Experience has shown that such disputes can be solved through mutual cooperation on sharing water. Legal agreements on water sharing have been negotiated and maintained even as conflicts have persisted over other issues. Thailand, Vietnam, Laos and Cambodia have been able to cooperate since 1957 within the framework of the Mekong River Commission. Hydroelectric dams are increasingly popular in water-rich countries of Sub-Saharan Africa, especially those less endowed with oil. For example, a 250-MW dam wascompleted in 2012 on the Nile in Uganda. A 300-MW dam was also built by China and completed in 2009 on the Tekeze River in Ethiopia. A smaller, 120-MW dam was completed in 2012 on the Wele River in Equatorial Guinea, to mention a few. On the other hand, the Jordan River and its tributes, for example, have been considered as a tension point between the sharing countries of the River, namely: Lebanon, Syria, Jordan, Palestine, and Israel (Salem, 2009). Also, the Grand Ethiopian Renaissance Dam (GERD), which is under construction on the Blue Nile River near the Ethiopian-Sudanese borders might be a trigger point for conflicts among Ethiopia, Sudan, and Egypt. The idea of a dam on the Nile River in Ethiopia, and the threat this would pose for Egypt, have been on the minds of the people of the Nile Basin for centuries. Ethiopia has long claimed a right to use Nile waters, but it was only in 2011 that Meles Zenawi (the former Prime Minister of Ethiopia from 1995 to 2012) announced that Ethiopia would begin construction of a large dam on the Blue Nile River, near its border with Sudan. The advantages of storing

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water in the Blue Nile gorge for hydropower generation and flood control have been recognized for decades. But until recently Ethiopia did not have the political or financial strength to pursue this economic development strategy, without the assistance from the USA and Israel. According to Kenawy (2013), the issue of the Nile water for Egypt is the issue of "life or death", and one of the issues of the conflict that was raised between Egypt and the Nile Basin countries on water resources through the past three decades, as a result of absence of Egypt from Africa during this period. This is in addition to the entry of the USA, Israel, and the World Bank to the Nile Basin's countries and manipulation of the issue of water security, and the launching of new concepts, including water pricing, water privatization, and exchanging of water by these forces. All of these influences may lead to a conflict among those countries in the coming years.

Lake Malawi, also called Lake Nyasa in Tanzania and Lago Niassa in Mozambique, is the lake located between Malawi, Tanzania, and Mozambique, and is ranked 3rd in Africa and 9th in the world in size, and 2nd deepest in Africa (Yihdego and Andrew, 2016). It has the highest number of fish species than any other lake. The partition of the Lake's surface area (29,600 km^2) between Malawi and Tanzania is under dispute. Tanzania claims that the international border runs through the middle of the Lake. On the other hand, Malawi claims the entire surface of this Lake that is not in Mozambique. Both sides cite the Heligol and Treaty of 1890 between Great Britain and Germany concerning the borders. The wrangle in this dispute occurred when the British colonial government, just after they had captured Tanganyika from Germany, placed all of the waters of the Lake under a single jurisdiction, that of the territory of Nyasaland, without a separate administration for the Tanganyikan portion of the surface. Later in colonial times, two jurisdictions were established. The dispute came to a head in 1967 when Tanzania officially protested to Malawi; however, nothing was settled (Chitsulo, 2012). Occasional flare-ups of conflict occurred during the 1990s and in the 21st century. In 2012, Malawi's oil exploration initiative brought the issue to the fore, with Tanzania demanding that exploration cease until the dispute was settled (allAfrica, 2012).

Lake Tanganyika is an African great lake, and is estimated to be the second largest freshwater lake in the world by volume, and the second deepest, in both cases, after only the Lake Baikal in Siberia. It is also the world's longest freshwater lake. The Lake is divided among four countries – Tanzania, Democratic Republic of the Congo (DRC), Burundi (8% of shoreline), and Zambia (6%), with Tanzania (46%) and DRC (40%) possessing the majority of the Lake. The water flows into the Congo River system and ultimately into the Atlantic Ocean. The total Lake's surface area is 32,600 km^2. No disputes have emerged in the Lake Tanganyika yet, but as the borders between the four littoral countries have not be demarcated, potential for disputes exist. The Lake is divided by a median line, but given that Lake levels have dropped considerably in recent years where that line lies needs to be fully established.

The Tigris and Euphrates Rivers: Both rivers are transboundary sources of water among Turkey, Iraq, Syria, Saudi Arabia, and Iran. Although Saudi Arabia and Iran are considered as drainage basin states, they are usually not included in studies of the basins of the two rivers. The Tigris River is approximately 1,840 km long, while the Euphrates is between 2,700 and 3,000 km long, making it the longest river in south-west Asia. Both rivers originate in the mountainous region of southern Anatolia in eastern Turkey. The drainage basin of the Euphrates is located 28% in Turkey, 17% in Syria, 40% in Iraq, and 15% in Saudi Arabia. Meanwhile, the Tigris Basin is stretched into Turkey (12%), Syria (0.2%), Iraq (54%), and Iran (34%). Both rivers merge in their last 190 km, forming the Shatt Al-Arab before flowing into the Arabian (Persian) Gulf. Water flow is roughly estimated at around 32 BCM/yr for the Euphrates River, while it is roughly around 43 BCM for the Tigris River (Kirschner and Tiroch, 2012). With economic growth, population increase, and urbanization, the demand for water and water use have steadily increased in the region. Iraq, for instance, was especially keen to bring more water for irrigation, and, hence, it built several dams on both rivers. The first dam which Turkey built on the Euphrates was the Keban Dam, which was built by the Soviet Union in 1973 to generate hydroelectric power, with a storage capacity of 14.1 km^3 and a total surface area of 674 km^2. The Atatürk Dam on the Euphrates River is located in Bozova in the Sanliurfa Province of the Anatolia region of south-east Turkey. It was built to supply water for irrigation and to generate hydroelectric power. It is the largest dam in Turkey and ranks sixth amongst the largest earth-and-rock fill embankment dams in the world. It was undertaken in the years 1983-1992 with a total cost of US$ 1.25 billion. The central core of the Dam has a crest length of 1,820 m and height of 184 m, and a storage capacity of around 85 MCM, as well as a catchment area of more than 92 km^2, and annual inflow of approximately 27 MCM (Water-Technology Net, 2016).The project of the Turkey's Ataturk Dam has been receiving strong political resentment from Iraq and Syria and other riparian countries as it significantly reduces the flow of Euphrates. In 2009, however, the three countries (Turkey, Iraq, and Syria) initiated talks to establish a water institution to resolve issues related to sharing of the Euphrates and Tigris waters.

Jordan River: The basin of this transboundary river exists in a greatly troubled area in the Middle East, and it is shared by Jordan (40%), Syria (37%), Israel (10%), Palestine (9%), and Lebanon (4%). The basin of the transboundary Jordan River, with a total area of approximately 20,000 km^2 is home to more than 20 million inhabitants that belong to the River Basin's five countries. Due to low average annual precipitation of less than 400 mm/yr and the semi-arid to arid climate conditions throughout most parts of the River's Basin, available freshwater resources are limited (Al-Weshah and Yihdego, 2016). As climate projections indicate further aridification of the region, available freshwater resources will continue to decline in the future while demand on water is dramatically increasing, which is due to the high rates of population growth and the rising standards of living, as well development and urbanization. Therefore, securing adequate access to water resources in the region is considered by decision makers as integral to national security of each of the riparian countries of the Jordan River. The Jordan River's Basin and its water are central issues of both the Arab-Israeli conflict and the Israeli-Palestinian conflict. The Jordan River is more than 360 km in length, but because its course is meandering, the actual distance between its source and the Dead Sea is less than 200 km.Over most of its distance, the Jordan River flows at elevations below sea level. Its waters originate from the high precipitation areas in and near the Lebanon's mountains in the north, and flow through the Tiberias Lake (Sea of Galilee) and the Jordan River Valley, ending in the Dead Sea at an elevation of approximately 400 m below sea level, in the south. The current annual discharge of the Lower Jordan River into the Dead Sea is estimated at 20-200 MCM which is highly polluted, compared to the historic 1,300 MCM of good quality. Further details on the Jordan River can be found in Salem, 1994; Salem and Isaac, 2007; Isaac and Salem, 2007; Salem, 2009; and Salem, 2011.

The *Brahmaputra River* has origin in China and then flows through India and Bangladesh before entering Bay of Bengal. China and India have fought a war over contested territory through which the River flows, and Bangladesh faces human security pressures in the River's Basin that will be magnified by upstream river practices. Controversial dam-building activities and water diversion plans could threaten regional stability; yet, no bilateral or multilateral water management accord exists in the Brahmaputra Basin. The three riparians have taken modest steps at the bilateral level to cooperate in the Brahmaputra Basin, such as limited water data-sharing and government dialogues among technical experts.

The *Tasang Dam* also known as the *Mong Ton Dam*, is a planned multi-purpose dam on the Salween River in the Shan State, Burma. The Tasang Dam's location will be 480 km northeast of Rangoon and 52.8 km west of Mongtong. It will be the first dam on the Salween River and will be the largest hydroelectric dam in Burma and the tallest dam in Southeast Asia if completed. Substantial domestic and international controversy surrounds the Tasang Dam project. Thailand's MDX Group agreed in 2002 to develop the project. Thailand is the main investor in the Dam project and the trade of the Tasang's electricity is expected to help relations between Thailand and Burma. 85% of the hydro-electricity produced is expected to be transmitted to Thailand. The Tasang concrete-faced rockfill dam is designed to be 228 meters tall and house a hydro-power station with a 7,110-MW capacity to produce 35,446 GWh annually. Tasang's 870 km^{2}reservoir will bisect a large portion of Shan State, precluding serious social and environmental problems.

The Indus River, which has origin in Tebet, flows through India, Pakistan, and finally drains to Arabian Sea. The Indus Waters Treaty is a water-distribution treaty between India and Pakistan, negotiated by the World Bank in 1960. The Indus system of rivers comprises three western rivers — the Indus, the Jhelum, and the Chenab — and three eastern rivers — the Sutlej, the Beas, and the Ravi. According to this agreement, control over the three "eastern" rivers (the Beas, the Ravi, and the Sutlej) was given to India, while control over the three "western" rivers (the Indus, the Chenab, and the Jhelum to Pakistan. More controversial, however, were the provisions on how the waters were to be shared. Since Pakistan's rivers flow through India first, the treaty allowed India to use them for irrigation, transport, and power generation, while laying down precise regulations for Indian building projects along the way. The treaty was a result of Pakistani fear that, since the source rivers of the Indus Basin were in India, it could potentially create droughts and famines in Pakistan, especially at times of war. Now India is building hydropower projects on Indus River to meet its growing energy demands which is elevating tension between the two countries.

The approach followed in this study is mainly to review the recent studies related to the Grand Ethiopian Renaissance Dam (GERD)in relation to the environmental impacts and the shared Nile River resources management.

II. Study Area

According to the UN-Water (UN, 2008), approximately 40% of the world's population lives in river and lake basins that comprise two or more countries, and perhaps even more significantly, over 90% of the world's population lives in countries that share basins. The existing 263 transboundary lake and river basins cover nearly one half of the Earth's land surface and account for an estimated 60% of global freshwater flow. Continued high to very high risk of environmental and human water stresses, due to decrease in renewable freshwater resources and higher water demand from increased population and irrigation, as well as risks resulted from climate change impacts and pollution are important factors in increasing risks of hydropolitical tension among countries sharing transboundary river basins, due to political context, disagreement on river's water allocation, etc. These are some examples of transboundary river basins in the Middle East: Orontes, Jordan River, Euphrates and Tigris. The countries significantly affected by these river basins are: Lebanon, Syria, Turkey, Iraq, Palestine, Israel, and Jordan. Regarding the Nile River, which is the subject of this study, it is an international river as its water resources are shared by eleven countries, namely, Tanzania, Uganda, Rwanda, Burundi, Congo-Kinshasa, Kenya, Ethiopia, Eritrea, South Sudan, Sudan, and Egypt. In particular, the Nile is the primary water source for Egypt and Sudan. The Nile River's drainage basin covers 3,254,555 km^2, forming approximately 10% of the total area of the continent of Africa. The Nile Basin is complex, and because of this, the discharge at any given point along the mainstream of the River depends on many factors including weather, diversions, evaporation and evapotranspiration, and groundwater flow (Yihdego and Becht, 2013; Yihdego et al., 2016; Yihdego and Webb, 2016; Yihdego and Webb, 2017; Yihdego et al., 2017a; Yihdego et al., 2017b). The Nile River is 6,853 km long, and, thus, it is considered the longest river in the world. The Nile has two major tributaries, the White Nile and the Blue Nile. The White Nile is considered to be the headwaters and primary stream of the Nile itself. The Blue Nile, however, is the source of most of the water. The White Nile is longer and it rises in the Great Lakes region of central Africa, with the most distant source still undetermined but located in either Rwanda or Burundi. It flows north through Tanzania, Lake Victoria, Uganda, and South Sudan. The Blue Nile begins at Lake Tana in Ethiopia and flows into Sudan from the southeast. The two rivers (White and Blue) meet just north of the Sudanese capital of Khartoum. The northern section of the Nile River flows north almost entirely through the Sudanese desert to Egypt, then ends in a large Delta and empties into the Mediterranean Sea. Egyptian civilization and Sudanese kingdoms have depended on the Nile River since ancient times. Most of the population and cities of Egypt lie along those parts of the Nile Valley north of the city of Aswan (where the Aswan High Dam was built in the 1950s, as it was a key objective of the Egyptian Government following the Egyptian Revolution of 1952), and nearly all the cultural and historical sites of ancient Egypt are found along the banks of the Nile River.

The Grand Ethiopian Renaissance Dam (GERD) will impound the Blue Nile River in the Benishangul-Gumuz region (1°12′55″N and 35°05′35″E) of Ethiopia and is about 15 km from the borders of Sudan. It is previously called as the Millennium Dam and occasionally referred to as the Hidase Dam. It is a gravity dam with a reservoir surface area of 1,561 km^2 and storage capacity of 79 BCM (Billion Cubic Meter), making it one of the largest dams in the African continent. The main purpose of the Dam is hydro-electric (hydel) power production and similar dams have been built by the Ethiopian Government (Jembere and Yihdego 2016). Maximum planned installed capacity of the Dam is 6,000 MW making it the Africa's largest hydel power plant and the 11th globally. It is currently under construction and as of October 2014, the Ethiopian Government announced that 40% of the Dam was completed (Al-Ahram, 2014). The construction of the Dam started in April 2011 and is expected to complete in 2017,but unlikely to accomplish as planned. Ethiopia is close to finishing 70% of GERD (Daily News Egypt, 2016). The rendition of the Dam is shown in Figure 1.

The construction of theDam and its potential impacts have led to severe debates in the region. Egypt and Sudan are located downstream and depend heavily on the Nile River for agricultural, industrial, and domestic purposes. The Government of Egypt has demanded from Ethiopia to terminate the project. Egypt has planned a diplomatic initiative to sought support in the region as well as other countries that support the project such as China, Italy and Norway, along with the USA, Israel, and the World Bank (as mentioned earlier). Sudan has accused Egypt of mishandling the dispute. Sudan's shift over the Dam project could be motivated by factors such as: regulation of upstream flow on the Blue Nile will irrigate croplands in Sudan, need of electric power could be alleviated by GERD, and prospects of increased trade with Ethiopia (Sudan Tribune, 2014). Ethiopia has rejected the claims of Egypt and has stated that the project will increase the water flows downstream by decreasing evaporation from the Lake Nasser, covering a total surface area of 5,250 km^{2}and has a storage capacity of some 132 km^3. The Lake was created as a result of the construction of the Aswan High Dam across the waters of the Nile between 1958 and 1970, during the Gamal Abdul-Nasser's presidency, and hence it was called "Lake Nasser". Egypt has demanded an increase in its share of the Nile water from 66% to 90% (Mwakenya & Kalinda, 2016). In May 2011, Ethiopia announced that it will share the blue prints of the Dam with Egypt for examining the downstream impacts. Map of the Nile River along with the location of GERD is shown in Figure 2.

The site for the Dam was identified by the United States Bureau of Reclamation (USBR) between 1956 and 1964 while conducting the Blue Nile survey. Subsequently, the Government of Ethiopia carried out survey at the site in October 2009 and later in August 2010. The design of the Dam was submitted in November 2010. The project was made public on 31 March 2011. The contract for the project was awarded to Salini Costruttori (an Italian construction company) at the cost of US$ 4.8 billion. The finance for the Dam comes from the Government's bonds and private funds. The foundation of the project was laid on 2 April 2011 by the then Prime Minister (Mr. Meles Zenawi) of Ethiopia. The project is owned by the Ethiopian Electric Power Corporation (EEPCO). The planning phase of the project was carried out under the name called Project X, which was later changed to Millennium Dam and finally to the present name (Grand Renaissance Dam, or just Renaissance Dam).

Figure 1: Rendition of the Grand Ethiopian Renaissance Dam (GERD) (Source: Wikipedia)

(Source: Wikimedia Commons/Yale Environment 360)

Figure 2: Map showing the Nile River with its main branches, White and Blue Niles, and the site of the Dam (GERD).

III. Cost and Financing

The total estimated cost of the GERD project, with the characteristics given in Table 1, is US$ 4.8 Billion (as mentioned earlier). The Government of Ethiopia has indicated to self-manage all the costs of the project. For this purpose bonds were issued targeting Ethiopians both inside and abroad. Chinese banks funded the turbines and associated electrical equipment for the hydel power plants at the cost of US$ 1.8 Billion. The remaining US$ 3 Billion will be managed by the Ethiopian Government. The total cost which does not apparently include the cost of power transmission lines is less than 15% of Ethiopia's GDP (Gross Domestic Product), which was US$ 41.906 Billion in 2012.

Table 1: The main characteristics of GERD (Source: Wikipedia)

Type of Dam	Gravity, roller-compacted concrete
Impounds	Blue Nile River
Height	175 m
Length	1,800 m
Elevation at crest	645 m
Spillway Type	Controlled overflow
Spillway Capacity	15,000 m^3/s
Total Reservoir Capacity	79×10^9 m^3(79 BCM)
Turbines	16 x 375 MW Francis turbines
Saddle Dam Height	45 m
Saddle Dam Length	4,800 m

IV. Construction

The Italian company (Salini Costruttori)was awarded the project which has already worked on other projects such as the dams of Gilgel Gibe II, Gilgel Gibe III, and Tana Beles. It is estimated that the project will consume 10 Million metric tons of concrete to be produced locally. Diversion of the Blue Nile River was completed on 28 May 2013. Nearly 32% of the project was completed in April 2013 (Mariam, 2015). The contract for supply of low- and high-voltage cables for the Dam was awarded to the Italian firm - Tratos Cavi SPA - in March 2012 by Salini Costruttori. Alstom (a French multinational company) has providedthe eight 375 MW Francis turbines for the first phase of the project at a cost of €250 Million (approximately US$ 264 Million). Over 9,000 workers (including 400 foreigners) have been working on the construction of the Dam. An overview of the Dam on July 31, 2016 is shown in Figure 3.

Figure 3: Overview of GERD on July 31, 2016 (photo by AL-MONITOR/Ayah Aman)

V. Analysis and Interpretation

a) Benefits

The main benefit from the project is hydel power production which is 6,000 MW (6 GW). The electric power will not only be supplied to domestic consumers but will also be sold to neighboring countries, including Sudan and possibly Egypt. This will require construction of major electricity transmission lines to major consumption areas, such as the Ethiopian capital (Addis Ababa) and the Sudan's capital (Khartoum), both of which are located more than 400 km from the Dam's site. The GERD will improve the electric availability in Ethiopia by 200% with full utilization of the power (Tesfa, 2013). The benefits of the project is not limited with power supply, it can also benefit the downstream countries, mainly Sudan and Egypt, by removing silts and sedimentation, as a result of regulating the water flow (Yildiz et al., 2016).

b) Environmental and social impacts

The GERD is the biggest project in the history of Ethiopia. So far, the Government of Ethiopia has not produced any document about the environmental and social impacts of GERD. Thus, little is known about the impacts of the Dam. Impact of a Dam requires detail assessment of the site and its surroundings (Yihdego 2016a, Yihdego, 2016b). The major concern is that the project will alter the flow of the Blue Nile River which will affect the neighboring countries (Sudan and Egypt), which are located downstream and which rely heavily on the water from the River. The volume of the Dam's reservoir is almost 1.3 times that of the annual discharge of the Blue Nile. The Dam construction has begun without any mutual consultation between Ethiopia and downstream nations (Sudan and Egypt). Critics have asked Ethiopia for more transparency on the impacts of the project. Because of the little information available, the NGO International Rivers hired a local research to conduct a field survey of the Dam's site and adjoining area. A giant dam, such as GERD with a cost of approximately US$ 5 billion, really deserves an environmental and socio-economic impact assessment study with a cost of a few millions of US$. According to Swanson (2014), GERD will reduce sediment loads that travel downstream and interfere with the performance of dams in Sudan and Egypt. Also, silt accumulation in reservoirs and dams can reduce reservoir capacity, lead to power failures, and reduce hydropower output overall. For dams that also serve irrigation purposes, sediment buildup can block irrigation channels and reduce agricultural production. Dredging and maintenance costs to address these challenges can escalate quickly.

Previous studies highlighted some issues that require more attention, which resulted in the following findings:1) At least 5,110 people living downstream will be resettled. Villages located near the Dam (home to 7,380 people) will also be resettled. This estimate is higher than the official presentation of around 800 people to be resettled. Also, the project's planning did not involve participation of the affected people; 2) The high lands of Ethiopia are most sediment-prone and, thus, will pose a big risk for sedimentation of the reservoir and, consequently, will affect the Dam's power generation capacity and life span. Currently no watershed management practices are taken to deal with this problem. Climate change could increase the rates of sediments' flow to the reservoir and the rates of sedimentation; 3) The Benishangul-Gumuz region, where the Dam is located, is one of the few places in Ethiopia that has remnant forest vegetation. The Dam's reservoir will flood 1,680 km^2, which comprise 90% of the forest area. Construction of roads to the Dam's site will also impact the forests, which are a source of livelihood for the local community, and which represents an excellent variety of biodiversity; 4) Studies have indicated at least 150 species of fish in the Ethiopian portion of the Nile River which resulted in high consumption of fish by the local population, implyingthe Dam will impact the natural habitat and the fishery.

c) Impacts on Ethiopia

Ethiopians greatly value the project as it is considered as a sign of modernity, hope, reducing poverty, and of development (Abdelhady et al., 2015; Kahsay et al., 2015; Zhang et al., 2015). The Dam is self-funded by the Ethiopians and they are proud of it as a home-grown project. It has createdup to 12,000 jobs during the construction phase of the project. The Blue Nile River is highly seasonal, so the Dam will reduce flooding downstream. The Dam will be capable of handling a flood of 19,370 m^3/sec (The Brussel Times, 2015). This will help in reduction of damages from floods by protecting the settlements. But contrary to this, if flood recession agriculture is practiced then those fields could be deprived of water availability. The Dam could also be used asa bridge across the Blue Nile, this will complement a bridge upstream under construction in 2009 (Daily Ethiopia, 2009). According to an independent study field report (2013) conducted by a local researcher commissioned by International Rivers, at least 5,110 people will have to be relocated due the project. Another estimate is that 20,000 people are to be resettled (International Rivers, 2014). According to Jennifer (2013), the Ethiopian Government has a solid plan for resettlement of the affected people. The resettled people are happy in their newly built houses and are compensated more than what was expected. Except a few elderly people, all other locals are of the opinion that the Dam is a sign of hope and prosperity for them. The area around the Dam will comprise of a 5 km buffer zone for control of malaria. Similarly, some sediments' control measures have to be taken upstream of the Dam to reduce the flow of sediments into the reservoir. Ethiopia intends to become a regional power hub by damming the Nile. The regulated flow from the Dam will improve agriculture. The impact from evaporation of water from the Dam will be minimal compared to other dams in Ethiopia, which will help in water conservation.

d) Impact on Sudan and Egypt

The Blue Nile River is a source of around 85% of the Nile River water. The Blue Nile starts from the Lake Tana in the north of Ethiopia and then enters into Sudan to join the White Nile in Khartoum then they flow into Egypt as the Nile River. Both Sudan and Egypt have concerns about the construction of GERD, as they say it will affect their share of water use from the Nile River according to the colonial era agreement, which gave them 90% of water share from the Nile River. It is believed that the Dam has already created some geopolitical impacts among the three countries affected by the Dam, which are Ethiopia, Sudan, and Egypt (Conniff, 2017). The Egyptians, in particular, are not satisfied with the Dam project, because the Dam means to them considerable reduction of the amount of water flows to Egypt through the Nile River (Eckstein, 2010; Ashok, 2011; Salman, 2013; Tawfic, 2016; Wheeler et al., 2016; EZEGA, 2017). This means a huge amount of water will be captured and stored behind the Dam. So, the question is: Will the Dam be a trigger in the future for conflicts on water among the three countries (Ethiopia, Sudan, and Egypt)?

The Dam will cut down alluvium in Sudan by 100 MCM (million cubic meter) and also facilitate irrigation of about 500,000 ha of new agricultural lands. In 2016, the population of North Sudan reached more than 41 million and of South Sudan approximately 13 million (Worldometers, 2016). It will also reduce about 40 km of flooding in Sudan upon its completion. GERD will retain sediments which will increase the life of dams located in Sudan, such as the Roseires Dam, the Sennar

Dam, and the Merowe Dam, as well as the Aswan High Dam in Egypt. The reservoir is around 200m deep and is located in the high lands of Ethiopia which will cause a reduction in evaporation of water as compared to Aswan High Dam located on the Lake Nasser that loses 12% of its water due to evaporation.

The exact impact of the Dam (GERD) is not known, but Egypt claims that it will reduce a flow of water in the Nile River during the filling of the reservoir and due to evaporation from the Dam. Egypt, with a population of more than 94 million in 2016 and is forecasted to exceed 151 million in 2050 (Worldometers, 2016), being a dry country, is heavily dependent on the water of the Nile River. And the supply of water from the River could reduce between 11 and 19 billion m^3/yr (BCM/yr), which according to experts, would cause 2 million Egyptians to lose their income (Al Jazeera, 2013). This project will also interrupt Egypt's electricity supply by 25 to 40%, which would leave upper part of Egypt in darkness. The project could also lower permanently the water level in the Lake Nasser, if the flood waters are stored in Ethiopia. This would reduce the evaporation of 10 BCM/yr, but also reduce the ability of Aswan Dam to produce hydropower with a 100 MW loss of generating capacity for a 3 m decrease in the water level (Arab Today, 2015).

The Delta (particularly along the Mediterranean coast) is also subsiding (and becoming less fertile), because it is no longer replenished each year by 100 million tons of flood sediments from the Nile. Instead, those sediments now drop out where the Nile enters the reservoir created by the Aswan High Dam. Other studies have attributed increased seismic activity in the region due to the weight of the Dam and the huge amounts of water stored behind it. In addition to the loss of land area in the Delta, the combination of sea level rise and land subsidence will also increase saltwater intrusion. Egypt is already one of the poorest nations in the world in terms of water availability per capita; it has just 660 m^3 of freshwater a year for each resident. Saltwater intrusion from a one-meter rise in sea level could jeopardize more than a third of the freshwater volume in the Delta (Conniff, 2017).

e) What options are left for Egypt?

While Egypt, Ethiopia, and Sudan are awaiting two studies being conducted by French firms BRL and Artelia on the Dam's impacts, many experts predict that the Dam will operate and start its first filling process in 2017 regardless of the report's recommendations, amid Egyptian concerns about the Ethiopian side, and whether it will be diligent in trying not to harm Egypt's interests and water resources. Hani Sewilam, Managing Director of the UNESCO Chair on Hydrological Changes and Water Resources Management at Germany's RWTH Aachen University, said that *"it does not make sense that we assess the impacts of the Ethiopian Dam after its construction,"* referring to the three countries, especially Egypt, that are waiting for the French firm's reports (HornAffairs, 2016).

The reports, which are expected to take 11 months to complete, were started in February 2016. *"We have never heard of this in the history of engineering. Normally, the country intending to build a dam [Ethiopia] in consultation with downstream countries*[Egypt and Sudan] *carry out all the studies, design scenarios, assess the impacts (economic, social, and environmental) and then select the design scenario with the minimum negative impacts and maximum positive impacts,"* (HornAffairs, 2016). Sewilam said, *"In our current case, by the time the two firms complete the impact studies, the construction process of the dam will be done. What will we [Egypt] do if the studies show significant impacts on the downstream countries? Will we demolish the Dam* [GERD]*? Will we be able to modify the body of an existing Dam* [GERD]*? Or are they* [Ethiopia] *just consuming time because they know that the answer for all these questions is a big NO?"* (HornAffairs, 2016). From a legal perspective, Ayman Salama, Professor of International Law and member of the Egyptian Council for Foreign Affairs (ECFA), articulates that Egypt does not have the right to ask Ethiopia to stop the building process under any conditions (HornAffairs, 2016). Sherine El-Baradei, Assistant Professor in the Department of Construction and Architectural Engineering at the American University in Cairo, said that both Egypt and Ethiopia can try to settle on two main things: the operational process of the Dam and the number of years dedicated to filling it. *"We can make an agreement that when it's the agricultural season for Egypt's peasants, Ethiopia can't close the Dam's gate to generate electricity since we will be in need of the water flow for the inauguration process, especially that 85% of the Nile water that goes towards agriculture and the remaining 15 percent for drinking,"* (HornAffairs, 2016). El-Baradei went on to say that Egypt needs to persuade Ethiopia to increase the years of filling the Dam, which is set to be from 5-7 years. She said that a set period will reduce Egypt's share of water from 12 to 25% while adding more years will minimize the detrimental effects of the Dam. Sewilam (HornAffairs, 2016; King & Block, 2014) listed some facts that Egypt must consider while negotiating with Ethiopia, such as connecting the construction time-plan with the impact assessment time-plan, as the *"construction should go hand-in-hand with the negotiations and assessment, not 10 times faster as is the case right now."* This is in addition to reducing the storage capacity of the Dam, *"because Ethiopia does not need to store 74 BCM (Billion Cubic Meter), which is equivalent to the annual share of the Nile water of Egypt and Sudan combined."* But for Nader Nour El-Din, Professor of Water Resources at Cairo University,

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Egypt's stance on the Renaissance Dam issue is *"backwards and critical"* (HornAffairs, 2016). *"We are still in the status of negotiating with Ethiopia and the latter started the building process in April 2011, and in March 2015 we signed a Deceleration of Principles which was a carte blanche for Addis Ababa to go build the Dam with its current measurements and storage capacity"* (HornAffairs, 2016). *"In July 2017, Ethiopia will start the first process of generating electricity and by October 2017 the Dam is expected to operate in its full capacity and options and this means that a very large amount of water will be retained behind the Dam"* (HornAffairs, 2016). Nour El-Din argues that Egypt should negotiate with the Ethiopians on reducing the height of the project's smaller side Dam (or Saddle dam), which is currently set at 45m high, and try to reduce it to between 20 ~~to~~and 22m, as the current height would allow the Dam to hold 60 BCM of water. The main Dam, although 145m high, will only retain 14 BCM of water, as it is surrounded by 16 electricity generating turbines. According to HornAffairs(2016), Prime Minster of Egypt Sherif Ismail said that the other regulations and policies Egypt is willing to implement as alternatives to Nile waterare treating sewage water, which can provide 4 BCM, and using new irrigation methods to save water. The Government will resort to linking some canals, providing between 1 and 1.5 BCM of water. Egypt is coordinating with other African countries on a regional project aiming to link the Victoria Lake with the Mediterranean Sea, helping to divert more water to the Nile River. Sewilam asserted that some Egyptian researchers are currently working in different concentrations, such as water treatment, water recycling, increased irrigation efficiency, and desalination. El-Baradei also said (HornAffairs, 2016) that the Government of Egypt needs to consider using groundwater wells as a water resource, but only after treating the saltwater. Sewilam, however, believes that the solution ultimately lies in greater cooperation between the Nile Basin's countries to secure water and other natural resources (HornAffairs, 2016). *"There should be an integrated Water-Energy-Food Nexus plan for all the Nile Basin countries. We should be thinking of self-sufficiency of resources by complementing each other, as for example, we need to identify the countries in the Basin which can generate energy and other countries which can supply water and also the countries that can make use of water and energy to produce enough food for the whole basin"* (HornAffairs, 2016). *"I think the lack of trust, cooperation, and participatory long-term planning between all the Nile Basin's countries are the main reasons for the current situation"* (HornAffairs, 2016). *"The main Dam is allocated for generating electricity while the side Dam is just for water reserves and it won't affect the power generation process of Ethiopia if the amount of the reserved water is reduced"* (HornAffairs, 2016). The GERD's both main and saddle dams are shown in Figure 4.

Figure 4: Main Dam and Saddle Dam of GERD (Source: Hydro World, 2016)

Egypt is exploring ways it might make up the shortfall in its water needs if the US$ 4.8 billion Renaissance Dam is completed. A recent study, conducted by Gamal Al-Qalyoubi, Professor of

Petroleum and Energy at the American University in Cairo (AUC), on connecting the Nile and Congo water systems, suggests one possible way of ensuring water security (Al-Ahram, 2014). The River Congo pours more than 1,000 BCM (one trillion cubic meter) of water each year into the Atlantic. *"Water could be diverted by digging a 600-km canal from the White Nile in southern Sudan to northern Sudan and then to the Lake Nasser,"* said Al-Qalyoubi. The canal, he said, could provide Egypt with an additional 95 BCM annually, almost double its current share (55.5 BCM) of the Nile water. *"Digging the canal would take two years and the entire project, including four pumping stations to transport water from the Congo Basin to the Nile Basin, as well as infrastructure works needed to move the water, would cost US$ 8 billion"* (Al-Ahram, 2014). For such a huge project to succeed, says water expert Diaa Al-Qousy, it must garner international support and guarantees that the hugely expensive infrastructure can be properly secured. *"Both Egypt and Congo should start pushing the project as Egypt's only way out from the current crisis with Ethiopia. They must also begin the process of attracting the necessary funding,"* says Diaa Al-Qousy (Al-Ahram, 2014). Former Minister of Irrigation and Water Resources Nasreddin Allam questions the viability of the canal. The swamps of southern Sudan, he argues, present a major obstacle to digging. He also questions the political costs of the project. *"International treaties prohibit the transfer of river waters outside their basins. Egypt cannot risk violating this international principle, not to mention the very high cost of such a project,"* he warns. *"The Congo and White Nile flow at different altitudes and linking them would require the construction of a huge dam as well as the digging of canals."* He continues, *"Even if the Government did overcome all the technical and financial obstacles to the project, Egypt would still be in danger of violating international rules,"* says Allam. He continues, *"The Congo's tributaries flow through Cameroon, Guinea, and the Central African Republic, each of which could file a lawsuit in front of the International Court of Justice which they are certain to win. Egypt then will be the only loser."*(Al-Ahram, 2014). Diaa Al-Qousi is unconvinced by Allam's arguments. He insists there is no legal impediment to linking the two rivers (Congo and White Nile). Water experts have reviewed more than 300 river agreements and none of them contain legal deterrents to the project, he says (Al-Ahram, 2014). Cameroon, Guinea, and the Central African Republic could easily be convinced of the mutual benefits that will accrue from the project, says Al-Qalyoubi. And money, he adds, could be forthcoming from oil-rich Arab countries (Al-Ahram, 2014). Congo will welcome the project which will alleviate the flooding of agricultural lands, and such approval will be instrumental in winning the support of the international community and donor nations. *"The River Congo lies on the Equator and is fed by massive rainfalls. The project has any number of benefits for Congo, including the generation of cheap electricity,"* says Al-Qalyoubi (Al-Ahram, 2014). According to a study conducted by the Mineral Resources Authority (Al-Ahram, 2014), linking the White Nile with the Congo River includes three different alternatives that would determine the path of the water. The length of the first proposed canal would be 424 km with a water-level altitude differential of 1,500 m, which would be impossible to implement. The second alternative is to have the canal length 940 km, with an altitude differential of 400 m. Meanwhile, the third alternative would carry the water a distance of 600 km with an altitude differential of 200 m. According to Al-Qousi, the last alternative has the best chances of being implemented, through the use of four consecutive water-pumping stations. *"The project would be capable of generating 300 trillion watts of electricity per hour, enough to satisfy all of Africa's electricity needs,"* claims Diaa Al-Qousi (Al-Ahram, 2014). And according to the feasibility study undertaken by the Mineral Resources Authority (Al-Ahram, 2014), the project will necessitate the construction of a road and rail network that could form the core of a trans-continental transport system, thus promoting trade between Egypt and the rest of Africa.

Reactions: Cooperation and Condemnation

In order to address its concerns over the project, Egypt has requested the Government of Ethiopia for inspection of the project design and other studies related to it. However, the Ethiopian Government has denied the request. After a joint meeting in March 2012 between the ministers for water of Ethiopia, Sudan, and Egypt, the President of Sudan – Omar Bashir - announced that he supported the construction of the Dam (Sudan Tribune, 2012). A Nile treaty was signed by the countries located on the upstream in 2010, however the cooperative network agreement, has not been signed by Sudan and Egypt. They claim that it violates the 1959 treaty which gives Sudan and Egypt exclusive rights to the water of the Nile (Voice of America, 2011). The Nile Basin Initiative (NBI) which was launched in February 2009 serves as a collaboration between the Nile riparian countries that *"seeks to develop the River in a cooperative manner, share substantial socioeconomic benefits, and promote regional peace and security."* To review the study reports of the Dam, an international panel of experts has been established by Ethiopia, Sudan, and Egypt. There are 10 members of the panel with 6 members (2 from each country) and 4 international members expert in the fields of water resources and hydrological modeling, dam engineering, socioeconomics, and the environment. The panel also called tripartite committee, held its fourth meeting in November 2012 in the Ethiopian capital Addis Ababa. The panel visited the Dam's site and reviewed documents related to environmental impacts of the

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Dam(Sudan Tribune, 2012). The preliminary report was submitted to the respective governments in May 2013. Full report has not been made public till reviewed by respective governments. Egypt and Ethiopia have made the details of the report public. According to the Ethiopian Government, *"the design of the Dam follows the international standards and principles"* (HornAffairs, 2013), however, it did not mention them. It also stated that *"the Dam offers high benefits for all the three countries and would not cause significant harm on both the lower riparian countries".* According to the Egyptian Government, the report *"recommended changing and amending the dimensions and size of the Dam"* (HornAffairs, 2013). The political leaders in Egypt in a meeting with former President - Muhammad Morsi - on June 3, 2016 suggested different methods for destruction of the Dam including support for the anti-government rebels (Business Insider, 2012). The meeting was televised live without the knowledge of the participants of the meeting. In response Ethiopia called the Ambassador of Egypt to explain the meeting. The Spokesman of the Egyptian President apologized for the *"unintended embarrassment"* and the cabinet released a statement promoting *"good neighborliness, mutual respect, and pursuit of joint interests without either party harming the other"* (Yalibnan, 2013). The Spokesman for the Ethiopian Government said that Egypt is day dreaming and have tried to destabilize Ethiopia in the past (Yalibnan, 2013). Former President of Egypt – Mohammed Morsi - stressed on engaging Ethiopia rather than forcing them on the issue by issuing a statement on June 10, 2013 that all the options are open implying that he is not calling for a war but Egypt's water security cannot be violated at all (BBC NEWS, 2013). Egypt left negotiations for the Dam in January 2014, accusing Ethiopia of intransigence. The military backed administration in Egypt began to gather international support against the Dam. The campaign aimed to persuade the international community that the construction of the Dam will further destabilize the region, citing that more negotiations with Ethiopia is a waste of time and it directly threatens the Egypt's water security (UPI, 2014). However, the Ethiopian President in February 2014 said that Addis Ababa will not back down on the $4.8 billion GERD, which will be the largest in Africa (Waltainfo, 2014). Egypt also tried to *"target all countries that provide technical assistance for designing and building GERD through private contractors and also the states that likely to fund the construction of the Dam"* (Daily News Egypt, 2014). On February 06, 2014, the Egyptian Minister of Water Resources and Irrigation visited Italy, considered to be Ethiopia's main technical supporter in building the Dam. Egypt sent its Foreign Minister to Tanzania and Democratic Republic of Congo to seek support against the project. The Ethiopians consider the Dam and the other dams they plan to build as a symbol of national pride, as they will produce electricity that will transform the economic prospects not only for their country but also for much of seriously under-developed East Africa as it stands on the cusp of a major oil and gas boom. Egypt, with its 94 million people totally dependent on the Nile River for water, cites the British agreements in 1929 and 1959 that guarantee it the lion's share of the water and a veto over upstream dam construction (Al Jazeera America, 2014). But Ethiopia, along with Tanzania, Rwanda, Kenya, and five other African states with growing populations and mounting demands on agriculture, dismiss these accords as colonial relics. In April 2014, Ethiopia invited Sudan and Egypt for another round of talks over the Dam and the Foreign Minister of Egypt said in May 2014 that Egypt is still open for negotiations. Following an August 2014 Tripartite Ministerial-level meeting, the three nations agreed to set up a Tripartite National Committee (TNC) meeting over the Dam. The first TNC meeting occurred from 20 to 22 September 2014 in Ethiopia (allAfrica, 2014). Experts estimated that already water-starved Egypt could lose as much as 20% of its water in the 3-5 years that it would take to fill the Dam's massive reservoir. It is reported that Ethiopia has asked Egypt to be 50% shareholder in the Dam. The Ethiopian Prime Minister - Hailemariam Desalegn - has already declared in October 2013 that his Government considered the project to be "jointly owned" with Sudan and Egypt (EthioFreedom, 2013). It was the hope of the late Ethiopian former Prime Minister Meles Zenawi that they would finance half of the US$ 4.8 billion construction of the Dam to ensure cheap future electricity. The project is not eligible for funding from the World Bank or other financial concession, due to the fact that multilateral lenders cannot provide support for transnational projects which are unilaterally initiated by one country. Ethiopia has called the project as national sovereignty and has denied the right of any other country in its plans. Lenders are also reluctant because so far no agreement has been signed with neighboring countries for purchase of electricity generated at the Dam. Such agreements are considered essential in the Dam's planning (EthioFreedom, 2013).

Flow is the crucial issue. A draft study which three Oxford Brookes University academics, Emanuele Ferrari, Professor Scott McDonald and Rehab Osman, presented in June 2013 at the 16th Annual Conference on Global Economic Analysis in Shanghai, China, said that the GERD's reservoir capacity is roughly equivalent to the whole annual flow of the Nile River at the Sudanese-Egyptian border (i.e. 65.5 BCM)(Ethio-Freedom, 2013). If all flow at that point were stopped, it would take a year to fill the reservoir. Possibly the most crucial and controversial factor is how long the reservoir would take to fill: if the time is short, shortages are suffered downstream. If it is too long, Ethiopia may not make a return to its power generation. *"This loss to the downstream countries' water share would take place* *only over the reservoir's filling period,"* the Oxford Brookes paper states (EthioFreedom, 2013). However, the loss might continue to induce noticeable long-term effects on the downstream countries. Evaporative losses from the Dam's reservoir would permanently reduce the flow of the Blue Nile. The magnitude of these losses is not accurately estimated yet.

An Assistant Professor at the University of Wisconsin, Paul Block, author of a paper on filling the reservoir (EthioFreedom, 2013), says no filling rate has been established. *"It becomes very important from a hydropower generation, economics and livelihood perspective, clearly for Ethiopia but also for Sudan and Egypt,"* he said. If Egypt, Sudan, and Ethiopia decide to fill the reservoir slowly, abstracting *"say 5% of the monthly flow, to minimize downstream effects,"* he says, *"our analysis shows that the reservoir would actually never fill due to evaporation. Hydropower could be generated but never at design capacity."* If Ethiopia were to impound water at a much higher rate, say 25% of the monthly flow, *"certainly the reservoir would fill and they would be generating hydropower at a much sooner time,"* says Block (EthioFreedom, 2013). That, however, would mean lower flows reaching Sudan and Egypt.

Ethiopia wants to earn valuable foreign exchange by exporting electricity all over the region but it could also be used for domestic consumption and would boost the economy. Filling the reservoir fast could be bad for the country, even if it meant generating power sooner. In an earlier research paper, Block (EthioFreedom, 2013) had noted the importance of securing energy contracts before extensive generation. *"Ethiopia may not be ready to immediately absorb all of this new electricity and if they begin generating but don't have a buyer for a few years, this could be financially devastating,"* he says. Energy trade contracts secured prior to the Dam's generation stage, if any, are not publicly available.

Other academicians do not see evaporation as a problem. "It is completely out of the question that the GERD reservoir will not fill due to evaporation. The Dam will fill during a few years," Professor Ånund Killingtveit of the Norwegian University of Science and Technology said (EthioFreedom, 2013). *"The design of GERD seems to be based on good hydrological data and there can be no doubt about the long-term viability of this project."* Killingtveit acknowledges, however, that the devil is in the detail of how long it takes to fill the reservoir. *"There will have to be some reduced flow in the Nile downstream from GERD during the first years after GERD is completed,"* he said, estimating that if filling took 6 years, about 12% less water would reach the Aswan Dam of Egypt over that period of time, meaning less power-generation and less water for irrigation for Egyptians. Yet Killingtveit thinks it is a price well-worth paying because there would be, *"significant long-term benefits for Sudan and Egypt, since the flow in the Blue Nile now will be much more evenly distributed during the year, with reduced floods during the wet season and much higher flow during the dry season from November to June."*(EthioFreedom, 2013). This demonstrates how intensely political the reservoir is, since Egypt will want the minimum disruption to the Aswan Dam.

The Spokesman for Egypt's Ministry of Irrigation and Water Resources, Khaled M. Wassif, appears to agree with Killingtveit. *"We want the end result of the Dam to be achieved but without the side effects,"* he says, noting Egypt's ultimate concern, reductions in flow. *"Farmers sometimes come to us in our headquarters in the Ministry with a dead plant, as a symbol, a proof that a lack of water caused damage to them,"* Wassif said (EthioFreedom, 2013). Water is an extremely emotive issue and any impression of upstream countries *"stealing Egypt's water"* could cause popular unrest and create problems with Ethiopia. Wassif is conciliatory, *"We are not greedy,"* he says. *"We do not want development for just Egypt. We can achieve development in both countries."* (EthioFreedom, 2013).

Sudan's position is different from Egypt's. It has strong concerns about the safety of the Dam because, *"They know if the Dam fails, it will destroy all the cities and villages on the Blue Nile past Khartoum,"* according to Salman Mohamed Ahmed Salman, a Sudanese water lawyer who until December 2009 was lead counsel with the Legal Vice-Presidency of the World Bank and the Bank's Advisor on Water Law (EthioFreedom, 2013). *"They are less concerned about the decrease in the flow of the Nile waters as Sudan uses only 12 BCM of its share of 18.5 BCM under the 1959* [Nile Waters] *treaty with Egypt."* (EthioFreedom, 2013).

The Ethiopian Government estimated the cost of the Dam at US$ 4.8 billion, equivalent to about 11.12% Ethiopia's 2012 economic output ($43.13 billion in 2012, according to World Bank's data).Some engineers believe the 6,000 MWgenerating plant is too big and others doubt the provisional cost estimate. Mamdouh Hamza, a leading Egyptian dam engineer, says his rough calculations put the cost *"in excess of US$ 7 billion"* or 16.2% of Ethiopia's GDP (EthioFreedom, 2013). Without advance electricity agreements, Hamza says the economic viability of the Dam is in question.

In April, 2013 Ethiopia's Deputy Prime Minister of Economy and Finance - Debretsion Gebremichael - told the press that China Electric Power Equipment and Technology has plans to finance a US$1 billion (EthioFreedom, 2013). A 619-km transmission line that will bring electricity from GERD to the Ethiopian capital; and that funding would come primarily from the Export-Import Bank of China. Plans for a national distribution grid have lagged behind the plans for generation and could prove to require a national effort almost as monumental as building the Dam itself.

Kefyalew Mekonen, who studied in the School of Natural and Rural Systems Management at the university of Queensland came up with better ways to harness the flow of the Nile River (UQ News 2005). His Thesis is titled, *"The economics of developing water resource projects in the Ethiopian Nile River Basin, their socio-economic, political, environmental and transboundary implications"*. The Thesis investigates the economics of building small water storages in the upper Nile Basin – the world's longest river which flows from Ethiopia through Sudan and Egypt. Mekonnen said drip irrigation could save up to 48% of the water potentially used to irrigate small areas of cereals, vegetables, and traditional crops on a typical Ethiopian farm, and thus would improve farm productivity, earnings, and family livelihoods. A fairer distribution and use of water in the Nile River Basin could lessen the risk of regional conflict over water resources. The majority of the Nileoriginates in Ethiopia but more than 97% of its annual flow of 84 BCM, is used by downstream countries such as Sudan and Egypt. *"Water resources of the Nile River Basin are not only scarce but also shared among several countries and have the potential to become a major source of conflict.""Egypt is even demanding additional water and there is no unallocated Nile water available to Ethiopia"*. His Thesis detailed the likely costs of building dams, weirs and irrigation, calculated water consumption per crop and analyzed new ways of water harvesting, storage, and delivery to fields. He said new technology, innovative uses of water, distribution and production systems, funding, research, and water trading systems could make better use of the Nile waters, but education and awareness were also important (UQ News, 2005).

Many people are ignorant of the power of the "common pool" approach to resources management sustainability. But there is an emerging acceptance that a common pool resource is an emerging acceptance that a common pool resource is one that is jointly managed with co-owners who act in the best interest of the resources and everyone who uses it. Such common pool resources management is viewed as an effective way to ensure equitable use of shared water resources. The fact demonstrates that the common pool system of resources management is a viable alternative to the strictly 'legal' approaches characterized by the transboundary international law professional or through market-based or state based resources management systems. The Rowland-Ostrom Framework for common pool resources management provides a two-step solution to resource management problems, including transboundary disputes as the case of the Nile River. The first step is identifying the crises that endanger the resource and users of the resources. Crises may include drought, aging or damaged infrastructure, under capacity infrastructure, or over-pumping of water resources. Other crises may involve salt water intrusion, which is typical to the case of the Delta region. The onset of the water resources is detected through the monitoring of critical resources' characteristics, such as dam water level, water table levels, water pressure, salinity, and system efficiency (watermetered for use vs water produced). The most critical and difficult part for people who share a common pool water resources to agree that a crisis situation exists. Self-interest is a mighty counterforce. Relevant lessons can be drawn from the Turkey-Syria relationship on the Euphrates River issues. However, the existence of many long-standing, effective common pool resources' arrangement demonstrates that it is possible to overcome these obstacles. The second step in the Rowland-Ostrom Framework involves transitioning from whatever type of water management system a region is using to a common pool system that follows Ostrom's eight principles. This is a difficult task that requires sacrifice by the users. The means for preventing and resolving transboundary disputes prevails once a common pool resources' management system is in place (Hilhorst 2016; Rowland, 2005).

f) Assumed Oversizing of the Grand Ethiopian Renaissance Dam

The peak flow rate of the Blue Nile River is 5,663 m^3/sec. Data from *Water Balance Assessment of the Roseires Reservoir in South Sudan* (Khartoum, Sudan; Ministry of Irrigation and Water Resources, Sudan) gave a flow rate of the same range: 6,944 m^3/sec in 1985; 5,208 m^3/sec in 1995; and 5,787 m^3/sec in 2005 (Beyene, 2013). The numbers for the Roseires Dam in South Sudan are more reliable since the Dam is close to the Ethiopian-Sudanese borders. The Dam is reported to have 145 mheight. The flow rate and the Dam height fix the maximum possible theoretical power output from the Dam at about 7,250 MW, assuming some 90% efficiency for the Francis turbine. The annual peak flow rate varies, but the above average value 5,663 m^3/sec can be assumed for further analysis. If the Dam were designed to use this peak flow, most of the turbines of the 7,250 MW have to idle when the flow rate drops below 5,663 m^3/sec, and there would be no storage required if not for the required head (elevation). In fact, even after years of initial storage time, the reservoir cannot possibly produce the peak flow rate for extended period of time. The average flow rate of the Blue Nile River is reported to be about 2,350 m^3/sec. This average for the same height of the Dam would provide about 3,000 MW power output. Reverse calculation yields 4,700 m^3/sec flow rate (Figure 5), for the proposed design of 6,000 MW, which is way above the annual average of 2,350m^3/sec. In fact, the 16 turbines with 350 MW each can only produce a total of 5,600 MW, not 6,000 MW. This corrects the design flow rate to

4,400 m^3/sec, not 4,700 m^3/sec. There are many possible input and design scenarios, which we simplydo not know. One thing is true however. Given the height of the Dam and the flow rate, there is no way the Dam can operate at the level of 5,600 MW output throughout the yeareven if the Dam stores the difference between peak-flow and design-flow rates. If we assume the design engineers factored in two turbines, – 700 MW down time (allowing equivalent water for bypass or storage) for a more realistic 4,900 MW output, the flow rate has to be about 3,800 m^3/sec, which still remains way above the average flow rate (see Figure 5) implying, the peak covers few months to fill the reservoir in the summer when the discharge drops significantly.

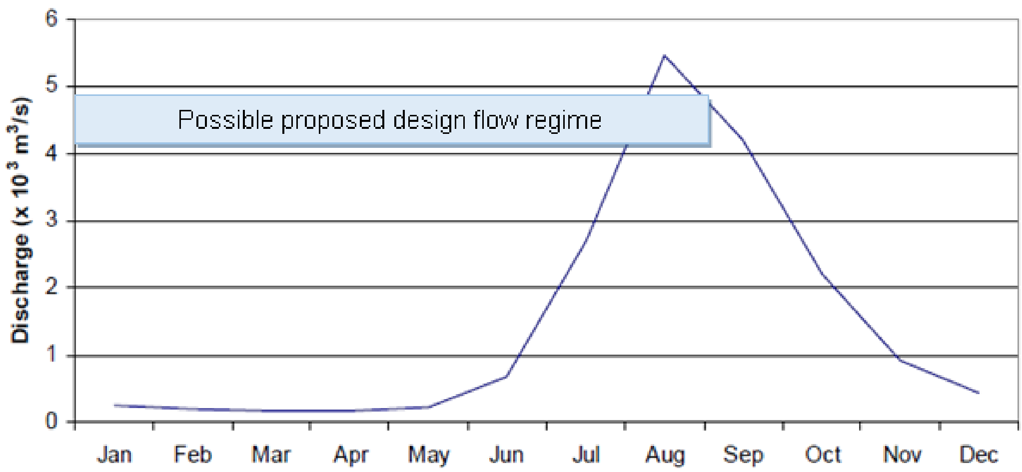

Figure 5: Upper Blue Nile River observed monthly flow based on 1966-2001 *(Source: Nawaz et al., 2010)*

Allowing the average flow rate of 2,830 m^3/sec to pass to downstream countries during peak months will fill the reservoir in about 5 years, but the refill per annum will be too small to sustain annual operation even close to 4,800 MW. The only scenario under which the power supply will be consistent, and the refill can be sustained for summer at about the same power output level is if the hydroelectric dam is designed for a mean flow, which is about 1,456 m^3/sec. This will provide just less than 2,100 MW (say, 7 turbines with 350 MW each). Assuming 700 MW (two turbines for maintenance downtime), the appropriate design target would be 2,800 MW, still larger than the 2,100 MW at the Aswan High Dam – to please those who like to compete. This assures year-round supply of electricity at almost constant level, also requiring a shorter period for initial refill. Such consistency offers high rate on investment. The total price at US$ 800/kW rate will be about US$ 2.3 billion– much less than the $ 4.8 billion for the 6,000 MW (Beyene, 2013). More importantly, Egypt may be happy, making it easy to borrow money for the project.

Of course, the input values are not known and flow rates also vary from year to year, rendering the calculations here a bit tentative. Regardless, there is little doubt that the system is designed for near-peak flow rate. The question then is, – should one design a system for near-peak flow, i.e., near the theoretical maximum power generation, or for the mean flow rate? This is a common topic in system design, and the question arises whenever input resources or supply demands vary. Hydroelectric dams are best designed to provide maximum kilowatt hour (not kW), which means we target mean flow values. This decision is fairly trivial for the Blue Nile River that has very low flow rate during the dry season. Targeting near peak or peak flow rate makes no economic sense. The remaining question is then, why is it sized for 6,000 MW?

Asfaw Beyene, Professor of Mechanical Engineering and Director of the Center for Renewable Energy and Energy Efficiency at San Diego State University stated that GERD is being oversized (International Rivers, 2013). According to him the consequences of the oversized Dam means that more than half of the turbines will be rarely used. The height of the Dam and flow rate fix the potential of the power generation. The GERD's available power output, based on the mean flow rate (the average of the River's flow throughout the year) and the Dam's height (145 m), is about 2,000 MW. There is little doubt that the system has been designed for near-peak flow rate, but that high flow only happens during the 2-3 months of the rainy season. The planned 17 turbines are in excess of what can be produced given the Dam's height and the River's flow rate. Targeting near peak or peak flow rate makes no economic sense. Engineers use a calculation called "plant load factor" to describe the ratio of a power plant's actual output over a period of time, to its potential output if it were possible for it to operate at full capacity indefinitely. In the case of GERD, the load factor for the Dam designed to produce 6,000 MW would be about 30%. If it were "right-sized" to 2,000 MW, its load factor would be about 90%. The Dam is sized for the peak flow rate of the River, which lasts just a few months. The peak flow rate of the Blue Nile River is under 6,000 m^3/sec, even exceeding 6,500 m^3/sec once in a while. With 145 m of the Dam's height, this peak flow can produce about 7,000 MW. The average flow rate of the Blue Nile River is reported to be much lower. So, given the height of the Dam and the flow rate, there is no way the Dam can produce 6,000 MW for more than 3 months of the year even if the Dam would store the difference between peak-flow and design-flow rates. The only scenario under which the power output will be annually consistent is if the hydroelectric dam is designed for a mean flow, which is about 1,456 m^3/sec. This will provide just less than 2,100 MW. The extra 10 or so turbines will be parked for about 9 months of the year. The size calls for about 7 turbines with 350 MW each. Even if we add one extra turbine for maintenance downtime, the appropriate design target should not exceed 2,800 MW. What does this mean in human terms? According to the World Bank, Ethiopians use on average about 200 kWh of electricity per capita per year. A per capita comparison is, however, less than useful because it shifts with population growth. A better comparison is kilowatt-hours used per household per year, which is about 500 kWh for Sub-Saharan Africa. (For comparison's sake, the global baseline is around 13,000 kWh/year, and the average US household uses 18,000 kWh per year, including natural gas and electric.) If we assume 500 kWh/year per household, the 4,000 MW of "missing power" could have covered more than 70 million households (not including the cost of transmission lines). If we take a South African household average of 5,000 kWh/year, it could affect over7 million households. It has been suggested that the concerned authorities of the project should make the matter transparent, rethink the number of turbines that are to be installed, and resize the hydroelectric power output by reducing the number of turbines (International Rivers, 2013).

VI. Conclusion

In this paper the Authors have tried to explore the different impacts and dimensions of the Grand Ethiopian Renaissance Dam (GERD). This Dam, with a total estimated cost of around US$ 5 billion, is considered by the Ethiopians as a symbol of modernity, development, hope and reducing poverty. The Dam, which is the largest hydropower project in Africa, generating 6,000 MW electricity, will not only meet the country demands but will also be exported to the neighboring countries. For Ethiopians, the Dam is empowering regardless of any ethnicity of political affiliation. It will empower Ethiopia's plan to become middle income country and become carbon emission free by 2025. Entirely financed by the Ethiopian Government, the Dam is said to be source of pride for Ethiopians. According to the Ethiopian Government, the project will equally benefit the downstream countries. The Dam has already affected the dynamics of the region and is a source of controversies between Ethiopia, Sudan, and Egypt. The three countries have so far failed to agree on how to manage the water of the Nile River. Egypt is worried that what impact the Dam will have on its water supplies. On March 23, 2015, the three countries signed an agreement on Declaration of Principles on GERD in Khartoum, Sudan, as a sign of future cooperation. The study's commission by the three governments has not been released yet, and the real scale of the environmental impact is unclear. What certain is that a successful GERD will play an important role in empowering development and will contribute to the future of Ethiopia. Nevertheless, regardless of the importance of GERD to Ethiopia, in particular, the issues of such a Dam should be negotiated and agreed upon, in advance, among the three riparian countries of the Nile River (Ethiopia, Sudan, and Egypt), which will be affected, negatively or positively, by such a mega project, in order to avoid any future conflicts. So, geopolitical agreements, based on strategic plans, should be reached among Ethiopia, Sudan, and Egypt. In addition, environmental, socioeconomic, cultural, legal, etc. impact assessment's studies should be carried out before the beginning of the construction of the Dam, which (studies) unfortunately were not conducted. The filling rate of the reservoir, considered as major point of dispute, has not been established yet. Abebe (2014) argued that the traditional doctrinal approach, one based solely on an examination of international water law, treaties, and customary international law is unlikely to result in a legal conclusion that either state (Egypt and Ethiopia) is likely to respect, because such an approach fails to consider the incentives, material capabilities, and national interests of both countries. Transboundary water conflicts are frequently considered to be international issues resulting from human modifications in the way water moves across the international boundaries. However transboundary problems are more complex than this, and they arise when a decision affecting a resource in one place has an impact on someone in another place. The goal of any water rights system is to achieve equity, efficiency, and certainty. Critical element in any system of water right must define how the water can be used and define relationships that each use has with the other users and uses in the system. Resolution of the Nile River transboundary disputes via Rowland-Ostrom framework for common pool resources arrangement could be among the viable solutions the way transboundary water conflicts are prevented and resolved. The best solution is to answer and see if conflicts can be prevented. The key to preventation is understanding and defining the relationships that exist within the water rights system for the equitable use of shared water resources, including on other common transboundary resources (forest, oil/gas and minerals). Revising a water rights system is never easy, but if transboundary conflicts are to be prevented, this is the starting point. Egypt in any case has little ground for negotiating a favorable deal. It has always asserted its right to the lion's share of the Nile River waters, formalizing that claim in the 1959-Nile Waters Agreements, with little regard to the needs of upstream countries. Hosni Mubarak compounded that slight during his long reign as Egypt's President, taking other Nile Basin's countries for granted and effectively withdrawing from the rest of Africa (Conniff, 2017).

It has been suggested that, the key factor to reconcile the contrasting concept of 'nationalism' and 'regional hydrosolidarity" is to expand traditional integrated water resources management to better include the cultural, social and political complexity of the GERD (Abdelhady et al., 2015).According to Conniff (2017), as Egypt slept, a competent government in Ethiopia has rebuilt its economy, deftly worked with both U.S. and Chinese interests, and launched a hydropolitical offensive to re-order the region, not just in political or theoretical terms, but on the ground, by asserting control over the Nile waters that are the region's lifeblood. The only international agreement that directly addressed transboundary water resources was between France and Switzerland, whereby both countries set aside international law in favor of a simple agreement on a schedule of water extraction and artificial recharge for aquifer management. The case highlights a glaring omission in current international law. International legal principles cover surface water but do not address important specific conditions applicable to groundwater, an important resource depended upon by half of the world's population (Rowland, 2005).In line with this,Egypt needs to invest in desalinization for fresh water, water-saving drip irrigation, and come up with an Aquifer Storage Recovery (ASR) scheme, artificial recharge and scheduled water extraction, in order to minimize the compounded effects of the Grand Ethiopian Renaissance Dam (GERD) and saline sea water intrusion along the Mediterranean coast. With Egypt now also facing a "contraceptive crisis," better government investment in family planning would also help for the longer term. But with the Nile no longer their birthright, and the Nile Delta gradually disappearing into the Mediterranean Sea, millions of Egypt's people will obviously need to look elsewhere for a promising future. Perhaps, a way out from the current crisis with Ethiopia, due to the construction of GERD, could be connecting Nile and Congo water system, through diverting water consideredto be as an alternative way of ensuring Egypt's water security, despite its inevitable engineering challenges being the Congo River and the White Nile River flow at different altitudes, and,thus, linking them would require construction of massive infrastructures (by digging a 600-km canal together with pumping stations and construction of huge dams) to transport water from the Congo Basin to the Nile Basin.

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Progress in Green Energies, Sustainable Development and the Environment

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Abstract- Globally, Buildings Are Responsible For Approximately 40% Of The Total World Annual Energy Consumption. Most Of This Energy Is For The Provision Of Lighting, Heating, Cooling, And Air Conditioning. Increasing Awareness Of The Environmental Impact Of Co2, Nox And Cfcs Emissions Triggered A Renewed Interest In Environmentally Friendly Cooling, And Heating Technologies. Under The 1997 Montreal Protocol, Governments Agreed To Phase Out Chemicals Used As Refrigerants That Have The Potential To Destroy Stratospheric Ozone. It Was Therefore Considered Desirable To Reduce Energy Consumption And Decrease The Rate Of Depletion Of World Energy Reserves And Pollution Of The Environment. This Article Discusses A Comprehensive Review Of Energy Sources, Environment And Sustainable Development. This Includes All The Renewable Energy Technologies, Energy Efficiency Systems, Energy Conservation Scenarios, Energy Savings And Other Mitigation Measures Necessary To Reduce Climate Change.

Keywords: green energy technologies, sustainable development, mitigation measurements.

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Strictly as per the compliance and regulations of:

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I. Introduction

Over millions of years ago plants covered the earth, converting the energy of sunlight into living tissue, some of which was buried in the depths of the earth to produce deposits of coal, oil and natural gas. During the past few decades has found many valuable uses for these complex chemical substances, manufacturing from them plastics, textiles, fertilisers and the various end products of the petrochemical industry. Each decade sees increasing uses for these products. Coal, oil and gas are non-renewable natural resources, which will certainly be of great value to future generations, as they are to ours. The rapid depletion of non-renewable fossil resources need not continue, since it is now or soon will be technically and economically feasible to supply all of man's need from the most abundant energy source of all, the sun. The sunlight is not only inexhaustible; it is the only energy source, which is completely non-polluting [1].

Industry's use of fossil fuels has been blamed for our warming climate. When coal, gas and oil are burnt, they release harmful gases, which trap heat in the atmosphere and cause global warming. However, there has been an ongoing debate on this subject, as scientists have struggled to distinguish between changes, which are human induced, and those, which could be put down to natural climate variability. Industrialised countries have the highest emission levels, and must shoulder the greatest responsibility for global warming. However, action must also be taken by developing countries to avoid future increases in emission levels as their economies develop and population grows. Human activities that emit carbon dioxide (CO_2), the most significant contributor to potential climate change, occur primarily from fossil fuel production. Consequently, efforts to control CO_2 emissions could have serious, negative consequences for economic growth, employment, investment, trade and the standard of living of individuals everywhere. Scientifically, it is difficult to predict the relationship between global temperature and greenhouse gas (GHG) concentrations. The climate system contains many processes that will change if warming occurs. Critical processes include heat transfer by winds and currents, the hydrological cycle involving evaporation, precipitation, runoff and groundwater and the formation of clouds, snow, and ice, all of which display enormous natural variability. The equipment and infrastructure for energy supply and use are designed with long lifetimes, and the premature turnover of capital stock involves significant costs. Economic benefits occur if capital stock is replaced with more efficient equipment in step with its normal replacement cycle. Likewise, if opportunities to reduce future emissions are taken in a timely manner, they should be less costly. Such flexible approaches would allow society to take account of evolving scientific and technological knowledge, and to gain experience in designing policies to address climate change [2].

The World Summit (WS) on Sustainable Development in Johannesburg committed itself to "encourage and promote the development of renewable energy sources to accelerate the shift towards sustainable consumption and production". The WS aimed at breaking the link between resource use and productivity. It is about:

- Trying to ensure economic growth doesn't cause environmental pollution.
- Improving resource efficiency.
- Examining the whole life-cycle of a product.
- Enabling consumers to receive more information on products and services.
- Examining how taxes, voluntary agreements, subsidies, regulation and information campaigns,

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The energy conservation scenarios include rational use of energy policies in all economy sectors and use of combined heat and power systems, which are able to add to energy savings from the autonomous power plants. Electricity from renewable energy sources is by definition the environmental green product. Hence, a renewable energy certificate system is an essential basis for all policy systems, independent of the renewable energy support scheme. It is, therefore, important that all parties involved support the renewable energy certificate system in place. Existing renewable energy technologies (RETs) could play a significant mitigating role, but the economic and political climate will have to change first. Climate change is real. It is happening now, and GHGs produced by human activities are significantly contributing to it. The predicted global temperature increase of between 1.5 and 4.5°C could lead to potentially catastrophic environmental impacts. These include sea level rise, increased frequency of extreme weather events, floods, droughts, disease migration from various places and possible stalling of the Gulf Stream. This has led scientists to argue that climate change issues are not ones that politicians can afford to ignore, and policy makers tend to agree [3]. However, reaching international agreements on climate change policies is no trivial task.

Renewable energy is the term used to describe a wide range of naturally occurring, replenishing energy sources. The use of renewable energy sources and the rational use of energy are the fundamental inputs for any responsible energy policy. The energy sector is encountering difficulties because increased production and consumption levels entail higher levels of pollution and eventually climate change, with possibly disastrous consequences. Moreover, it is important to secure energy at an acceptable cost in order to avoid negative impacts on economic growth. On the technological side, renewables have an obvious role to play. In general, there is no problem in terms of the technical potential of renewables to deliver energy. Moreover, there are very good opportunities for RETs to play an important role in reducing emissions of GHGs into the atmosphere, certainly far more than have been exploited so far. However, there are still some technical issues to address in order to cope with the intermittency of some renewables, particularly wind and solar. Yet, the biggest problem with relying on renewables to deliver the necessary cuts in GHG emissions is more to do with politics and policy issues than with technical ones [3]. The single most important step governments could take to promote and increase the use of renewables is to improve access for renewables to the energy market. This access to the market would need to be under favourable conditions and, possibly, under favourable economic rates as well. One move that could help, or at least justify, better market access would be to acknowledge that there are environmental costs associated with other energy supply options and that these costs are not currently internalised within the market price of electricity or fuels. This could make a significant difference, particularly if appropriate subsidies were applied to renewable energy in recognition of the environmental benefits it offers. Similarly, cutting energy consumption through end-use efficiency is absolutely essential. This suggests that issues of end-use consumption of energy will have to come into the discussion in the foreseeable future.

II. Energy and Population Growth

Throughout the world urban areas have increased in size during recent decades. About 50% of the world's population and approximately 7.6% in more developed countries are urban dwellers. Even though there is evidence to suggest that in many 'advanced' industrialised countries there has been a reversal in the rural-to-urban shift of populations, virtually all population growth expected between 2000 and 2030 will be concentrated in urban areas of the world. With an expected annual growth of 1.8%, the world's urban population will double in 38 years [1].

With increasing urbanisation in the world, cities are growing in number, population and complexity. At present, 2% of the world's land surface is covered by cities, yet the people living in them consume 75% of the resources consumed by mankind [2]. Indeed, the ecological footprint of cities is many times larger than the areas they physically occupy. Economic and social imperatives often dictate that cities must become more concentrated, making it necessary to increase the density to accommodate the people, to reduce the cost of public services, and to achieve required social cohesiveness. The reality of modern urbanisation inevitably leads to higher densities than in traditional settlements and this trend is particularly notable in developing countries.

The world population is rising rapidly, notably in the developing countries. Historical trends suggest that increased annual energy use per capita is a good surrogate for the standard of living factors, which promote a decrease in population growth rate. If these trends continue, the stabilisation of the world's population will require the increased use of all sources of energy, particularly as cheap oil and gas are depleted. The improved efficiency of energy use and renewable energy sources will, therefore, be essential in stabilising population, while providing a decent standard of living all over the world [3]. Moreover, energy is the vital input for economic and social development of any country. With an increase in industrial and agricultural activities the demand for energy is also rising. It is a well-accepted fact that commercial energy use has to be minimised. This is because of the environmental effects and the availability problems. The focus has now shifted to non-commercial energy resources, which are renewable in nature. This is found to have less environmental effects and also the availability is guaranteed. Even though the ideal situation will be to enthuse people to use renewable energy resources, there are many practical difficulties, which need to be tackled. The people groups who are using the non-commercial energy resources, like urban communities, are now becoming more demanding and wish to have commercial energy resources made available for their use. This is attributed to the increased awareness, improved literacy level and changing culture [3]. The quality of life practiced by people is usually represented as being proportional to the per capita energy use of that particular country. It is not surprising that people want to improve their quality of life. Consequently, it is expected that the demand for commercial energy resources will increase at a greater rate in the years to come [3]. Because of this emerging situation, the policy makers are left with two options: either concentrate on renewable energy resources and have them as substitutes for commercial energy resources or have a dual approach in which renewable energy resources will contribute to meet a significant portion of the demand whereas the conventional commercial energy resources would be used with caution whenever necessary. Even though the first option is the ideal one, the second approach will be more appropriate for a smooth transition [3]. Worldwide, renewable energy contributes as much as 20% of the global energy supplies [4]. Over two thirds of this comes from biomass use, mostly in developing countries, some of it unsustainable. Yet, the potential for energy from sustainable technologies is huge.

The RETs have the benefit of being environmentally benign when developed in a sensitive and appropriate way with the full involvement of local communities. In addition, they are diverse, secure, locally based and abundant. In spite of the enormous potential and the multiple benefits, the contribution from renewable energy still lags behind the ambitious claims for it due to the initially high development costs, concerns about local impacts, lack of research funding and poor institutional and economic arrangements [4].

An approach is needed to integrate renewable energies in a way to meet high building performance. However, because renewable energy sources are stochastic and geographically diffuse, their ability to match demand is determined by adoption of one of the following two approaches [5]: the utilisation of a capture area greater than that occupied by the community to be the reduction of the community's energy demands to a level commensurate with the locally available renewable resources.

III. Energy Saving in Buildings

The prospects for development in power engineering are, at present, closely related to ecological problems. Power engineering has harmful effects on the environment, as it discharges toxic gases into atmosphere and also oil-contaminated and saline waters into rivers, while polluting the soil with ash and slag and having adverse effects on living things on account of electromagnetic fields and so on. There is thus an urgent need for new approaches to provide an ecologically safe strategy. Substantial economic and ecological effects for thermal power projects (TPPs) can be achieved by improvement, upgrading the efficiency of the existing equipment, reduction of electricity loss, saving of fuel, and optimisation of its operating conditions and service life.

Improving access for rural and urban low-income areas in developing countries through energy efficiency and renewable energies is important. Sustainable energy is a prerequisite for development. Energy-based living standards in developing countries, however, are clearly below standards in developed countries. Low levels of access to affordable and environmentally sound energy in both rural and urban low-income areas are therefore a predominant issue in developing countries. In recent years many programmes for development aid or technical assistance have been focusing on improving access to sustainable energy, many of them with impressive results. Apart from success stories, however, experience also shows that positive appraisals of many projects evaporate after completion and vanishing of the implementation expert team. Altogether, the diffusion of sustainable technologies such as energy efficiency and renewable energies for cooking, heating, lighting, electrical appliances and building insulation in developing countries has been slow. Energy efficiency and renewable energy programmes could be more sustainable and pilot studies more effective and pulse releasing if the entire policy and implementation process was considered and redesigned from the outset. New financing and implementation processes are needed which allow reallocating financial resources and thus enabling countries themselves to achieve a sustainable energy infrastructure. The links between the energy policy framework, financing and implementation of renewable energy and energy efficiency projects have to be strengthened and capacity building efforts are required.

The admission of daylight into buildings alone does not guarantee that the design will be energy efficient in terms of lighting. In fact, the design for increased daylight can often raise concerns relating to visual comfort (glare) and thermal comfort (increased solar gain in the summer and heat losses in the winter from larger apertures). Such issues will clearly need to be addressed in the design of the window openings, blinds, shading devices, heating system, etc. In order for a building to benefit from daylight energy terms, it is a prerequisite that lights are switched off when sufficient daylight is available. The nature of the switching regime; manual or automated, centralised or local, switched, stepped or dimmed, will determine the energy performance. Simple techniques can be implemented to increase the probability that lights are switched off [6]. These include:

- Making switches conspicuous.
- Loading switches appropriately in relation to the lights.
- Switching banks of lights independently.
- Switching banks of lights parallel to the main window wall.

There are also a number of methods, which help reduce the lighting energy use, which, in turn, relate to the type of occupancy pattern of the building [6]. The light switching options include:

- Centralised timed off (or stepped)/manual on.
- Photoelectric off (or stepped)/manual on.
- Photoelectric and on (or stepped), photoelectric dimming.
- Occupant sensor (stepped) on/off (movement or noise sensor).

Likewise, energy savings from the avoidance of air conditioning can be very substantial. Whilst day-lighting strategies need to be integrated with artificial lighting systems in order to become beneficial in terms of energy use, reductions in overall energy consumption levels by employment of a sustained programme of energy consumption strategies and measures would have considerable benefits within the buildings sector. The perception is often given however is that rigorous energy conservation as an end in itself imposes a style on building design resulting in a restricted aesthetic solution. It would perhaps be better to support a climate sensitive design approach, which encompassed some elements of the pure conservation strategy together with strategies, which work with the local ambient conditions making use of energy technology systems, such as solar energy, where feasible. In practice, low energy environments are achieved through a combination of measures that include:

- The application of environmental regulations and policy.
- The application of environmental science and best practice.
- Mathematical modelling and simulation.
- Environmental design and engineering.
- Construction and commissioning.
- Management and modifications of environments in use.

While the overriding intention of passive solar energy design is to achieve a reduction in purchased energy consumption, the attainment of significant savings is in doubt. The non-realisation of potential energy benefits is mainly due to the neglect of the consideration of post-occupancy user and management behaviour by energy scientists and designers alike. Buildings consume energy mainly for cooling, heating and lighting. The energy consumption was based on the assumption that the building operates within ASHRAE-thermal comfort zone during the cooling and heating periods [7]. Most of the buildings incorporate energy efficient passive cooling, solar control, photovoltaic, lighting and day lighting, and integrated energy systems. It is well known that thermal mass with night ventilation can reduce the maximum indoor temperature in buildings in summer [8]. Hence, comfort temperatures may be achieved by proper application of passive cooling systems. However, energy can also be saved if an air conditioning unit is used [9]. The reason for this is that in summer, heavy external walls delay the heat transfer from the outside into the inside spaces. Moreover, if the building has a lot of internal mass the increase in the air temperature is slow. This is because the penetrating heat raises the air temperature as well as the temperature of the heavy thermal mass. The result is a slow heating of the building in summer as the maximal inside temperature is reached only during the late hours when the outside air temperature is already low. The heat flowing from the inside heavy walls can be removed with good ventilation in the evening and night. The capacity to store energy also helps in winter, since energy can be stored in walls from one sunny winter day to the next cloudy one.

IV. Energy Use in Agriculture

The land area required to provide all our energy is a small fraction of the land area required to produce our food, and the land best suited for collecting solar energy (rooftops and deserts) is the land least suited for other purposes. The economical utilisation of solar energy in all its varied forms- photovoltaic, direct solar thermal, renewable fuels, ocean-thermal, and wind can offer the world the technology, then can conserve valuable non-renewable fossil resources for future generations to enjoy, and all can live in a world of abundant energy without pollution. Energy in agriculture is important in terms of crop production and agro-processing for value adding. Human, animal and mechanical energy is extensively used for crop production in agriculture. Energy requirements in agriculture are divided into two groups being direct and indirect.

Table 1: Energy equivalent of inputs and outputs

Input	Unit	Equivalent energy (MJ)
1. Human labour	h	2.3
2. Animal labour		
Horse	h	10.10
Mule	h	4.04
Donkey	h	4.04
Cattle	h	5.05
Water buffalo	h	7.58
3. Electricity	kWh	11.93
4. Diesel	Litre	56.31
5. Chemicals fertilisers		
Nitrogen	kg	64.4
P2O5	kg	11.96
K2O	kg	6.7
6. Seed		
Cereals and pulses	kg	25
Oil seed	kg	3.6
Tuber	kg	14.7
Output		
7. Major products		
Cereal and pulses	kg	14.7
Sugar beet	kg	5.04
Tobacco	kg	0.8
Cotton	kg	11.8
Oil seed	kg	25
Fruits	kg	1.9
Vegetables	kg	0.8
Water melon	kg	1.9
Onion	kg	1.6
Potatoes	kg	3.6
Olive	kg	11.8
Tea	kg	0.8
8. By products		
Husk	kg	13.8
Straw	kg	12.5
Cob	kg	18.0
Seed cotton	kg	25.0

Direct energy is required to perform various tasks related to crop production processes such as land preparation, irrigation, interculture, threshing, harvesting and transportation of agricultural inputs and farm produce. It is seen that direct energy is directly used at farms and on fields. Indirect energy, on the other hand, consists of the energy used in the manufacture, packing and transport of fertilisers, pesticides and farm machinery. As the name implies, indirect energy is not directly used on the farm. Major items for indirect energy are fertilisers, seeds, machinery production and pesticides (Table 1).

Calculating energy inputs in agricultural production is more difficult in comparison to the industry sector due to the high number of factors affecting agricultural production. However, considerable studies have been conducted in different countries on energy use in agriculture [10-15].

Energy use in the agricultural sector depends on the size of the population engaged in agriculture, the amount of arable land and the level of mechanisation.

To calculate the energy used in agricultural production or repair of machinery, the following formula is used:

$$ME = (G \times E) / (T \times C_a) \quad (1)$$

where:
ME is the machine energy (MJ/ha)
G is the weight of tractor (kg)
E is the constant that is taken 158.3 MJ/kg for tractor
T is the economic life of tractor (h)
C_a is the effective field capacity (ha/h)
For calculation of C_a, the following equation is used:

$$C_a = (S \times W \times E_f) / 10 \quad (2)$$

where:
C_a is the effective field capacity (ha/h)
W is the working width (m)
S is the working speed (km/h)
E_f is the field efficiency (%)

Agricultural greenhouses have a very poor efficiency of thermal conversion of the received solar energy. This is particularly evident in Europe, where, in a cycle of 24 h, and in winter period, the following constraints are observed:

- During the day to maintain through ventilation, an inside temperature at a level lower than the excessive temperatures, harmful for the growth and the development of the cultures.
- At night to assure, by a supply of heating energy, an optional temperature higher than the crucial level of the culture.

This low thermal efficiency is due to the fact that, in a classic greenhouse, the only usable thermal support is the greenhouse soil, which has a weak thermal inertia.

Storage of most of the daily excess energy, in order to reuse it during the night where the temperature is low, is therefore impossible. Among other climatic factors contributing in the development of greenhouse cultivation, the inside air temperature, in contact with the aerial part of the plant, constitutes a dominant representative factor.

The impact of heating on the increase of the inside air temperature is very important, because a significant increase of agronomic efficiency in the experimental greenhouse.

Explanations for the use of inefficient agricultural-environmental polices include: the high cost of information required to measure benefits on a site-specific basis, information asymmetries between government agencies and farm decision makers that result in high implementation costs, distribution effects and political considerations [16]. Achieving the aim of agric-environment schemes through:

- Sustain the beauty and diversity of the landscape.
- Improve and extend wildlife habitats.
- Conserve archaeological sites and historic features.
- Improve opportunities for countryside enjoyment.
- Restore neglected land or features, and
- Create new habitats and landscapes.

V. Renewable Energy Technologies

Sustainable energy is energy that, in its production or consumption, has minimal negative impacts on human health and the healthy functioning of vital ecological systems, including the global environment. It is an accepted fact that renewable energy is a sustainable form of energy, which has attracted more attention during recent years. A great amount of renewable energy potential, environmental interest, as well as economic consideration of fossil fuel consumption and high emphasis of sustainable development for the future will be needed. Nearly a fifth of all global power is generated by renewable energy sources, according to a new book published by the OECD/IEA [17]. Renewables for power generation: status and prospects claims that renewables are the second largest power source after coal (39%) and ahead of nuclear (17%), natural gas (17%) and oil (8%). From 1973-2000 renewables grew at 9.3% a year, and the authors predict this will increase 10.4% a year to 2010. Wind power grew fastest at 52% and will multiply by seven times to 2010, overtaking biopower. Reducing GHGs by production of environmental technology (wind, solar, fuel cells, etc.). The challenge is to match leadership in GHG reduction and production of renewable energy with developing a major research and manufacturing capacity in environmental technologies.

More than 50% of world's area is classified as arid, representing the rural and desert part, which lack electricity and water networks. The inhabitants of such areas obtain water from borehole wells by means of water pumps, which are driven by diesel engines. The diesel motors are associated with maintenance problems, high running cost, and environmental pollution. Alternative methods are pumping by photovoltaic (PV) or wind systems. Renewable sources of energy are regional and site specific. It has to be integrated in the regional development plans.

a) Solar Energy

The availability of data on solar radiation is a critical problem. Even in developed countries, very few weather stations have been recording detailed solar radiation data for a period of time long enough to have statistical significance. Solar radiation arriving on earth is the most fundamental renewable energy source in nature. It powers the bio-system, the ocean and atmospheric current system and affects the global climate. Reliable radiation information is needed to provide input data in modelling solar energy devices and a good database is required in the work of energy planners, engineers, and agricultural scientists. In general, it is not easy to design solar energy conversion systems when they have to be installed in remote locations. Firstly, in most cases, solar radiation measurements are not available for these sites. Secondly, the radiation nature of solar radiation makes difficult the computation of the size of such systems. While solar energy data are recognised as very important, their acquisition is by no means straightforward. The measurement of solar radiation requires the use of costly equipment such as pyrheliometers and pyranometers. Consequently, adequate facilities are often not available in developing countries to mount viable monitoring programmes. This is partly due to the equipment cost and also the cost of technical manpower. Several attempts have, however, been made to estimate solar radiation through the use of meteorological and other physical parameter in order to avoid the use of expensive network of measuring instruments
[18-21].

Two of the most essential natural resources for all life on the earth and for man's survival are sunlight and water. Sunlight is the driving force behind many of the RETs.

The worldwide potential for utilising this resource, both directly by means of the solar technologies and indirectly by means of biofuels, wind and hydro technologies is vast. During the last decade interest has been refocused on renewable energy sources due to the increasing prices and fore-seeable exhaustion of presently used commercial energy sources. The most promising solar energy technology are related to thermal systems; industrial solar water heaters, solar cookers, solar dryers for peanut crops, solar stills, solar driven cold stores to store fruits and vegetables, solar collectors, solar water desalination, solar ovens, and solar commercial bakers. Solar PV system: solar PV for lighting, solar refrigeration to store vaccines for human and animal use, solar PV for water pumping, solar PV for battery chargers, solar PV for communication network, microwave, receiver stations, radio systems in airports, VHF and beacon radio systems in airports, and educational solar TV posts in villages. Solar pumps are most cost effective for low power requirement (up to 5 kW) in remote places. Applications include domestic and livestock drinking water supplies, for which the demand is constant throughout the year, and irrigation. The suitability of solar pumping for irrigation is uncertain because the demand may vary greatly with seasons. Solar systems may be able to provide trickle irrigation for fruit farming, but not usually the large volumes of water needed for wheat growing.

The hydraulic energy required to deliver a volume of water is given by the formula:

$$E_w = \rho_w \, g \, V \, H \qquad (3)$$

where E_w is the required hydraulic energy (kWh day^{-1}); ρ_w is the water density; g is the gravitational acceleration (ms^{-1}); V is the required volume of water (m^3 day^{-1}); and H is the head of water (m).
The solar array power required is given by:

$$P_{sa} = E_w / E_{sr} \, \eta \, F \qquad (4)$$

where: P_{sa} is the solar array power (kW$_p$); E_{sr} is the average daily solar radiation (kWhm^{-2} day^{-1}); F is the array mismatch factor; and η is the daily subsystem efficiency.

Substituting Eq. (1) in Eq. (2), the following equation is obtained for the amount of water that can be pumped:

$$V = P_{sa} \, E_{sr} \, \eta \, F / \rho_w \, g \, H \qquad (5)$$

PV consists of 32 modules P_{sa} = 1.6 kW$_p$, F = 0.85, η = 40%.

A further increase of the PV depends on the ability to improve the durability, performance and the local manufacturing capabilities of the PV. Moreover, the availability of credit schemes (e.g., solar funds) would increase the annual savings of oil and foreign currency and further improve the security of energy supply and further employment could be created.

b) Efficient Bio-Energy Use

The data required to perform the trade-off analysis simulation can be classified according to the divisions given in Table 2: The overall system or individual plants, and the existing situation or future development.

The effective economic utilisations of these resources are shown in Table 3, but their use is hindered by many problems such as those related to harvesting, collection, and transportation, besides the photo-sanitary control regulations. Biomass energy is experiencing a surge in interest stemming from a combination of factors, e.g., greater recognition of its current role and future potential contribution as a modern fuel, global environmental benefits, its development and entrepreneurial opportunities, etc. Possible routes of biomass energy development are shown in Table 4.

a) Biomass Energy for Domestic Needs

1. Population increase
2. Urbanisation
3. Agricultural expansion
4. Fuel-wood crisis
5. Ecological crisis
6. Fuel-wood plantations
7. Community forestry
8. Improved stoves
9. Agro-forestry
10. Improved charcoal production
11. Residue utilisation

b) Biomass Energy For Petroleum Substitution

1. Oil price increase
2. Balance of payment problems
3. Economic crisis
4. Fuel-wood plantations
5. Residue utilisation
6. Wood based heat and electricity
7. Liquid fuels from biomass
8. Producer gas technology

c) Biomass Energy for Development

1. Electrification
2. Irrigation and water supply
3. Economic and social development
4. Fuel-wood plantations
5. Community forestry
6. Agro-forestry
7. Briquettes
8. Producer gas technology

Table 2: Classifications of data requirements

	Plant data	System data
Existing data	Size Life Cost (fixed and var. O&M) Forced outage Maintenance Efficiency Fuel Emissions	Peak load Load shape Capital costs Fuel costs Depreciation Rate of return Taxes
Future data	All of above, plus Capital costs Construction trajectory Date in service	System lead growth Fuel price growth Fuel import limits Inflation

Table 3: Effective biomass resource utilisation

Subject	Tools	Constraints
Utilisation and land clearance for agriculture expansion	• Stumpage fees • Control • Extension • Conversion • Technology	• Policy • Fuel-wood planning • Lack of extension • Institutional
Utilisation of agricultural residues	• Briquetting • Carbonisation • Carbonisation and briquetting • Fermentation • Gasification	• Capital • Pricing • Policy and legislation • Social acceptability

The use of biomass through direct combustion has long been, and still is, the most common mode of biomass utilisation as shown in Tables (2-4). Examples for dry (thermo-chemical) conversion processes are charcoal making from wood (slow pyrolysis), gasification of forest and agricultural residues (fast pyrolysis – this is still in demonstration phase), and of course, direct combustion in stoves, furnaces, etc. Wet processes require substantial amount of water to be mixed with the biomass. Biomass technologies include:

- Briquetting
- Improved stoves
- Biogas
- Improved charcoal
- Carbonisation
- Gasification

Table 4: Agricultural residues routes for development

Source	Process	Product	End use
Agricultural residues	Direct Processing Processing Carbonisation Fermentation	Combustion Briquettes Carbonisation (small scale) Briquettes Carbonised Biogas	Rural poor Urban household Industrial use Industrial use Limited household use Rural household (self sufficiency) Urban fuel Energy services Household Industry
Agricultural, and animal residues	Direct Briquettes Carbonisation Carbonisation Fermentation	Combustion Direct combustion Carbonised Briquettes Biogas	(Save or less efficiency as wood) (Similar end use devices or improved) Use Briquettes use Use

i. *Briquette Processes*

Charcoal stoves are very familiar to African society. As for the stove technology, the present charcoal stove can be used, and can be improved upon for better efficiency. This energy term will be of particular interest to both urban and rural households and all the income groups due to the simplicity, convenience, and lower air polluting characteristics. However, the market price of the fuel together with that of its end-use technology may not enhance its early high market penetration especially in the urban low income and rural households.

Briquetting is the formation of a char (an energy-dense solid fuel source) from otherwise wasted agricultural and forestry residues. One of the disadvantages of wood fuel is that it is bulky with a low energy density and is therefore enquire to transport. Briquette formation allows for a more energy-dense fuel to be delivered, thus reducing the transportation cost and making the resource more competitive. It also adds some uniformity, which makes the fuel more compatible with systems that are sensitive to the specific fuel input.

ii. *Improved Cook Stoves*

Traditional wood stoves can be classified into four types: three stone, metal cylindrical shaped, metal tripod and clay type. Another area in which rural energy availability could be secured where woody fuels have become scarce, are the improvements of traditional cookers and ovens to raise the efficiency of fuel saving. Also, is by planting fast growing trees to provide a constant fuel supply. The rural development is essential and economically important since it will eventually lead to better standards of living, people's settlement, and self sufficient in the following:

- Food and water supplies.
- Better services in education and health care.
- Good communication modes.

iii. *Biogas Technology*

Biogas technology can not only provide fuel, but is also important for comprehensive utilisation of biomass forestry, animal husbandry, fishery, agricultural economy, protecting the environment, realising agricultural recycling, as well as improving the sanitary conditions, in rural areas. The introduction of biogas technology on wide scale has implications for macro planning such as the allocation of government investment and effects on the balance of payments. Factors that determine the rate of acceptance of biogas plants, such as credit facilities and technical backup services, are likely to have to be planned as part of general macro-policy, as do the allocation of research and development funds [22].

iv. *Improved Forest and Tree Management*

Dry cell batteries are a practical but expensive form of mobile fuel that is used by rural people when moving around at night and for powering radios and other small appliances. The high cost of dry cell batteries is financially constraining for rural households, but their popularity gives a good indication of how valuable a versatile fuel like electricity is in rural area. Dry cell batteries can constitute an environmental hazard unless they are recycled in a proper fashion (Table 5). Direct burning of fuel-wood and crop residues constitute the main usage of biomass, as is the case with many developing countries. However, the direct burning of biomass in an inefficient manner causes economic loss and adversely affects human health. In order to address the problem of inefficiency, research centres around the world have investigated the viability of converting the resource to a more useful form, namely solid briquettes and fuel gas. Biomass resources play a significant role in energy supply in all developing countries. Biomass resources should be divided into residues or dedicated resources, the latter including firewood and charcoal can also be produced from forest residues (Table 6).

v. *Gasification Application*

Gasification is based on the formation of a fuel gas (mostly CO and H_2) by partially oxidising raw solid fuel at high temperatures in the presence of steam or air. The technology can use wood chips, groundnut shells, sugar cane bagasse, and other similar fuels to generate capacities from 3 kW to 100 kW. Three types of gasifier designs have been developed to make use of the diversity of fuel inputs and to meet the requirements of the product gas output (degree of cleanliness, composition, heating value, etc.).

Table 5: Energy carrier and energy services in rural areas

Energy carrier	Energy end-use
Fuel-wood	Cooking Water heating Building materials Animal fodder preparation
Kerosene	Lighting Ignition fires
Dry cell batteries	LightingSmall appliances
Animal power	Transport Land preparation for farming Food preparation (threshing)
Human power	Transport Land preparation for farming Food preparation (threshing)

Table 6: Biomass residues and current use

Type of residue	Current use
Wood industry waste	Residues available
Vegetable crop residues	Animal feed
Food processing residue	Energy needs
Sorghum, millet, wheat residues	Fodder, and building materials
Groundnut shells	Fodder, brick making, direct fining oil mills
Cotton stalks	Domestic fuel considerable amounts available for short period
Sugar, bagasse, molasses	Fodder, energy need, ethanol production (surplus available)
Manure	Fertiliser, brick making, plastering

vi. *Major Research Gaps*

A major gap with biomass energy is that research has usually been aimed at obtaining supply and consumption data, with insufficient attention and resources being allocated to basic research, to production, harvesting and conservation process. Biomass has not been closely examined in terms of a substitute for fossil fuels compared to carbon sequestration and overall environmental benefits related to these different approaches. To achieve the full potential of biomass as a feedstock for energy, foods, or any other uses, require the application of considerable scientific and technological inputs [22]. The aim of any modern biomass energy systems must be:

i. To maximise yields with minimum inputs.
ii. Utilisation and selection of adequate plant materials and processes.
iii. Optimum use of land, water, fertiliser.
iv. Create an adequate infrastructure and strong R&D base.

But, social policy conditions are critical.

This is still very much lacking particularly under developing country conditions. During the 1970s and 1980s different biomass energy technologies were perceived in sub-Saharan Africa as a panacea for solving acute problems. On the account of these expectations, a wide range of activities and projects were initiated. However, despite considerable financial and human efforts, most of these initiatives have unfortunately been a failure.

Future research efforts should be concentrating on the following areas:

- Directed R&D in the most promising areas of biomass to increase energy supply and to improve the technological base.
- Formulate a policy framework to encourage entrepreneurial and integrated process.
- Pay more attention to sustainable production and use of biomass energy feed stocks, methodology of conservation and efficient energy flows.
- More research aimed at pollution abatement.
- Greater attentions to interrelated socio-economic aspects.
- Support R&D on energy efficiency in production and use.
- Improve energy management skills and take maximum advantage of existing local knowledge.
- Examine closely past successes and failures so as to assist policy makers with well-informed recommendations.

vii. *Recent Trends of Research on Biomass Energy*

There are many emerging biomass technologies with large and immediate potential applications e.g., biomass gasifier/gas turbine (BGST) systems for power generation with pilot plants, improved techniques for biomass harvesting, transportation and storage. Gasification of crop residues such as rice husks, groundnut shells etc. with plants already operating in China, India, and Thailand. Treatment of cellulosic materials by steam explosion which may be followed by biological or chemical hydrolysis to produce ethanol or other fuels, cogeneration technologies, hydrogen from biomass, striling energies capable of using biomass fuels efficiently etc. The main research of recent years can thus be summarised as follows:

1. Direct combustion of biomass to produce heat, steam or electricity.
2. Production of liquid fuels such as ethanol and methanol, vegetable oils, and electricity cogeneration.
3. Production of charcoal and char.
4. Thermo-chemical conversion of biomass for generating heat and electricity.
5. Anaerobic digestion of biomass residues, wastes, and dung.

viii. *Barriers to Implementation*

The afforestation program appears an attractive option for the country to pursue in order to reduce the level of atmospheric carbon by enhancing carbon sequestration in the nation's forests, which would consequently mitigate climate change. However, it is acknowledged that certain barriers need to be overcome if the objectives were to be fully achieved. These include the following:

- Low level of public awareness of the economic/environmental benefits of forestry.
- The generally low levels of individual income.
- Pressures from population growth.
- The land tenural system, which makes it difficult (if not possible) for individuals to own or establish forest plantations.
- Poor pricing of forest products especially in the local market.
- Inadequate financial support on the part of governments.
- Weak institutional capabilities of the various Forestry Departments as regards technical manpower to effectively manage tree plantations.

c) Combined Heat and Power (CHP)

District Heating (DH), also known as community heating can be a key factor to achieve energy savings, reduce CO_2 emissions and at the same time provide consumers with a high quality heat supply at a competitive price. The DH should generally only be considered for areas where the heat density is sufficiently high to make DH economical. In countries like Denmark DH may today be economical even to new developments with lower density areas due to the high level of taxation on oil and gas fuels combined with the efficient production of the DH. To improve the opportunity for The DH local councils can adapt the following plan:

- Analyse the options for heat supply during local planning stage.
- In areas where DH is the least cost solution it should be made part of the infrastructure just like for instance water and sewage connecting all existing and new buildings.
- Where possible all public buildings should be connected to the DH.
- The government provides low interest loans or funding to minimise conversion costs for its citizens.
- Use other powers, for instance national legislation to ensure the most economical development of the heat supply and enable an obligation to connect buildings to a DH scheme.

Denmark has broadly seen three scales of the CHP which where largely implemented in the following chronological order [23]:

- Large-scale CHP in cities (>50 MWe)
- Small (5 kWe – 5 MWe) and medium-scale (5-50 MWe)
- Industrial and small-scale CHP

Most of the heat is produced by large CHP plants (gas-fired combined cycle plants using natural gas, biomass, waste or biogas) as shown in Table 7.

Table 7: Sources of renewable energy

Energy source	Technology	Size
Solar energy	Domestic solar water heaters Solar water heating for large demands PV roofs: grid connected systems generating electric energy	Small Medium-large Medium-large
Wind energy	Wind turbines (grid connected)	Medium-large
Hydraulic energy	Hydro plants in derivation schemes Hydro plants in existing water distribution networks	Medium-small Medium-small
Biomass	High efficiency wood boilers CHP plants fed by agricultural wastes or energy crops	Small Medium
Animal manure	CHP plants fed by biogas	Small
CHP	High efficiency lighting High efficiency electric Householders appliances High efficiency boilers Plants coupled with refrigerating absorption machines	Wide Wide Wide Small-medium Medium-large

The DH is energy efficient because of the way the heat is produced and the required temperature level is an important factor. Buildings can be heated to temperature of 21°C and domestic hot water (DHW) can be supplied with a temperature of 55°C using energy sources that are most efficient when producing low temperature levels (<95°C) for the DH water. Most of these heat sources are CO_2 neutral or emit low levels. Only a few of these sources are available to small individual systems at a reasonably cost, whereas DH schemes because of the plant's size and location can have access to most of the heat sources and at a low cost. Low temperature DH, with return temperatures of around 30-40°C can utilise the following heat sources:

- Efficient use of the CHP by extracting heat at low calorific value (CV).

- Efficient use of biomass or gas boilers by condensing heat in economisers (Table 8).
- Efficient utilisation of geothermal energy.
- Direct utilisation of excess low temperature heat from industrial processes.
- Efficient use of large-scale solar heating plants.

Heat tariffs may include a number of components such as: a connection charge, a fixed charge and a variable energy charge. Also, consumers may be incentivised to lower the return temperature. Hence, it is difficult to generalise but the heat practice for any DH company no matter what the ownership structure can be highlighted as follows:

- To develop and maintain a development plan for the connection of new consumers
- To evaluate the options for least cost production of heat
- To implement the most competitive solutions by signing agreements with other companies or by implementing own investment projects
- To monitor all internal costs and with the help of benchmarking, improve the efficiency of the company
- To maintain a good relationship with the consumer and deliver heat supply services at a sufficient quality

Installing DH should be pursued to meet the objectives for improving the environment through the improvement of energy efficiency in the heating sector. At the same time DH can serve the consumer with a reasonable quality of heat at the lowest possible cost. The variety of possible solutions combined with the collaboration between individual companies, the district heating association, the suppliers and consultants can, as it has been in Denmark, be the way forward for developing DH in the United Kingdom.

Table 8: Final energy projections including biomass (Mtoe) [24]

1995				
Region	**Biomass**	**Conventional Energy**	**Total**	**Share of Biomass (%)**
Africa	205	136	341	60
China	206	649	855	24
East Asia	106	316	422	25
Latin America	73	342	416	18
South Asia	235	188	423	56
Total developing countries	825	1632	2456	34
Other non-OECD countries	24	1037	1061	1
Total non-OECD countries	849	2669	3518	24
OECD countries	81	3044	3125	3
World	**930**	**5713**	**6643**	**14**
2020				
Region	Biomass	Conventional Energy	Total	Share of Biomass (%)
Africa	371	266	631	59
China	224	1524	1748	13
East Asia	118	813	931	13
Latin America	81	706	787	10
South Asia	276	523	799	35
Total developing countries	1071	3825	4896	22
Other non-OECD countries	26	1669	1695	1
Total non-OECD countries	1097	5494	6591	17
OECD countries	96	3872	3968	2
World	1193	9365	10558	11

d) Fuel Cells

Platinum is a catalyst for fuel cells and hydrogen-fuelled cars presently use about two ounces of the metal. There is currently no practicable alternative. Reserves are in South Africa (70%), and Russia (22%). In South Africa there are sufficient accessible reserves to increase supply by up to 5% per year for each of the next 50 years, but there are significant environmental impacts associated with its mining and refining, like groundwater pollution and atmospheric emissions of sulphur dioxide ammonia, chlorine and hydrogen chloride.

The carbon cost of platinum use equates to 360 kg for a current fuel cell car; or 36 kg for a future car with the target platinum loading of 0.2 oz-neglible compared to the CO_2 currently emitted by vehicles. The metal is almost completely recyclable. At current prices and loading, the platinum would cost 3% of the total cost of a fuel cell engine. The likely resource costs of hydrogen as a transport fuel are apparently cheapest if it is reformed from natural gas with pipeline distribution, with or without carbon sequestration. However, this is not as sustainable as using a renewable energy sources. Substituting hydrogen for fossils fuels will have a positive environmental impact in reducing both photochemical smog and climate change. There could be an adverse impact on the ozone layer but this is likely to be small, though potentially more significant if hydrogen was to be used as aviation fuel.

e) Hydrogen Production

Hydrogen is now beginning to be accepted as a useful form for storing energy for reuse on, or for export off, the grid. Clean electrical power harvested from wind and wave power projects can be used to produce hydrogen by electrolysis of water- splitting this into its constituent parts of hydrogen and oxygen. Electrolysers split water molecules into its constituent parts: hydrogen and oxygen. These are collected as gases, hydrogen at the cathode and oxygen at the anode. The process is quite simple. Direct current is applied to the electrodes to initiate the electrolysis process. The reaction that occurs is:
At the anode:

$$4OH^- => O_2 + 2H_2O + 4é$$

At the cathode:

$$4H_2O + 4é =>2H_2 + 4OH^-$$

The overall reaction is:

$$2H_2O => 2H_2 + O_2$$

Production of hydrogen is an elegant environmental solution. Hydrogen is the most abundant element on the planet, it cannot be destroyed (unlike hydrocarbons) it simply changes state- water to hydrogen and back to water- during consumption. In its production and consumption there is no CO or CO_2 production and depending upon methods of consumption, the production of oxides of nitrogen can be avoided too. The transition will be very messy, and will take many technological paths- converting fossil fuels and methanol to hydrogen, building hybrid engines and so on- but the future will be hydrogen fuel cells. Hydrogen is already produced in huge volumes and used in a variety of industries. Current worldwide production is around 500 billion Nm^3 per year [25].

Most of the hydrogen produced today is consumed on-site, such as at oil refineries, and is not sold on the market. From large-scale production, hydrogen costs around $0.70/kg if it is consumed on-site [25]. When hydrogen is sold on the market, the cost of liquefying the hydrogen and transporting it to the user adds considerably to production cost. The energy required to produce hydrogen via electrolysis (assuming 1.23 V) is about 33 (kWh/kg). For 1 mole (2 g) of hydrogen the energy is about 0.066 (kWh/mole) [25]. The achieved efficiencies are over 80% and on this basis electrolytic hydrogen can be regarded as a storable form of electricity.
Hydrogen can be stored in a variety of forms:

- Cryogenic; this has the highest gravimetric energy density.
- High-pressure cylinders; pressures of 10.000 psi are quite normal.
- Metal hydride absorbs hydrogen, providing a very low pressure and extremely safe mechanism, but is heavy and more expensive than cylinders, and
- Chemical carriers offer an alternative, with anhydrous ammonia offering similar gravimetric and volumetric energy densities to ethanol and methanol.

Hydrogen can be used in internal combustion engines, fuel cells, turbines, cookers gas boilers, road-side emergency lighting, traffic lights or signalling where noise and pollution can be a considerable nuisance, but where traffic and pedestrian safety cannot be compromised.

f) Hydropower Generation

Hydropower has a valuable role as a clean and renewable source of energy in meeting a variety of vital human needs. Water resources management and benefit sharing and among other points (safe drinking water and sanitation, water for food and rural development, water pollution and ecosystem conservation, disaster mitigation and risk management) the recognition of the role of hydropower as one of the renewable and clean energy sources and that its potential should be realised in an environmentally sustainable and socially acceptable manner.

Water is a basic requirement for survival: for drinking, for food, energy production and for good health. As water is a commodity, which is finite and cannot be created, and in view of the increasing requirements as the world population grows, there is no alternative but to store water for use when it is needed.

The major challenges are to feed the increasing world population, to improve the standards of living in rural areas and to develop and manage land and water in a sustainable way. Hydropower plants are classified by their rated capacity into one of four regimes: micro (<50kW), mini (50-500 kW), small (500kW-5MW), and large (>5 MW) [30].

The total world installed hydro capacity today is around 730 GW, and 1500 GW more will be built during this century, principally in developing countries in Asia,

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Africa and South America. The present production of hydroelectricity is only about 18 per cent of the technically feasible potential (and 32 per cent of the economically feasible potential); there is no doubt that a large amount of hydropower development lies ahead [26]. Table 9, which is reproduced from [26], classified hydro plants in the world.

g) Wind Energy

The utilisation of energy from renewable sources, such as wind, is becoming increasingly attractive and is being widely used for the substitution of oil-produced energy, and eventually to minimise atmospheric degradation. Most of the world's energy consumption is greatly dependent on fossil fuel, which is exhaustible and is being used extensively due to the continuous escalation in world's population and development.

Table 9: World hydro potential and development

Continent	Africa	Asia	Australia & Oceania	Europe	North & Central America	South America
Gross theoretical hydropower potential ($GWhy^{-1}$)	$4x10^6$	$19.4x10^6$	$59.4x10^6$	$3.2x10^6$	$6x10^6$	$6.2x10^6$
Technically feasible hydropower potential ($GWhy^{-1}$)	$1.75x10^6$	$6.8x10^6$	$2x10^6$	10^6	$1.66x10^6$	$2.7x10^6$
Economically feasible hydropower potential ($GWhy^{-1}$)	$1.1x10^5$	$3.6x10^6$	$90x10^4$	$79x10^4$	10^6	$1.6x10^6$
Installed hydro capacity (MW)	$21x10^3$	$24.5x10^4$	$13.3x10^4$	$17.7x10^4$	$15.8x10^4$	$11.4x10^4$
Production by hydro plants in 2002 or average ($GWhy^{-1}$)	$83.4x10^3$	$80x10^4$	$43x10^3$	$568x10^3$	$694x10^3$	$55x10^4$
Hydro capacity under construction (MW)	> 3024	>$72.7x10^3$	>177	>$23x10^2$	$58x10^2$	>$17x10^3$
Planned hydro capacity (MW)	$77.5x10^3$	>$17.5x10^4$	>647	>10^3	>$15x10^3$	>$59x10^3$

This valuable resource needs to be converted and its alternatives need to be explored. In this perspective, utilisation of renewables, such as wind energy, has gained considerable momentum since the oil crises of the 1970s. Wind energy is non-depleting, site-dependent, non-polluting, and a potential source of the alternative energy option. Wind power could supply 12% of global electricity demand by 2020, according to a report by European Wind Energy Association and Greenpeace [27]. Wind energy can and will constitute a significant energy resource; it must be converted at a usable form (Figure 1).

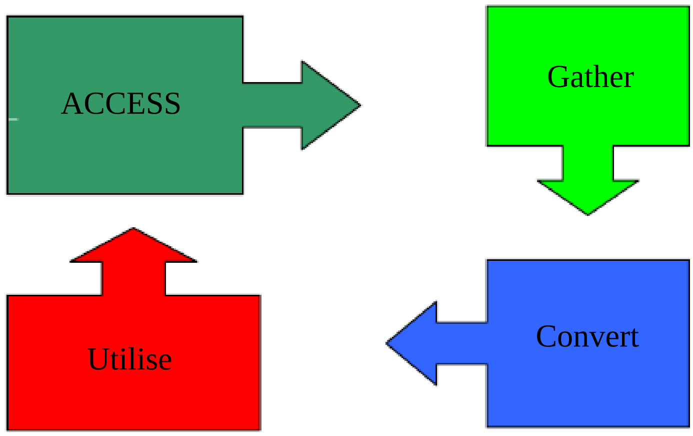

Figure 1: The renewable cycle

As Figure 1 illustrates, information sharing is a four-stage process and effective collaboration must also provide ways in which the other three stages of the 'renewable' cycle: gather, convert and utilise, can be integrated. Efficiency in the renewable energy sector translates into lower gathering, conversion and utilisation (electricity) costs. A great level of installed capacity has already been achieved.

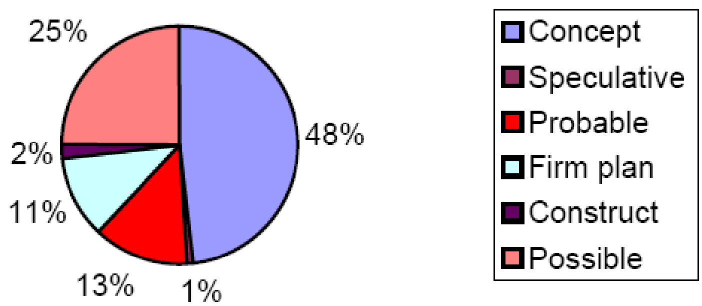

Figure 2: Global prospects by 2003-2010

Figure 2 clearly shows that the offshore wind sector is developed, and this indicates that wind is becoming a major factor in electricity supply with a range of significant technical, commercial and financial hurdles to be overcome. The offshore wind industry has the potential for a very bright future and to emerge as a new industrial sector (Figure 3).

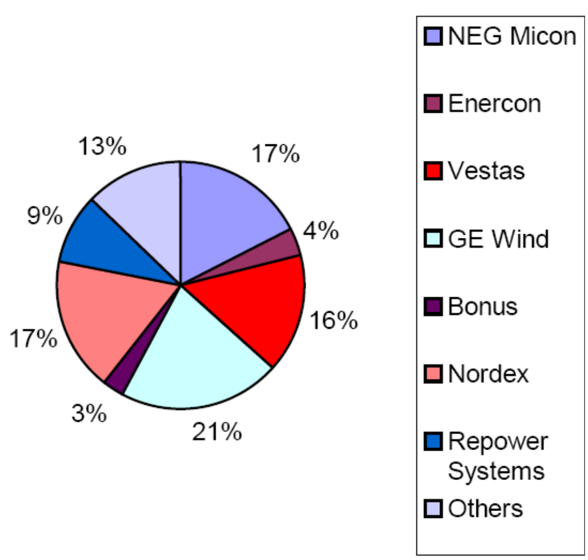

Figure 3: Turbines share for 2003-2010

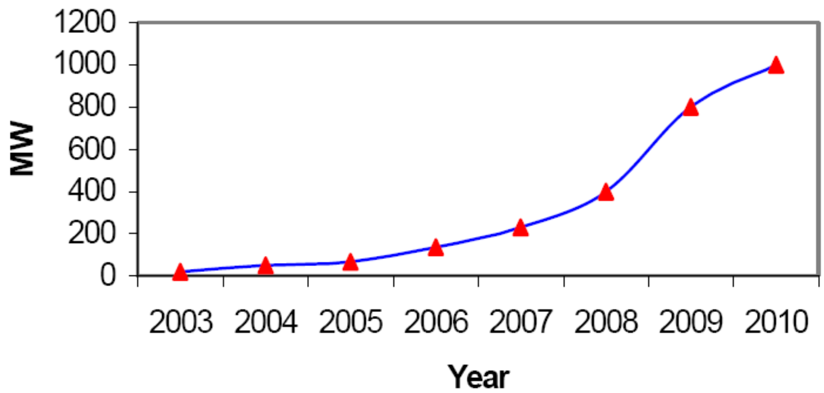

Figure 4: Average windfarm capacity 2003-2010

The speed of turbine development means that more powerful models have superseded the original specification turbines in the time from concept to turbine order. Levels of activities are growing (Figure 4), at phenomenal rate, new prospects are developing, new players are entering and existing players are growing in experience, technology is evolving and political will appears to support the sector. Water is the most natural commodity for the existence of life in the remote desert areas. As a condition of settling and growing, the supply of energy comes into a second priority. The high cost and the difficulties of a main power lines extension, especially to low populated regions can divert the attention to the utilisation of more reliable and independent sources of energy like the renewable wind energy.

VI. Energy and Sustainable Development

Sustainability has been defined as the extent to which progress and development should meet the need of the present without compromising the ability of the future generations to meet their own needs [28]. This encompasses a variety of levels and scales ranging from economic development and agriculture, to the management of human settlements and building practices. This general definition was further developed to include sustainable building practices and management of human settlements. The following issues were addressed during the Rio Earth Summit in 1992 [29]:

- The use of local materials and indigenous building sources.
- Incentive to promote the continuation of traditional techniques, with regional resources and self-help strategies.
- Regulation of energy-efficient design principles.
- International information exchange on all aspects of construction related to the environment, among architects and contractors, particularly non-conventional resources.
- Exploration of methods to encourage and facilitate the recycling and reuse of building materials, especially those requiring intensive energy use during manufacturing, and the use of clean technologies.

Action areas for producers:

- Management and measurement tools- adopting environmental management systems appropriate for the business.
- Performance assessment tools- making use of benchmarking to identify scope for impact reduction and greater eco-efficiency in all aspects of the business.
- Best practice tools- making use of free help and advice from government best practice programmes (energy efficiency, environmental technology, and resource savings).
- Innovation and ecodesign- rethinking the delivery of 'value added' by the business, so that impact reduction and resource efficiency are firmly built in at the design stage.
- Cleaner, leaner production processes- pursuing improvements and savings in waste minimisation, energy and water consumption, transport and distribution, as well as reduced emissions. Tables (10-12) indicate energy conservation, sustainable development and environment.
- Supply chain management- specifying more demanding standards of sustainability from 'upstream' suppliers, while supporting smaller firms to meet those higher standards.
- Product stewardship- taking the broadest view of 'producer responsibility' and working to reduce all the 'downstream' effects of products after they have been sold on to customers.
- Openness and transparency- publicly reporting on environmental performance against meaningful targets; actively using clear labels and declarations so that customers are fully informed; building stakeholder confidence by communicating sustainability aims to the workforce, the shareholders and the local community (Figure 5).

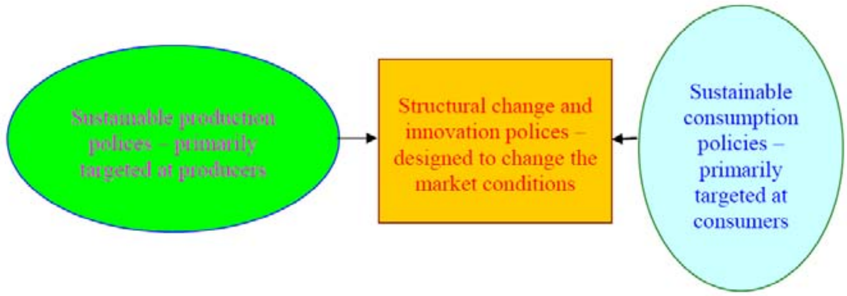

Figure 5: Link between resources and productivity

This is the step in a long journey to encourage a progressive economy, which continues to provide us with high living standards, but at the same time helps reduce pollution, waste mountains, other environmental degradation, and environmental rationale for future policy-making and intervention to improve market mechanisms.

Table 10: Energy and sustainable environment

Technological criteria	Energy and environment criteria	Social and economic criteria
Primary energy saving in regional scale	Sustainability according to greenhouse gas pollutant emissions	Labour impact
Technical maturity, reliability	Sustainable according to other pollutant emissions	Market maturity
Consistence of installation and maintenance requirements with local technical known-how	Land requirement	Compatibility with political, legislative and administrative situation
Continuity and predictability of performance	Sustainability according to other environmental impacts	Cost of saved primary energy

Table 11: Classification of key variables defining facility sustainability

Criteria	Intra-system impacts	Extra-system impacts
Stakeholder satisfaction	• Standard expectations met • Relative importance of standard expectations	• Covered by attending to extra-system resource base and ecosystem impacts
Resource base impacts	• Change in intra-system resource bases • Significance of change	• Resource flow into/out of facility system • Unit impact exerted by flow on source/sink system • Significance of unit impact
Ecosystem impacts	• Change in intra-system ecosystems • Significance of change	• Resource flows into/out of facility system • Unit impact exerted by how on source/sink system • Significance of unit impact

This vision will be accomplished by:

- 'Decoupling' economic growth and environmental degradation. The basket of indicators illustrated shows the progress being made (Table 13). Decoupling air and water pollution from growth, making good headway with CO_2 emissions from energy, and transport. The environmental impact of our own individual behaviour is more closely linked to consumption expenditure than the economy as a whole.

Table 12: Positive impact of durability, adaptability and energy conservation on economic, social and environment systems

Economic system	Social system	Environmental system
Durability	Preservation of cultural values	Preservation of resources
Meeting changing needs of economic development	Meeting changing needs of individuals and society	Reuse, recycling and preservation of resources
Energy conservation and saving	Savings directed to meet other social needs	Preservation of resources, reduction of pollution and global warming

Table 13: The basket of indicators for sustainable consumption and production

Economy-wide decoupling indicators	Decoupling indicators for specific sectors
1. Greenhouse gas emissions 2. Air pollution 3. Water pollution (river water quality) 4. Commercial and industrial waste arisings and household waste not cycled	5. Emissions from electricity generation 6. Motor vehicle kilometres and related emissions 7. Agricultural output, fertiliser use, methane emissions and farmland bird populations 8. Manufacturing output, energy consumption and related emissions 9. Household consumption, expenditure energy, water consumption and waste generated
Resource use indicators 10. Material use 11. Water abstraction 12. Homes built on land not previously developed, and number of households	

- Focusing policy on the most important environmental impacts associated with the use of particular resources, rather than on the total level of all resource use.
- Increasing the productivity of material and energy use that are economically efficient by encouraging patterns of supply and demand, which are more efficient in the use of natural resources. The aim is to promote innovation and competitiveness. Investment in areas like energy efficiency, water efficiency and waste minimisation.
- Encouraging and enabling active and informed individual and corporate consumers.

VII. Global Warming

With the debate on climate change, the preference for real measured data has been changed. The analyses of climate scenarios need an hourly weather data series that allows for realistic changes in various weather parameters. By adapting parameters in a proper way, data series can be generated for the site. Weather generators should be useful for:

- Calculation of energy consumption (no extreme conditions are required)
- Design purposes (extremes are essential), and
- Predicting the effect of climate change such as increasing annually average of temperature.

This results in the following requirements:

- Relevant climate variables should be generated (solar radiation: global, diffuse, direct solar direction, temperature, humidity, wind speed and direction) according to the statistics of the real climate.
- The average behaviour should be in accordance with the real climate.
- Extremes should occur in the generated series in the way it will happen in a real warm period. This means that the generated series should be long enough to assure these extremes, and series based on average values from nearby stations.

On some climate change issues (such as global warming), there is no disagreement among the scientists. The greenhouse effect is unquestionably real- it is essential for life on earth. Water vapour is the most important GHG; next is carbon dioxide (CO_2). Without a natural greenhouse effect, scientists estimate that the earth's average temperature would be –18°C instead of its present 14°C. There is also no scientific debate over the fact that human activity has increased the concentration of GHGs in the atmosphere (especially CO_2 from combustion of coal, oil and gas). The greenhouse effect is also being amplified by increased concentrations of other gases, such as methane, nitrous oxide, and CFCs as a result of human emissions. Most scientists predict that rising global temperatures will raise the sea level and increase the frequency of intense rain or snowstorms. Climate change scenarios sources of uncertainty and factors influencing the future climate are:

- The future emission rates of the GHGs (Table 14).
- The effect of these emissions on the GHGs concentrations in the atmosphere.
- The effect of this increase in concentration on the energy balance of the atmosphere, and
- The effect of this change in energy balance on global and regional climate.

It has been known for a long time that urban centres have mean temperatures higher than their less developed surroundings. The urban heat increases the average and peak air temperatures, which in turn affect the demand for heating and cooling. Higher temperatures can be beneficial in the heating season, lowering fuel use, but they exacerbate the energy demand for cooling in the summer times. In temperate climates neither heating nor cooling may dominate the fuel use in a building, and the balance of the effect of the heat is less. As the provision of cooling is expensive with higher environmental cost, ways of using innovative alternative systems like mop fan will be appreciated. The solar gains would effect energy consumption. Therefore, lower or higher percentage of glazing, or incorporating of shading devices might affect the balance between annual heating and cooling load. In addition to conditioning energy, the fan energy needed to provide mechanical ventilation can make a significant further contribution to energy demand. Much depends on the efficiency of design, both in relation to the performance of fans themselves and to the resistance to flow arising from the associated ductwork. Figure 6 illustrates the typical fan and thermal conditioning needs for a variety of ventilation rates and climate conditions.

Building design has traditionally assumed an unchanging climate. The comfort of building occupants is dependent on many environmental parameters including those provided by the building envelope, building environmental services and control systems. Also, include air temperature, relative humidity, air quality, lighting and noise. Control of indoor environmental conditions in the winter and summer months are often relatively straightforward as only heating or cooling are required respectively. There is often a large difference between the required indoor conditions and the outdoor conditions, e.g., temperature. However, during the mid-seasons opportunity often exists to take advantage of phase and value differences between indoor and outdoor environments to enable improvements in energy efficiency of building environmental services operation. Consequentially, opportunity sometimes exists to increase fresh air ventilation rates and reduce indoor air temperatures without the need for mechanical cooling. Simultaneously, the benefit of improved indoor air quality is realised as a result of increased fresh air ventilation rates. It was also decided that cost efficiency was to be taken into account and should not be compromised in favour of energy efficiency as this would negatively impact on the overall building performance.

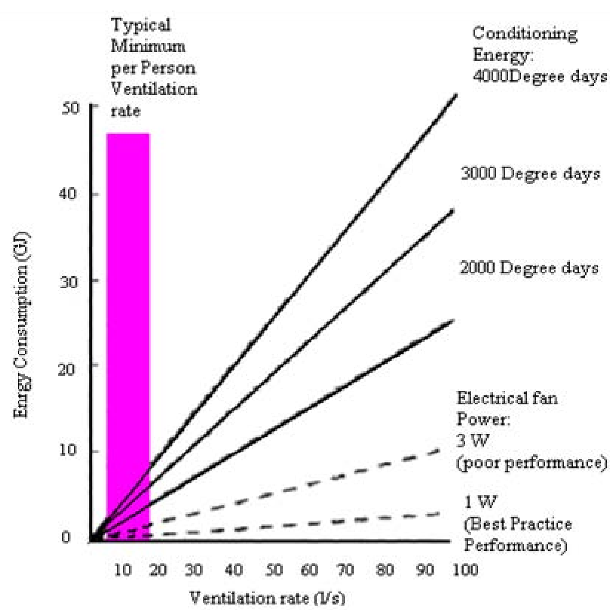

Figure 6: Energy impact of ventilation

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It was proposed that the central system objectives were to maintain indoor environmental quality within a predefined control volume, i.e., within parameters, while considering the best course of action with respect to energy and cost efficiencies. Temperature and relative humidity were assigned upper limits, lower limits, and preferred values to be sought when they were achievable without adversely affecting cost or energy efficiencies.

Table 14: EU member states greenhouse gas (GHG) emissions

Country	1990	1999	Change 1990-99	Reduction target
Austria	76.9	79.2	2.6%	-13%
Belgium	136.7	140.4	2.8%	-7.5%
Denmark	70.0	73.0	4.0%	-21.0%
Finland	77.1	76.2	-1.1%	0.0%
France	545.7	544.5	-0.2%	0.0%
Germany	1206.5	982.4	-18.7%	-21.0%
Greece	105.3	123.2	16.9%	25.0%
Ireland	53.5	65.3	22.1%	13.0%
Italy	518.3	541.1	4.4%	-6.5%
Luxembourg	10.8	6.1	-43.3%	-28.0%
Netherlands	215.8	230.1	6.1%	-6.0%
Portugal	64.6	79.3	22.4%	27.0%
Spain	305.8	380.2	23.2%	15.0%
Sweden	69.5	70.7	1.5%	4.0%
United Kingdom	741.9	637.9	-14.4%	-12.5%
Total EU-15	4199	4030	-4.0%	-8.0%

a) Wastes Management

Waste is defined as an unwanted material that is being discarded. Stuff is waste even when it is being taken for use, recycling or reclamation. Wastes produced at household, commercial and industrial premises are control waste and comes under all the waste regularly. Waste Incineration Directive (WID) emissions limit values will favour efficient, inherently cleaner technologies that do not need to rely heavily on abatement. For existing plant, the requirements together are likely to lead to improved control of:

- NO_x emissions, by the adoption of infurnace combustion control and abatement techniques
- Acid gases, by the adoption of abatement techniques and optimisation of their control
- Particulate control techniques, and their optimisation, e.g., of bag filters and electrostatic precipitators.

The waste and resources action programme has been working hard to reduce demand for virgin aggregates and market uptake of recycled and secondary alternatives. The programme is targeted:

- To deliver training and information on the role of recycling and secondary aggregates in sustainable construction for influences in the supply chain, and
- Develop a promotional programme to highlight the new information on websites.

b) Chemical Wastes

Humans and wildlife are being contaminated by a host of commonly used chemicals in food packaging and furniture, according to the World Wildlife Federation (WWF) and European Union. The chemical industry has been under no obligation to make the information public. The new rules would change this. ''Future dangers will only be averted if the effects of chemicals are exposed and then the dangerous ones are never used''. Chemicals used for jacket waterproofing, food packaging and non-stick coatings have been found in dolphins, whales, cormorants, seals, sea eagles and polar bears from the Mediterranean to the Baltic.

The European Commission has adopted an ambitious action plan to improve the development and wider use of environmental technologies such as recycling systems for wastewater in industrial processes, energy-saving car engines and soil remediation techniques, using hydrogen and fuel cells. The legislation that has not been implemented in time concerns the incineration of waste, air quality limit, values for benzene and carbon monoxide, national emission ceilings for sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia and large combustion plants.

c) Mitigation Measures

Potential mitigation measures to decrease GHG emissions from the oil industry and decelerate the threat of global climate change may include the following:

- Controlling GHGs emissions by improving the efficiency of energy use, changing equipment and operating procedures.
- Controlling GHGs emission detection techniques in oil production, transportation and refining processes.

- More efficient use of energy-intensive materials and changes in consumption patterns.
- A shift to low carbon fuels, especially in designing new refineries.
- The development of alternative energy sources (e.g., biomass, solar, wind, hydro-electrical and cogeneration).
- The development of effective environment standards, policies, laws and regulations particularly in the field of oil industry.
- Activating and supporting environmental and pollution control activities to effectively cope with the evolving oil industry.

VIII. Recommendations

- Launching of public awareness campaigns among local investors particularly small-scale entrepreneurs and end users of RET to highlight the importance and benefits of renewable, particularly solar, wind, and biomass energies.
- Amendment of the encouragement of investment act, to include furthers concessions, facilities, tax holidays, and preferential treatment to attract national and foreign capital investment.
- Allocation of a specific percentage of soft loans and grants obtained by governments to augment budgets of R&D related to manufacturing and commercialisation of RET.
- Governments should give incentives to encourage the household sector to use renewable energy instead of conventional energy.
- Execute joint investments between the private sector and the financing entities to disseminate the renewable with technical support from the research and development entities.
- Availing of training opportunities to personnel at different levels in donor countries and other developing countries to make use of their wide experience in application and commercialisation of RET particularly renewable energy.
- The governments should play a leading role in adopting renewable energy devices in public institutions e.g., schools, hospitals, government departments, police stations etc. for lighting, water pumping, water heating, communication and refrigeration.
- To encourage the private sector to assemble, install, repair and manufacture renewable energy devices via investment encouragement, more flexible licensing procedures.

IX. Conclusion

There is strong scientific evidence that the average temperature of the earth's surface is rising. This was a result of the increased concentration of carbon dioxide and other GHGs in the atmosphere as released by burning fossil fuels. This global warming will eventually lead to substantial changes in the world's climate, which will, in turn, have a major impact on human life and the built environment. Therefore, effort has to be made to reduce fossil energy use and to promote green energies, particularly in the building sector. Energy use reductions can be achieved by minimising the energy demand, by rational energy use, by recovering heat and the use of more green energies.

The study was a step towards achieving this goal. The adoption of green or sustainable approaches to the way in which society is run is seen as an important strategy in finding a solution to the energy problem. The key factors to reducing and controlling CO_2, which is the major contributor to global warming, are the use of alternative approaches to energy generation and the exploration of how these alternatives are used today and may be used in the future as green energy sources. Even with modest assumptions about the availability of land, comprehensive fuel-wood farming programmes offer significant energy, economic and environmental benefits. These benefits would be dispersed in rural areas where they are greatly needed and can serve as linkages for further rural economic development. The nations as a whole would benefit from savings in foreign exchange, improved energy security, and socio-economic improvements. With a nine-fold increase in forest – plantation cover, the nation's resource base would be greatly improved.

The international community would benefit from pollution reduction, climate mitigation, and the increased trading opportunities that arise from new income sources. The non-technical issues, which have recently gained attention, include: (1) Environmental and ecological factors e.g., carbon sequestration, reforestation and revegetation. (2) Renewables as a CO_2 neutral replacement for fossil fuels. (3) Greater recognition of the importance of renewable energy, particularly modern biomass energy carriers, at the policy and planning levels. (4) Greater recognition of the difficulties of gathering good and reliable renewable energy data, and efforts to improve it. (5) Studies on the detrimental health efforts of biomass energy particularly from traditional energy users.

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Economic and Environmental Management of Water Resources: Perspective of Groundwater

By Yohannes Yihdego & Alamgir Khalil
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Abstract- Subsurface water has a substantial economic value in drinking and irrigation water across the globe. Failure to recognise the economic value has led to wasteful and environmentally damaging uses of the resource. When the groundwater resource gets depleted, groundwater development costs increase and the aquifers 'capacity to provide the variety of environmental services, decreases with sinking groundwater level and diminished natural discharge. The cost of abstracting the fresh water increases with the need to lift groundwater from increasingly greater depths, and hence the cost-benefit ratio of groundwater use changes over time. The procedure of discounting adjusts for future values of related services by accounting for time differences. Environmental costs are rather difficult to assess and incorporate in groundwater resources management. Environmental damage costs refer to non-use values attached to a healthy functioning aquatic ecosystem, while the costs to those who use the water environment refer to the corresponding use values. This paper highlights the aspects relevant for decisions to groundwater management and rate of storage depletion and its financial implications.

Keywords: Water management; Economic value; Water resources; Groundwater; Hydrogeology; Sustainability.

GJHSS-B Classification: FOR Code: 040699

ECONOMICANDENVIRONMENTALMANAGEMENTOFWATERRESOURCESPERSPECTIVEOFGROUNDWATER

Strictly as per the compliance and regulations of:

Economic and Environmental Management of Water Resources: Perspective of Groundwater

Yohannes Yihdego [α] & Alamgir Khalil [σ]

Abstract- Subsurface water has a substantial economic value in drinking and irrigation water across the globe. Failure to recognise the economic value has led to wasteful and environmentally damaging uses of the resource. When the groundwater resource gets depleted, groundwater development costs increase and the aquifer's capacity to provide the variety of environmental services, decreases with sinking groundwater level and diminished natural discharge. The cost of abstracting the fresh water increases with the need to lift groundwater from increasingly greater depths, and hence the cost-benefit ratio of groundwater use changes over time. The procedure of discounting adjusts for future values of related services by accounting for time differences. Environmental costs are rather difficult to assess and incorporate in groundwater resources management. Environmental damage costs refer to non-use values attached to a healthy functioning aquatic ecosystem, while the costs to those who use the water environment refer to the corresponding use values. This paper highlights the aspects relevant for decisions to groundwater management and rate of storage depletion and its financial implications.

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I. Introduction

a) Economic and Financial Aspects of Storage Depletion

There are two major problems related to water use. First one is overconsumption that augments water scarcity (e.g. Asian and USA over drafting of ground water Rodell et al 2007; Kumar et al 2005) and the second is pollution (due to Industrial and human activities) which degrades water quality. Both these result in the fact that freshwater is a scarce resource. Water produces both benefits and costs due to consumption and supply. Benefits are increasing at a decreasing rate. It means that consuming more water will have more benefits but the benefits coming from initial quantity of water will decrease with additional quantities. The costs of water are increasing at an increasing rate. This means that the more water is consumed, the more resources are to be explored which may be costly to access and require additional investments in infrastructure without knowing quantitative perspective to future (Lehmann, 2016; Yihdego and Drury, 2016; Yihdego and Paffard, 2016)

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It goes without saying that groundwater abstraction has an economic value. However, keeping groundwater in situ has an economic value as well. When the groundwater resource gets depleted, groundwater development costs increase and the aquifer's capacity to provide the variety of environmental services, as described previously, decreases with sinking groundwater level and diminished natural discharge. Then operational cost of ground water extraction will be due to lifting it from increasingly greater depths, and hence the cost-benefit ratio of groundwater use will fluctuate over uncertain future time span. The procedure of discounting adjusts for future values of related services by accounting for time differences. There is a degree of uncertainty involved in assuming an appropriate discount rate and the discounting procedure is in practice less suitable to address values in the very long term. Higher discount rates by giving less weight to future net benefits encourage the present use of the resource (Dewsburya et al., 2016; Yihdego, 2017).

The expenses of groundwater extraction mainly depend on the efficiency of pump, the depth of water to be pumped, and energy cost. These costs increment with the increase in pumping depth and energy and decrease with the improvement in pump efficiency. The value of extraction also includes the price of the opportunity foregone due to extraction and the usage of the water now in preference to at some time in future. The user cost of water will depend on current costs associated with pumping and subsequently lowering of water table as well as the growing expenses of extraction for every future period. The rate of extraction in the present time frame will be effective only if the possibly higher expenses of pumping in future are correctly anticipated. Economic literature about groundwater stresses that when groundwater is pumped in independently competitive manner, pumpers have solid impetuses to disregard the client cost. In these conditions pumpers tend to regard ground water as an open source, with the outcome that rates of groundwater extraction surpass the economically proficient rate (National Research Council, 1997).

Failure to recognise the economic value has led to wasteful and environmentally damaging uses of the resource. In practice, factors contributing to groundwater depletion may include a lacking price signal reflecting the scarcity value of the groundwater threatened by depletion (Van der Gun & Lipponen, 2010; Yihdego et al., 2016a, 2016b). In general, basic economics require that the price of a service be at least as high as the cost of providing that service. In the context of water supply, sustainable cost recovery, which utilities are encouraged to aim for, includes operating and financing costs as well as the cost of renewing existing infrastructure (Molinos-Senante et al., 2016). Rogers et al. (2002) argue that sustainable and efficient use of water require the tariff to match not only costs of supply (*i.e.*, operation and management, capital costs), but also opportunity costs, economic externality costs, and environmental externality costs. From the perspective of economic theory, there is a so-called contemporaneous opportunity cost for not having the water available for another current use. If current use depletes the groundwater stock to the extent that it makes groundwater unavailable for future, then there is the intertemporal opportunity cost of not having the water available for future use. Water uses may have an additional charge if the use of water renders it unfit for other uses by hurting water quality, hence having negative impacts on other water users (Borrego-Marín et al., 2016).

Groundwater storage depletion and the associated groundwater level declines have two-fold economic impacts for those interested in groundwater abstraction: higher groundwater development cost and a reduced value of the remaining groundwater volume stored. They may have a negative impact as well on groundwater-related environmental functions and conditions. All these consequences constitute an economic loss, only acceptable if balanced or exceeded by the benefits produced by the abstracted groundwater (Kim & Schaible, 2000). How economic and financial aspects are or may be taken into account in decisions on groundwater development depends on the perspective: an exclusive groundwater pumper will have different interests and thus will make different decisions related to the aquifer's exploitation than the local community. This will be illustrated below.

A farmer who owns and uses a well for the supply of irrigation water will be unpleasantly surprised if he is confronted by steadily declining groundwater levels, year after year. From the onset, the water level declines will reduce well yield and increase the unit cost of pumping, thus gradually eroding profits of irrigated agriculture. Investments may be needed after some time to deepen the well and to replace the pump by a more powerful one. Whether these investments are made by the farmer or not depends on his judgment on the economic feasibility of continued groundwater pumping and his access to the necessary financing. Many individual farmers will sooner or later decide to give up because the economic profitability of pumping is disappearing or they cannot afford to continue pumping. This effect provides feedback from the users of the aquifer system, contributing to the conservation of groundwater.

The individual farmer will be concerned about increasing pumping costs of his well. However, he usually does not care about how he contributes to a reduction in the volume and economic value of stored groundwater, nor to increased pumping cost of other groundwater users, nor to diminished access to future generations to groundwater, nor to groundwater-related environmental degradation. To him, these aspects are externalities', representing costs to be shared by all who make use of the same common pool in this case the aquifer and its related ecosystems. The existence of these externalities explains why decisions made at the individual level may diverge from socially optimal decisions, which is a justification for government interventions.

The Upper Guadiana Basin, where groundwater acts as the primary driver behind the region's prosperity by supporting irrigated agriculture for the past decades, illustrates the related management challenges (Marchiori et al., 2012). The development of irrigation based on groundwater from the Mancha Occidental aquifer has come at a significant environmental cost, giving rise to long-standing conflicts, and there are concerns as to its mid-term sustainability. Uncontrolled intensive pumping by individual farmers has dramatically lowered water tables and has caused considerable negative environmental impacts on groundwater-dependent wetlands, streams and rivers. A large proportion of the wells is currently illegal, which makes it difficult to manage water resources (Martínez-Santos et al., 2008; Conan et al., 2003).

At the level of the community, the mentioned externalities should be incorporated into the groundwater quantity management approach. Plans for groundwater management should consider not only the benefits of pumped groundwater and the increase of pumping cost due to storage depletion but also the associated change in the value of groundwater stored and the allocation of all cost and benefits including intergenerational allocation. This involves a rather complex balancing of components, which may be guided by optimisation approaches analogous to those presented by Kessler et al. (1992) for natural resources management in general. In cases that allow simplification, simple decision rules may be helpful. An example is Burt's approximate decision rule for intertemporal allocation of groundwater abstraction from remote groundwater reservoirs (Domenico, 1972).

Groundwater availability can be determined by means of the interaction of geological, hydrologic, and financial elements. The quantities of water available now and in the future rely on the interplay of extraction and recharge. The cost of acquiring ground water is determined with the aid of pumping depths, energy prices, and the price assigned to the opportunity foregone as a result of extracting groundwater now as opposed to later. Groundwater value relies upon both the price of acquiring it and the willingness of customers to pay, and willingness to pay depends critically on water quality (National Research Council, 1997).

Environmental costs are rather difficult to assess and incorporate in groundwater resources management (Jasch, 2003). They consist of the environmental damage costs of aquatic ecosystem degradation and depletion caused by a particular water use such as water abstraction. Following the definition in Newig et al. (2005), a distinction can be made between damage costs to the water environment and to those who use the water environment. Interpreted regarding the concept of total economic value, one could argue that the environmental damage costs refer to non-use values attached to a healthy functioning aquatic ecosystem, while the costs to those who use the water environment refer to the corresponding use values. Use values are associated with the actual or potential future use of a natural resource (e.g., drinking water, irrigation water). Non-use values are not related to any actual or potential future use but refer to values attached to the environment and natural resource conservation based on considerations that, for example, the environment should be preserved for future generations (Brouwer et al., 2004). In conclusion, groundwater storage depletion may have significant financial and economic implications. Therefore, these aspects are relevant for both individual decisions to be made and groundwater resources management about the rate of groundwater storage depletion.

b) Full value and Full cost of a single water use

There is a direct value of water to users. This refers to the willingness to pay for water or marginal product of water. There may be net benefits from return flow, for example water for irrigation may recharge groundwater so there will be return benefit from a return flow from irrigation. Net benefits may come from indirect uses of water, for instance water for irrigation may be at the same time available for drinking or livestock feeding. Also, adjustment has to be made for societal objectives such as food security. All these refer to an economic value of water. The intrinsic value of water and economic value of water refer to full value of water as shown in Figure 1 (Lehmann, 2016).

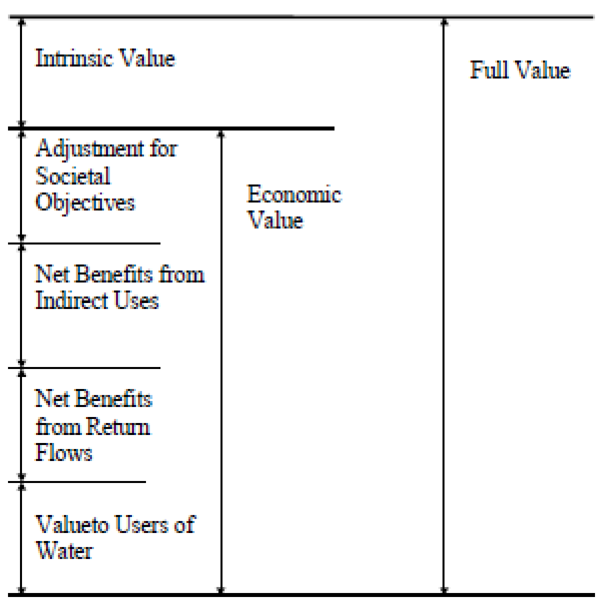

Figure 1: Full value of water (Rogers et al., 1998)

The cost of water will start with operation and maintenance of water, which arises from the daily supply of the water system. It includes the cost pumping water, repair cost and treatment cost. Capital costs refer to capital consumption and interest rates that has to be paid for loans. These correspond to the full supply costs of water. There may be opportunity cost by using water for one use and will not be available for other uses. For instance, water used for irrigation may not be available for drinking. Both full supply cost and opportunity cost correspond to full economic cost of water. External cost of water relates to the environmental cost of water. For example, pollution of water will forgo its use for other useful purposes. Full cost and external cost correspond to full cost of water as shown in Figure 2 (Lehmann, 2016).

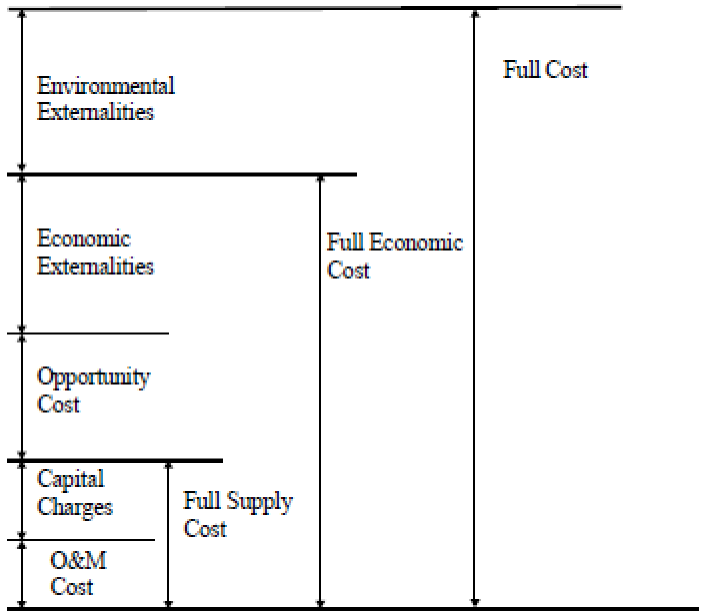

Figure 2: Full cost of water (Rogers et al., 1998)

c) Valuation techniques for groundwater

Water is regularly underestimated and under-valued. Policy makers and stakeholders are frequently unaware of the total economic value of the resource. For this reason, groundwater is not properly managed and is progressively under the danger of contamination and depletion (e.g. Asian countries like Pakistan, India and Bangladesh are at worse in this case having -2 cm mining per year). For a demanding groundwater management, it is important to determine its economic value and should consider it as an economic resource. Estimates of value can play a prime role in directing policy-makers and public attention on vulnerable undervalued resources. Such estimates are essential for determining the extent of funding in groundwater development, security, tracking, and management which can be financially advocated. The total economic value of groundwater is composed of both use values (for instance, extractive and in situ values) and non-use values (for example, bequest and existence values). In this scenarios the suitable methodologies may be adopted to determine the both use and non-use values for future perspective. (Pulido-Velazquez et al., 2013).

d) Market-based valuation techniques

For market value base evaluation, we can measure values via actual costs in market exchanges. For instance, supply of groundwater for irrigation. Since this water has a market value, therefore statistical approaches (econometric techniques) can be used to estimate this. Unfortunately, effects such as enhancements in quality of groundwater, ecosystems that dependent on groundwater etc. are not reflected in market transactions (Pulido-Velazquez et al., 2013). Therefore, it is essential to measure qualitative, quantities and environmental aspects as market transactions to help out policy makers for developing proper framework to incorporate ground water selling.

e) Non-market valuation techniques

These approaches are used when costs for goods and services of groundwater do not reflect the real value or when there is no available price but still the value needs to be determined for decision making. These approaches can be grouped into revealed and quantified preference methods.

Revealed preference method is based on actual observable choices and from which actual resource values can be directly inferred, mostly based on actual market prices or costs incurred (for example, hedonic pricing to decide the economic value of groundwater based ecosystems). Stated preference method is based on elicit respondents willingness to pay when the value is not directly observable (for instance, contingent valuation or choice experiments). Some applications to groundwater valuation are the assessment of the benefits of groundwater quality enhancements, or the full cost (environmental and resource expenses) of groundwater deterioration or depletion (Pulido-Velazquez et al., 2013).

The use of these approaches is frequently very costly and tedious, and needs specific skill. One option will be to deduce the estimation of groundwater value by interpreting the results acquired from different areas. Benefit transfer offers a quick and reasonably-priced opportunity to original valuation studies, but we have to be careful of their utility due to the fact a few situations ought to be met on the way to provide consistent estimates (Pulido-Velazquez et al., 2013).

f) Problem while defining cost in tragedy of commons

In market and non-market cost evaluation procedure is bound to some limits which need to defined properly. The simple example attached to ground water scarcities in supply economic supply regime is tragedy of commons proposed by Garret Hardin 1968. In south Asian countries like Pakistan, India and Bangladesh facing the problem with ground water supply system which is commonly cast-offed by individual masses based on their self-interests without knowing that how their selfishness will increase the cost of ground water in market to future. This may be removed by community driven approach to estimate the exact cost of each drop of ground water but it is not inevitable yet.

II. Groundwater Resources Development and Sustainability

a) Groundwater Storage: Blessing and Concern

Groundwater systems tend to have large volumes of water in storage, usually equivalent to the recharge of several tens to several thousands of years. These large storage volumes are a blessing, for some reasons. They keep water available during prolonged dry periods when no rain is occurring, and stream flows have become minimal or even zero. As a result, people have been able to settle in areas where otherwise human life would be impossible or onerous due to annually recurring dry seasons (most arid and semi-arid zones). Also even due to the absence of significant rain during the last centuries or millennia (e.g., a large part of Northern Africa, where most recent significant groundwater recharge occurred thousands of years ago) (De Vries et al., 2000). Available groundwater storage does contribute not only to reliable public and industrial water supplies but also to reliable irrigation water supplies. The latter is not only necessary to secure food supplies, but it also has very positive economic impacts. The fact that groundwater sources tend to be more reliable and predictable than surface water sources often results in significantly higher economic returns per cubic meter of water used for irrigation (Shah et al., 2007; Llamas & Martínez-Santos, 2005).

The same groundwater storage provides a reason for concern as well. If surface water users abstract water from streams at a hydrologically unsustainable rate, then most streams will rather quickly give feedback by reducing their flow rates, which forces abstractions to be reduced or even to be stopped. In the case of intensive groundwater abstraction, the feedback is much weaker. Groundwater levels will drop indeed, but the large groundwater volume in storage allows well owners to continue excessive pumping usually for many years. Consequently, pro-active rather than reactive groundwater quantity management is needed to protect the sustainability of the aquifer‘s abstraction potential and its groundwater-related environmental functions. As a sound basis for making the related decisions, groundwater monitoring with sufficient spatial and temporal resolution is required for detecting and observing storage depletion reliably (e.g.India and Pakistan). Lack of control may lead to practically irreversible losses of aquifer functionalities, in other words, it may undermine sustainability. Yemen is illustrative for countries being exposed to such a risk (Ohisson, 2000).

It is crucial to understand that groundwater overdraft may be economically proficient in some cases. At the point when the advantages of utilization are very high in connection to the expenses of extraction (which include the consumer price), overdraft might be proficient for some timeframe. In times of dry season, for instance, when surface water supplies might be truant or scarcer than regular, overdraft might be productive. But this over drafting will no longer hold profitability if water table will accelerate to mining. In any case, even in circumstances where overdraft is productive, it will eventually act naturally ending. Furthermore, in assessing the monetary desirability of overdraft, we need to account for certain unfavourable impacts, which include land subsidence, salt water intrusion, and harmful outcomes on surface water and aquatic habitats which will be curse to broken if consider the over drafting to be productive (National Research Council, 1997).

b) Groundwater Quantity Management is Based on Preferences

As mentioned before, groundwater pumping causes depletion of groundwater storage and changes the groundwater regime, thus modifying groundwater levels, groundwater in- and outflows and groundwater quality. These modifications have their impacts on people, ecosystems and the environment. In the majority of cases, such effects are negative, as opposed to the predictable positive results to the abstracted groundwater. One should be aware that consequences do not only depend on the rate of abstraction, but also in their spatial arrangement, quantification, quality parameters, pumping schedules and other constraints. Simulation models may help to explore the role of these factors. Furthermore, to what extent an impact is considered negative or positive is a judgment that is both subjective and dependent on time and location. For example, the disappearance of water-logging conditions due to pumping may have been considered fifty years ago by most people as wasteland recovery‘, whereas the same feature in several parts of the world nowadays tends to be considered rather as a loss of a valuable wetland.

It is an illusion to think that proper groundwater management will allow groundwater abstraction to take place without affecting any of the aquifer‘s functions and services negatively. One has to sacrifice almost always something in exchange. Therefore, the designation sustainable 'should not be interpreted too rigorously. As long as groundwater pumping does not threaten to exhaust the aquifer and society consider the benefits from pumping to outweigh the associated negative impacts both integrated over a prolonged period, one may speak of sustainable groundwater development. It is the challenge of groundwater resources management to strike a balance between the gains due to pumping, and the losses pumping may cause as a result of depletion. This balance is based on preferences, not on absolute 'values derived from knowledge. In more technical terms, one may characterise this as a multi-objective decision process moving along the Pareto frontier rather than an optimisation process subject to constraints (Vrugt et al., 2003). It is important to consider who benefits and who loses when the balance and distribution of costs and benefits upon the abstraction of the resource evolves. Hence, equity is a shared objective in the decision process, together with other key objectives such as meeting basic needs for water, sustainability of the water sources and economic efficiency. The decision process requires sufficient reliable local data to be available and will benefit from a proper diagnostic analysis and intelligent use of decision support systems (Simonovic, 1996).

After adopting preferences as a core element of decision-making in groundwater management, it remains to be decided whose preferences should be considered, how to define these preferences and how to incorporate them into the planning process. In most parts of the world, the idea is winning ground that not only technical specialists and politicians should be involved, but local stakeholders as well. After all, their interests are at stake, their perceptions of the local conditions and problems may give valuable guidance, and their support is crucial for the successful implementation of groundwater management measures. Therefore, stakeholder participation is becoming in many parts of the world an important component of groundwater resources management.

c) Dominating Concerns and Constraints Vary Geographically

Although groundwater resources management is based on preferences, geographical variations in physical and socio-economic setting leave their mark as well. Evidently, in water-scarce arid and semi-arid zones where no significant surface water resources are available, people readily sacrifice groundwater-related environmental functions if that will allow them to pump more groundwater. In more humid zones, the relative abundance of water and the presence of surface water as an alternative source of water tend to favour shifting priorities to conserving springs, base flows, wetlands and other groundwater-supported features.

This leads to adopting constraints to groundwater pumping that are much more restrictive than the water budget constraint, especially in wealthy countries that can afford a relatively high cost of water supplies (Kalf & Woolley, 2005). Furthermore, groundwater pumping regimes in coastal areas are first and for all constrained by the priority of preventing intrusion of sea water or upcoming of saline water underlying fresh groundwater. These and other differences in the setting are reflected in distinct geographical patterns of dominating constraints to groundwater pumping.

The topographical substrate of aquifers varies from area to area, with materials starting from coarse sediments to cracked rock. Substrates that consist of fine grained deposits such as clays tend to compact whilst water is eliminated, ensuing in removal of the pore spaces that formerly contained water. Hence expelling water decreases the water holding capability of the aquifer. In addition, the land subsidence may occur when compaction happens in such aquifers. This may bring about serious interruption of utilities, for example, sewer and water lines and harm to structures and streets. Subsidence can likewise bring about flooding, especially in seaside territories (National Research Council, 1997).

d) What Matters is Overall Sustainability

Groundwater systems are important, but their importance from a human perspective lies mainly in the functions and services they provide. Partially, these functions and services are not unique to groundwater systems and may be provided by other water system components as well. This is, in particular, the case for the water supply function: in most regions, one may choose between groundwater and surface water, or even desalinized seawater and non-conventional sources such as treated wastewater, as alternative sources for satisfying the same water demand. Therefore, overall sustainability is necessary, (*i.e.*, the viability of valuable functions and services, rather than the sustainability of the groundwater systems). The consequence is that groundwater development and management should be viewed in an integrated water resources management perspective, or even in a broader regional development context (Wu et al., 2015). The key question then is not whether the elaboration of a particular groundwater system is sustainable, but rather whether the complex of natural resources (to which that groundwater system belongs) allows and supports sustainable socio-economic development and preservation of desired environmental conditions in the region. Even properly planned development of non-renewable groundwater resources indeed a non-sustainable activity in the physical sense could in principle contribute to this overall sustainability.

III. Conclusions

Sustainability is a very complex concept. Its reasonable interpretation depends on the systems considered, the angle of view, the overall local context and subjective comparisons between alternative futures. Applied to groundwater abstraction, it makes a difference whether one has sustainable pumping in mind or the sustainability of the local society and ecosystems. In the latter perspective, even unsustainable pumping from a non-renewable groundwater resource might contribute to sustainable development, provided that other water resources are available to meet water demands on the long run after the non-renewable groundwater resource is exhausted. Furthermore, the extent of storage depletion due to pumping may vary from case to case, and the same applies to the impacts of storage consumption. Such effects tend to be more severe in arid than in humid climates, because buffering by other components of the water cycle there is less likely to occur. Also, whether one can cope with individual physical impacts varies according to the local conditions. Wealthy developed societies with good access to financial resources and technology are in this respect in a more favourable position than poor developing countries.

Whatever perspective is chosen, it is clear that groundwater development always comes at a cost (environmental, financial or otherwise). It is up to society to decide whether this cost is balanced or outweighed by the benefits of the abstracted groundwater and does not threaten sustainable development. To underpin such a decision adequately, it is important to have a good picture of the groundwater system considered, to understand its response to pumping (avoiding the water budget myth and other erroneous concepts) and to oversee its socio-economic and environmental setting.

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Impact of Urban Expansion on Surrounding Peasant Land the Case of Boloso Sore Woreda, Areka Town, SNNPR, Ethiopia

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Abstract- The main objective of the study was to assess the impact of urban expansion on surrounding peasant land in Areka town. The data were obtained from 68 randomly selected respondents by using questionnaires and interview from municipality office workers other illiterate indigenous peoples of the town as well as from secondary sources were also included. To analysis the collected data were edited, tabulated, percentage and finally descriptive method was employed. The result revealed that there are many factors causing urban expansion to surrounding peasant land: those are establishment of market, infrastructure, rural to urban migration and positive consequences of urban expansion. Such as advance in communication, eclectic power, health and education facilities and also negative consequences of urban expansion such as loss of agricultural land, expansions of crimes, urban pollution and housing problems and lastly the pattern of urban expansion are the major ones. To regulate the impacts of urban expansion that found in the town the participation of government and dwellers of the town are very necessary .

Keywords: *agriculture land, urban expansion, peasant, urbanization.*

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IMPACTOFURBAN EXPANSION ON SURROUNDING PEASANTLANDTHE CASEOFBOLOSO SOREWOREDAAREKATOWNSNNPRETHIOPIA

Strictly as per the compliance and regulations of:

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I. Introduction

a) Background of the Study

In historical terms, urbanization on any scale is essentially a recent. A feature of the last 100 and years. Urbanization has been estimated that before the beginning of the 19th C only 3% of the world's population lived in town of over 5000 people. By the present this has risen to near 4%. Expressed in a different way the world, population increased ¾ between 1800 and 1960. The world urban population increased thirty-four. Between 1950 and 1970 the world population rose from 28% to 38% (Devis,1972).

The UN defines urbanization as the course of shift in population from a rural to urban civilization. Numerically expressed urbanization denotes the increases in the share of the population that resides in urban areas predominantly because of net rural to urban migration (Devis, 1972).

In most conscious features of today's accelerated world population growth its even greater rapidity of urbanization. In many periods of history population cities have grown, but the change and dimensions of recent years have never been balanced. It follows that urbanization is the dominant process in the special organization of the world populations (UNFPA, 2007).

The association of industrialization with urbanization in the West conceals that the fact urban growth is the most consumption in developing countries indeed the areas of massive contemporary in the gradual South ward movement of the means latitude of the largest cities (UN, 1987).

Many countries in Sub-Saharan Africa have recently experienced urban expansion. According to 2004 UN report on world urbanization prospects in 1950, there were only 20 million people or 10-15% of the total population, living in urban areas in the Sub-Saharan Africa, Urban population also expected to be approximately 150 million in 1990. Its growth rate was 5% in the world per annum according to Woailta zone development office. Areka town is one of the Woreda city and its consists towns. the towns, in this towns are Gara Godo, Dola, Hembecho, Woybo and Achura are the preeminent in their urbanization process and critical to land use change that is loss of agricultural and socio-economic problems of the displace people (Toddaro, 2002).

b) Statement of the Problem

Housing shortage and poor housing conditions, the result of massive urbanization are life threatening, sub standard housing, unsafe water and poor sanitation in densely populated cities are responsible for 10 million deaths worldwide every years and area major factor in preventable environmental hazards, which are responsible for 25% of all premature deaths worldwide (UN – Habitat, 2003).

Urban expansion have significant impact on biodiversity hot spots around in the worlds moreover, urban expansion will encroach on or destroy habitat for 139 amphibians 41 mammalians and 25 birds species that are easier on the critically endangered lists of the international union for conservation of natural environment (WWW.Environmetn,YaleEdv). The phenol-mena of urban heat is land has become a growing concern. Incidence heat island is formed when industrial

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and urban areas are developing resulting in greater production and retention of rural area (Partk – H – S, 1987).

A large proportion of solar energy that affects, rural area is consumed evaporating water from vegetation and soil. In cities, where there is less vegetation and exposed soil, the majority of the sun's energy is absorbed by urban structures and aspects. Hence, during warm day light hours, less evaporative cooling in cities results in higher surface temperature than in rural areas (Grant – Ursula, 2008).

Urban expansion is the main problems in most developing countries. Our country Ethiopia also one of the country's facing the problem of urban expansion. It has been expansion or experiencing rapidly agricultural land use transformation in to urban land use due to expensive urban expansion. This town increases in size from time to time by four sides. That means North, South, West and East side. The urban expansion affects peasant land due to this expansion of town many farmers displaced from their land and loss of their farming land.

c) Objective of the Study

i. General Objectives

The general objectives of this study are to assess the major impacts of urban expansion on rural areas of surrounding peasants land in Areka town.

ii. Specific Objectives

The specific objectives of this study is

- To identify the pattern of urban expansion of Areka town.
- To examine the positive consequence of urban expansion to surrounding peasant land.
- To determine the cause of urban expansion in Areka town
- To indentify the negative impact of urban expansion to surrounding community.

iii. Research Questions

- What does the urban expansion of Areka town look like?
- What are the major causes of urban expansion study area?
- What is the negative consequence of urban expansion to surrounding community?
- What are the positive consequences of urban expansion to surrounding peasant?

d) Significance of the Study

The first and foremost reason of urban expansion is increase in urban population. Rapid growth of town population growth factors are natural increase in population and migration to urban area searching job opportunities better life and others. Both internal and external migrations contribute to urban expansion, in addition to: -

- It uses to create safe and quality urban environment.
- To conduct further research to address the concern of displaced people.
- To serves as to understand current or now environmental problems that is infrastructure.
- To provide solution for in the study area.
- It helps the administers and municipality workers of the town to take the information about urban growth and conducted problems.
- It serves as a bass of the study to conduct for research study.
- It forward some result to surrounding peasants who affected directly or indirectly by urban expansion in area.
- It provides information for those who will like to conduct detailed and reliable studies on the urban expansion impact on the agricultural lands.

e) Scope/Delimitation of the Study

This study was conducted in Boloso Sore Woreda, Areka town particularly in Areka town, the town has been expanding horizontally to all direction and the Kebeles that are found on the surrounding of the towns are subject to this study. This study also focuses on the impacts causes, consequences and patterns of urban expansion in the study area.

f) Limitation of the Study

The main limitation of the study was the reactance of the interviewers to give reliable information and Woreda has poor documentation system farther more some officials and authorities are not willing to give the required information.

II. Review of Related Literatures

a) Concept of Urbanization

The concept of urbanization is defined in different but interconnected ways Wough. urbanization is a processes by which rural and areas are transformed in to town areas and which included the growth of city population and natural increases of population (Wough, 1990).

Urbanization is defined as an increasing share of a nations of population living in urban areas and those a declining share living in rural areas. Most urbanization is the result of net rural to urban migration. A nations city population can grow from natural increase (Births Minces) deaths, net rural to urban migration and reclassification /as what was previously a rural settlement becomes classified as urban or an urban settlement boundaries are explained or expansion bringing in to its population or people who will peevishly classified as rural. Perhaps the most significant features of world urbanization are recently of its dominance. It has been estimated that before the start of the 19th C only 3% of the world's population lived in towns of over 500.

At the present time the figure is probably about 40%. Urban center have existed and have been evolving for many centuries across the world. However, the accelerated growth of urbanization is relatively a recent phenomena (Hall, 1973).

The enormous size of urban populations and more significantly, the city rapidity with which the urban areas have been and are grown in many developing countries. Urban population sub-Saharan Africa (SSSA) was projected to be approximately 150 million in 1909. They are growing rapidly. It will be expected to be about 260 million by 2000 (Potts, 2009).

The history of urbanization in Ethiopia goes to back the Axumite civilization. during this time there were a number of town, commerce had flourished countries. Later, this urban culture began to shift Lalibela and Gondar, However, the development was also facing the some rate of urbanization of expand (UN, 1969).

b) Pattern and Trend of Urban Growth in Ethiopia

Ethiopia, being the third popular country in Africa is one of the least urbanized. Its urban population constitutes 15% like most developing countries. Ethiopia, urban population is concentrated in one primate city of Addis Ababa representing 28.4% of the total urban population (Fessusu and Detachew, 2002).

At national level, the level and trends of urbanization indicates significant regional variation. For example Addis Ababa (28.4%) Amhara 17.32%) Oromia 17% SNNPR 15.2%, Tigray 15.2% and Gambela 9.62% respectively. Addis Ababa at 100% of urbanization is most urbanized and urban population in a country and Gambela has the lowest urban population the average mean of 9.6% (CSA, 2008).

Ethiopia is currently of the least urbanized countries in the world even Africa. Fewer than one person in five is city or town dweller. However, the rate of at which the countries urban areas the growing are among the highest in Africa. Many social, economic and environment problems have accomplined urbanization in Ethiopia and have been ignored for too long (Girma, 2004).

The people residing in urban areas also increasing from 4-3 million in 1987 to 7-4 million in 1994, which is estimated to have already reached 10-6 million in the year 2003 and projected to reach 20 million by the year 2020 (NUPI, 2003).

c) Causes of Urban Expansion

In line with broad historical trends elsewhere, rural to urban migration in developing countries constitutes the single most important cause of the rapid growth of the urban population migration from rural as population and in exceptional causes, as much as 75% in sub-Saharan Africa (Todaro, 2000).

Although rural to urban migration due to poverty in rural areas results from low agricultural productivity and due to rural areas are relatively, under served in terms of physical financial and economic infrastructure (Todaro, 2000).

Urbanization occurs as individually, commercial, social and governmental efforts reduce time and expense in commuting and transportation and improve opportunities for jobs, education, housing and transportation. Cities are known to be place where money, services, wealth and opportunities are centralized. Many rural inhabitants come to the city for the reasons for seeking for turns of social mobility, Businesses, which provides jobs and exchange of capital, are more concentrated in urban areas (Todaro, 2000).

Although the process of urbanization happens in both developed countries and least developed countries the fastest growing cities in the world are in least developed countries. The reasons for the growth of urban areas include lack of and poor employment opportunities in the country side over population and poor crop yields are all push factors – why people leave the country side. Better paid jobs in the cities an expected higher standard of living and more reliable food are an others factors why people are attracted to the city.

A nations urban population grow from natural increase birth minus deaths, net rural to urban migration and reclassification (as what was previously a rural settlement becomes classified as urban areas a urban settlements boundaries are expanded (BBC, 2014).

d) Negative Impact of urbanization

i. *The Environmental Impact of Urban Expansion*

The phenomena of urban heat islands have become a growing concern. Incidence of this phenomena as well as concern about it has increased over the years. Urban heat is land are formed when industrial and urban areas are developed resulting in greater production and retention of heat. A large proportion of solar energy that affects rural areas is consumed evaporating water from vegetation and exposed cites, where there is less vegetation and exposed soil (Park, 1987).

The paved surface in urban area creates runoff during rain storms. This run off pick up oil chemicals and gravel from the pavement and grass. These chemicals would usually be filtered out of water affected, fertilizers from yards, runoff in to streams causing algae blooms- the algae blooms decrease the oxygen in the water killing the fish and the water supply for the towns (C. Flore, 2007).

Urban expansion also results in less ground water, more paved surface means that there is less in filtration for ground water. Areas that depends on ground water as surface of public water supply are facing a water crises as the quality becomes depleted (Hardoy et al, 2001).

Urban expansion is not accompanied by environmental protection system. Urban waste is relay on open canals, open drains in the road side and holes in the ground as regular means of waste disposal particularly in the expansion area. This exposes the dwellers to sanitation related diseases and air pollution. In addition to farm land, environmental resources such as clean air and water peace and quietly access to the country side and recreational facilities are environmental values that rural farming community loss due to urban expansion (Balk et al, 2001).

ii. *Economic Impacts of Urbanization*

As activities develop, effects can include a dramatic increase and change in costs often pricing the local working class out of the market including such functionality as employs of the local municipalities (Grant Ursula, 2008).

Urban problems along with infrastructure developments are also fueling sub urbanization trends in developing nations through the trend for core cities inside nations tend to continue to become ever denser (Glaser Edulard, 1998).

In developing countries peoples are migrating to urban centers. From the center the poor move to periphery for urban renewal or squatting. This areas need provision of infrastructure of road, power line, water pipes and drainage line. This requires development cost that draws on the financial capacity of the municipal government. In many cases of municipality cannot afford to provide and people remain deficient to basic means of life. Because of this is most of the residents are exposed relatively to high cost of living. In some case urbanization does not involve economic growth but economic stagnation or low growth, mainly contributing to slum growth in sub-Saharan Africa and parts of Asia this type of urbanization involves a high rate of unemployment in sufficient financial resources and in consistent urban planning policy (Cheru F. 2005).

iii. *Social Consequence of Urbanization*

The increase in the world urban population will be most dramatic in the poorest and least developed or urbanized continents. Asia and Africa one billion people, seventh of the world population or one third of urban population now live in shanty towns, which as seen as breeding grounds, for social problems such as crime, drug, addition alcoholism, poverty and unemployment. There is increasing competition for facilities in urban areas which results in several negative affects many people mainly farmers who have move to cities in search of a better life and occupational opportunities and dup a casual laborers this lead to menacing problems of urban growth slum (Rashid Farid, 2012).

III. Research Methodology

a) Research Design

The researcher choice to qualitative type of research because the researcher will go to assess initiating factors of peasant land on local farmers at the study area. Quantitative and qualitative approach are applicable to phenomena that can be expressed in terms of quantity and to discover the motive of human behavior.

b) Sampling Techniques and Sample Size

Due to time and finance time, the researcher took only one Kebele from the four Kebele of the town: there are (01/ Kalehiwit number 1 Sefari, 02/ Meseret: Kiritose Church Sefar, 03/Maged Sefar, 04 / Mikael Chruch Sefari). Which is Kebele 02 due to high occurrence of the problem. So the researcher used simple random sampling method to select and take the respondents from the total households in the Kebele. The Kebele 02 have a total household of 4820 and from 2300 were male headed households and 2020 were female headed households. From the total households 10% were selected as sample respondents, which is 63 households.

c) Types and Sources of Data

In order to achieve the stated objectives both primary and secondary data was collected from primary and secondary data sources. Primary data was obtained from key information interview from municipality office workers and from other illiterate indigenous peoples of the town and questionnaires from selected respondents was employed. Secondary data was collected from various written materials, published and unpublished books, reports and from internet.

d) Methods of Data Collection

In this study, the researcher was made interview with the municipality workers and for other indigenous residents of the town to get reliable data and the next was questionnaires of similar type which include both open and close ended questions to the respondents was employed.

e) Method of Data Procedure

There was a different collection tools that were used in this study. The primary data was collected by questionnaires, which was distributed to sample respondents. In addition to the questionnaire data that was obtained by through interview with municipality workers and some indigenous people.

f) Methods of Data Analysis

The qualitative data such as data from interview and other secondary sources was analyzed in the form to essay. The data that was collected from sample respondents through questionnaire was statistically processed and some descriptive parameters like percentage, frequency, pie chart and tables were used to present data.

g) Ethical Consideration in the Field Work

During gathering information from different concerned bodies the researcher were show positive approach at any time for the respondents. The respondents asked question given by (answer) different things according to the need of the researcher. The respondents are giving clear information to the researcher asked question. The respondents are does not showed unethical behaviors.

IV. Description of the Study Area

a) Location and Size

Boloso Sore Woreda is located in Wolaita Zone, SNNPR state of Ethiopia and it include 12 Woreda's and 3 city administrations. Astronomically, the Woreda is located between 7000" 00' and 7011"00' N Latitude and 370 00"00' and 37050"00' E longitude. The Woreda capital Boloso Sore is found 299 km away from the country capital Addis Abeba , 158km away from Regional capital, Hawassa and 29 km from Sodo Which is capital city of Wolaita zone. The Woreda with a total land area of 28,800 hectare is further divided in to 29 rural kebeles. It is bordered with Kambata Tembaro Zone in the North, Damot Sore Woreda in the South, Boloso Bombe Woreda in the West and Damote Gale worda east and Badawacho Woreda of Hadiya Zone in the east.

The study area Arek is a major town of Boloso Sore Woreda and it was established 1955 E.C changed from Boloso Sore to area at the time of empire Haile Sellasie. This town also relatively located on the South of Yukara Kebele, on the West Tadisa Kebele on the East Dubo Kebele, on the North Wurimuma Kebele.

The two rivers are Kullia and Ululo which flows to North direction of the town on the West and East respectively bounds the town from both sides. These towns for from 299 km to Addis Ababa and 29 km from Sodo Which is capital city of Wolaita zone (Municipality Office, 2006).

b) Climate

Agro climatically, the Woreda is classified as Woina Dega which covers 83% of total area and the remaining 17% is Dega (BSWARD offices, 2014), where favorable climate condition for settlement. The average temperature varies between 10 to 20 . Rain is occurs during June to August and September is a transitional period between rainy and dry season and the annual rain fall of the Woreda is 1201mm to 1600mm (Wolaita Zone Metrological offices, 2014).

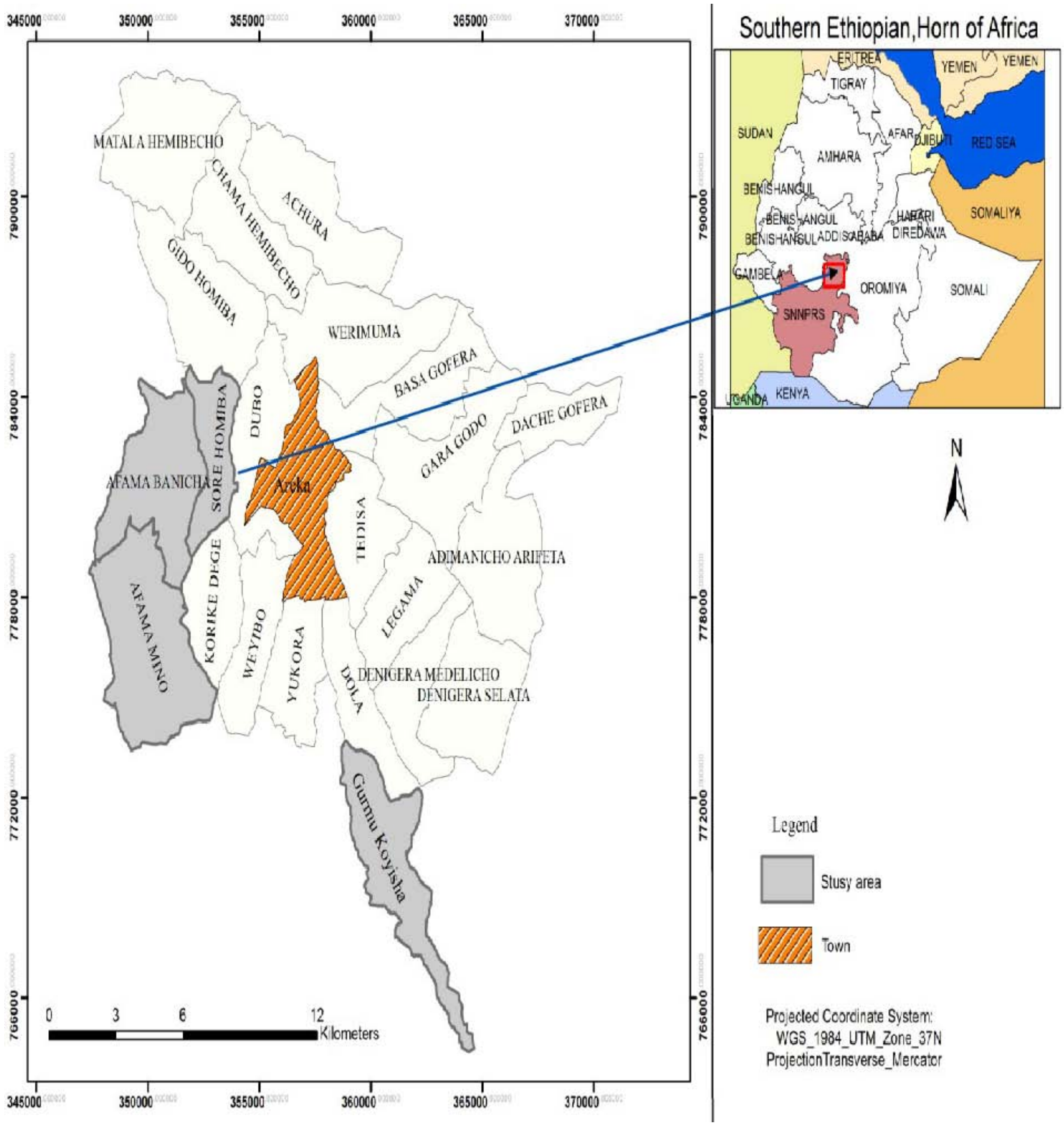

Figure 1: Map of the study area

The study area Arek is a major town of Boloso Sore Woreda and it was established 1955 E.C changed from Boloso Sore to area at the time of empire Haile Sellasie. This town also relatively located on the South of Yukara Kebele, on the West Tadisa Kebele on the East Dubo Kebele, on the North Wurimuma Kebele.

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c) Socio-Economic Profile of Areka Town

i. *Demographic of the Study Area*

Based on 2000 census conducted by the CSA, this Woreda has a total population 60,000 of whom 29000 are male and 31,000 are female. From the total population only 9.18% are urban dwellers and the rest were rural dwellers. Particularly the study area have a total population of 60,000 from whom 29,000 were males and 31,000 were females according to municipality office of the town in 2007. This town has also a total households of the town, the selected Kebele to the study which is 02/Meserat Kiristos Sefari, have a total households from 2900 are female and 2000 are male households.

The majority of inhabitants of the town were protestant, with 60.85% of population, reporting that beliefs 42.8% follow Orthodox and 0.95% practiced traditional beliefs. The largest ethnic groups reported in Woreda Wolaita (97.78%) and all other ethnics groups made up (2.26%) of the total population of Woreda

(Municipal Office, 2006) Wolaita was the dominant first languages spoken by 99% of the inhabitants. The remaining 0.1% spoken other languages (Office, 2007).

ii. *Socio-Economic Condition*

The Boloso Sore Woreda is known by its practicing predominantly agriculture (arable farming and animal husbandry). The major agricultural production includes Maize, Teff, Coffee, Enset, Banana and others in their ecological zone.

The economics of the people in this Woreda also mainly on the agriculture and some peoples in the densely populated areas practices commercial activity (Agricultural and development Office, 2006). Peoples in the study area also engaged in different economic activities, majority of the practices commercial activities. Some people also produce food and drinks and some peoples are shop keepers, carpenter and traders. Others are engaged on government sectors for their livelihood (Municipality Office, 2006).

iii. *Infrastructure*

The study area has different infrastructures, but the supply is not balanced with the demands of the town. The sources of water supply to the town are from the steam, ground and little rivers and pipe/ Tankers of water. The sources of electric power to the town from Wolatia zone Sodo and the town gets this power periodically now. The town also a total number 50 transformers. The distribution of health in the town also well and it has 1 health station, 10 clinics, 6 private pharmacy and 5 drug stores. The education services of the town were also good and its has 7 kg school, 6 elementary in government schools, 3 private elementary and 2 high school of government and 1 private high school and 2 preparatory school.

V. Data Analysis and Interpretation Results

This section of paper provides the backgrounds of respondents, cause urban expansion, negative and positive consequences well as pattern of urbanization in the study areas are explained. The researcher selected 68 respondents randomly and interview for old indigenous illiterate peoples and some municipality workers to get oral information is conducted to this study.

a) *Background of the Respondents*

i. *Age and Sex Composition of Respondents*

The age of respondents below 20 years, 20-30 years old and 30-40 years, 40-50 years, 50-66 years and 66 years above years old with this regard to sex from 68 respondents 42 respondents are males and 26 respondents are female households according to respondents.

Table 5.1: Age and Sex Composition of Respondents

Nº	Age	Sex			Percent
		Male	Female	Total	
1	<20	-	-	-	-
2	20-30	16	12	28	41.2
3	31-40	11	9	20	29.40
4	41-50	6	6	12	17.64
5	51-56	3	2	5	7.4
6	>66	2	1	3	4.4
	Total	42	26	68	100

Source: Field Survey, 2016

According to the table 5.1 highest share of respondents are males which is 42 and the remain g 26 are females households. The maximum number of respondents from both sex are 20-30 years old which is totally 28 respondents and the minimum is >60 years in both sex, which are only 3.

ii. *Educational Level of the Respondents*

According to the information that derived from questionnaire the education level of the respondents was shown in the table below.

Table 5.2: Educational Level of Respondents

Educational level	Frequency	Percentage
Cannot read and write	4	5.9
Read and write	14	20.6
Grade 1-4 class	16	23.52
Grade 5-8 class	13	19.11
Grade 9-12 class	12	17.64
Above grade 12 class	8^{+} =9	13.23
Total	68	100

Source: Field Survey, 2016

iii. *The Marital Status of the Respondents*

The marital status of respondents was shown in the table below.

Table 5.3: Marital Status of the Respondents

№	Marital status	Sex					Percent
		Male	%	Female	%	Total	
1	Single	18	42.87	6	23.07	24	35.29
2	Married	20	47.61	19	73.7	39	57.35
3	Divorce	2	4.76	1	3.84	3	4.41
4	Widowed	2	4.76	-	-	2	2.94
	Total	42	100	26	100	68	100

Source: Field Survey, 2016

According to the table the majority of the respondents were married which is 39(57.35%) were married, 24(35.29%) were single 3(4.41%) were divorce and the remaining 2 (2.94%) were widowed.

iv. *The Occupation of the Respondents*

The respondents are engaged in the different activities. From this the major ones are agriculture, on commerce or trade as government employer and in private sector. So the occupation level of the respondents are presented in the table below.

Table 5.4: Occupation of Respondents

Occupation level	Frequency	Percentage
Unemployed	3	4.41
Government employer	10	14.70
Agriculture	27	39.70
Trade	24	35.29
Private sector	4	5.88
Total	68	

Source: Field Survey, 2016

The table shows that majority of the respondents engaged in agriculture which 27(39.70%) and the next is trade which is 24(35.29%). some 10's are works in government offices as permanent workers and 3 households are engaged in private sectors.

b) Causes of Urbanization

As researcher got oral information from the old or indigenous peoples of the town and municipality office workers interview and questionnaires distributed to the selected respondents. The cause that result in urban expansions are the rural to urban migration due to establishment of market, road transportation, access to health and education in the urban areas; natural increases and reclassification of rural settlement in to urban settlement.

Table 5.5: The Major Causes of Urbanization

Causes of urban expansion	Frequency	Percentage
Infrastructure access (road market, education and health centers, etc	19	27.94
Natural increases	6	8.82
Rural-urban migration	34	50
Reclassification of rural settlement	9	13.23
Total	68	

Source: Field Survey, 2016

Table 5.5 presents the causes that exacerbate the Areka town to expand to its surrounding peasant land was infrastructure accessibility, natural increases, rural-urban migration and reclassification of the former rural settlement in to new urban settlement is the major ones. The most major cause of expansion of Areka town is rural-urban migration out of the total respondents 34(50%) are said the migration is the main dominant than others. The interviewers also suggests the rural-urban migration as a major causes which results from lack of job opportunity, low infrastructure facility and poverty in the rural areas than urban areas and other factors. Due to these factors the people move or migrate from the rural to town for the seek of good job opportunity, market access and good living standard (Municipal Office, 2007).

Infrastructure accessibility is the second major factors to expansion of Areka town according to the sample respondents from questionnaire. From the total of 68 respondents 19(27.94%) are responds it as a major cause. These infrastructures are goods transportation network, market accessibility, private and governments sectors and health and educations facilities. The interview also suggests the same as the information gathered from questionnaires in above paragraph. They suggest infrastructure accessibility in urban area is better than rural area attracts peoples from any periphery and due to right access of infrastructure like education, health centers market and road transportations. Reclassification of the former rural area in to new urban settlement is also another cause of the expansion of Areka town. From the total respondents 9(13.23%) respondents said reclassification of surrounding rural areas in to urban settlement is the main cause. The remaining 6(8.82%) respondents response not rural increase of the population as a cause of expansion of Areka town. The imbalance between fertility (birth) and mortality (death) or generally natural increase results in over population and the population number of the town will be increase and the people of the town needs rural to buy the cheap land and these results in the high urbanization process.

c) Negative Impacts of Urbanization

The expansion of the Areka town has several negative consequences on the surrounding physical and human environments. According to the respondents. These negative impacts are loss of agricultural land, displacement of people from their original area, environmental pollution and expansion of crime and social disorders. These negative impacts are presented in the table below.

Table 5.6: Negative Impacts of Urban Expansion in the Study Area

Negative impacts	Frequency	Percentage
Loss of agriculture land	27	39.70
Expansion of crime	7	10.29
Displacement of peoples	14	20.58
Environmental pollution	18	26.47
Housing problem	2	2.94
Tot al	68	100

Source: Field Survey, 2016

According to the table loss of agricultural land is the major impacts of urban expansion in study area. From the total respondents 27(39.70%) responds it as a major negative consequence. The next was environmental pollution which is 18(26.47%) of the respondents.

The third was displacement of peoples which is 14(20.58%) of following expansion of crime and housing problem which are 7(10.29%) and 2(2.94%) respectively from the total respondents. the loss of agricultural land due to urban expansion also results and land use change of the surrounding people. The peoples particularly farmers in the surrounding Kebeles are highly affect by this problem. Their land was over cultivated due to intensive cultivation and their grazing land and forest areas also affected by this expansion.

Crimes would intensive in every corner of the town, kinds of ghosts, slams, robber and theft would which may complicate with business activity in the formal sector and even attract the market and weaken the others. Illegal construction of houses to accommodate the incoming people and would accelerated pressure on public utilities like health, schools water supplies . etc that would alarmingly increase and so forth.

The other most impact was displacement of people from their original and due to urban expansion. The rural peoples that found on the surrounding of the town forcedly displace from their original land and they gave their land and their resource freely or in a low compensation to others. This result the surrounding peoples on poverty according to the questionnaire and interviewer. Some interviewers suggest that the other major factor that results from urban expansion is environmental pollution and housing problem. they states two rivers (such as Kulia and Puto) are mostly affected or polluted by these urban expansion. The people carry their waste to these rivers and consequently these rivers were out of home consumption.

The housing problem is one of a major consequence which results from high rural to urban migration and high land value and it results in disease like malaria and other respiratory diseases according to the interviewers.

d) Positive Consequences of Urban Expansion

The expansion of urban area has many advantages for the society of Areka town as well as for surrounding peoples. These advantages are creation of job opportunity, expansion of infrastructures like education, transportation, health, electricity and communication services are advancement.

Table 5.7: Positive Impacts of Urban Expansion

Advantages of urban expansion	Frequency	Percentage
Creation of job opportunity	28	41.17
Advance in communication	12	17.64
Electric power and health access	18	26.47
Transportation and education services	10	14.70
Total	68	

Source: Field Survey, 2016

According to the table 5.7 the largest share of the respondents which is 28(41.17%) responds to creation of job opportunities. The next was electric power and health services which 18(26.47%), the third one is advance communication services which is 12(17.64%) and the last was expansion of roads and education services which is 10(14.70%) from total respondents.

In the same manner the interviewers suggests or responds that the positive consequence of urban expansion is creation of job opportunity for unemployed youth and other age group populations of the town as well as for peoples in surrounding area. The creation or expansion for all type of infrastructure in the town employs some unemployed people as a permanent or daily paid workers and this supports their living conditions.

i. *Electric Power*

Areka town has electric power supply for 24 hours from Wolaita Sodo hydro electric power station. The current electric power of the town distributed 50 transformers. This amount of power services shared among different types of customers found the town, the town transformers are sufficient to available full service to the dwellers of the town. Furthermore, this power is not only shared for the town dwellers, but some surrounding rural peoples also use it from the town (Source: Field Survey, 2016).

ii. *Health Facility*

Health center is the most fundamental objectives for social service. the halth facilities which are occurred in the town are proportionally enough with the number of population in the town. In the town there are governmental and non-governmental health facilities. These are presented in the table below.

Table 5.8: Health Facility of the Town

Health facility	Government	Non-government	Total
Health center	1	-	1
Clinics	1	10	11
Drug house for cattle	1	2	3
Private pharmacy	-	10	10
Hospital	-	1	1
Other	-	-	-

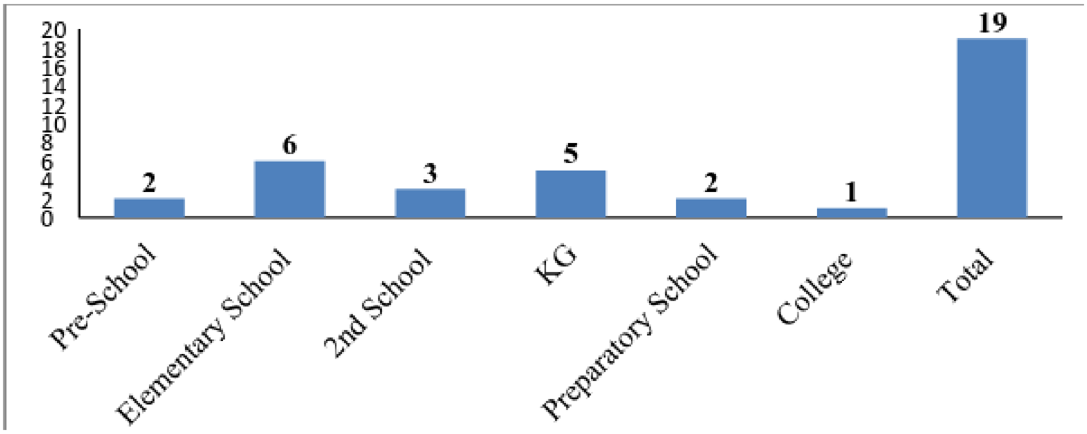
Source: Field Survey, 2016

At it can be seen from the table 5.8 above there is one health center, 11 clinics, 3 drugs houses for cattle, for human and cattle 10 pharmacy and 1 hospital. This shows that top the population of the urban of the town and other surroundings, there are sufficient health services.

iii. *Education Services of the Town*

According to the municipality office of the town, these town experience good in education services for the people. It also shows a change from year to year. In 1980's only one high school and one elementary school in the town and after 10 years around in 1990 these town have 3 high school and 5 elementary school, 2 preparatory school, 4kg schools presented in the table.

Bar graph 5.1: Educational facility



Source: Municipal Office, 2016

According to above bar graph the town has currently 2 pre-educational schools, 6 elementary school, 3 secondary school 5 kg school and 2 preparatory school and 1 college. This expansion of education services in the town provides good a education chance and endeavor for the peoples of the town and for the surrounding peoples.

iv. *Pattern of Urban Expansion*

As researcher got information from the urban dwellers where are participated in the interviews said that the town physical expansion is covered by the years from 1970 E.C to day's end this expansion is legally with a proper plan to invention the best and most appropriate future development of towns, to establish statement of land use and development principles, to establish local standard on the implementation of ordinance and other planning measures and to achieve smart growth, resources and environmental sustainability. However, some few interviewers stated that there are illegally constructed houses at the margins of the rural rebels, this houses are without plan constructed (i.e., built at night illegally). According to them, the expansion today is highly illegal due to lowland cost in the surrounding and new settlers or migrants from rural area buy a plot of land from surrounding peasants the town by low lost and they settle on that place. This type of expansion is mostly occurred in almost all direction of the town except northern peat because of good topography to the settlement. The expansion of this town is highly to the south and East ward due to flat topographic condition and good read links with other areas.

e) *Challenges of Social Service provision Associated with Urban Expansion*

The following discussion was made on the basis of information obtained from the municipal head of Areka town and land administration worker via interview. Problems of social service provision associated with urban expansion:

According to the interviewee, there are many problems associated with the expansion of urbanization. Due to geographical configuration and number of population of the town it was difficult to conduct different services lie education, health, water and other facilities.

The opportunities of urban expansion in social service provision:

According to the interviewee, there are many advantages of urban expansion in Areka town, these are transformation of technology, establishment of institution, civilization and it also creates job opportunity for people.

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i. *Problems of social service provision associated with urban expansion*

According to the interviewee, there are many problems associated with the expansion of urbanization. Due to geographical configuration and number of population of the town it was difficult to conduct different services lie education, health, water and other facilities.

ii. *The opportunities of urban expansion in social service provision*

According to the interviewee, there are many advantages of urban expansion in Areka town, these are transformation of technology, establishment of institution, civilization and it also creates job opportunity for people.

iii. *Major factors that contribute for urban expansion in Areka town*

As the interviewee replied, there are many factors that facilitate the horizontal urban growth in Areka town. These are rapid population growth, and rural to urban migration, Informal settlement in Areke town:

As the interviewee replied, there are informal constructions of houses in Areka town due to the expansion of the town; the farmers construct houses on their farm lands to protect their land from government influence.

VI. Summary, Conclusion and Recommendation

a) Summary

The relevant data for this study was obtained from distribution of questionnaire collected from peasant affected by urban expansion. These respondents are selected from Kebele 02 due to high occurrence of the problem and the researcher was taken 10% of them as a sample respondent which are 68 householders.

In this study the researcher tried to explain cause, consequences and patterns of urban expansion. The causes of urban expansion is rural-urban migration, natural growth, reclassification of the former rural land and etc. The consequences of urban expansion is both positive and negative. Positive impacts are access to infrastructure like road, communication and other services like education health facilities and etc. The negative consequences are environmental pollution, displacement of peoples, loss of agricultural land, expansion of crime and housing problem.

b) Conclusion

The urbanization process inflected the living of several farmers. In addition there are few exceptions of early adapters, the majority of the people are disposed of asset. The community becomes at large market dependent both for impulse and for consumption. Expense are an alarming increasing event, if they adopt urban life were as income is being dimensioned they have now purchase water and energy sources as it they adopt supply then in past. In addition to the construction of the new houses and project the demands for large land area per person is contributing for urban expansion. Wasted land without any defined function existed there in the town. Thus the problems related to expansion are partly resulted from the miss management of land and other resources in the inner cities.

The physical mobility of market a long with expansion of its size created and continued to create mass eviction and displacement, like of capital conspired with dimensioning asset demand the problems of displaced. These economically weakness illiterates, women, children and elderly area suffering the mildest of crises. The unplanned urbanization process are in fact affecting the environment itself can degradation, pollution, deforestation, and destruction of wild animals are clearly exhibited. If the current worth situation is aggravated, further more the overall environmental crises will be inevitable.

Urban expansion has an impact on land resources such as loss of agricultural land, causes forest destruction, loss of habitat and decrease in water quantity and quality in the town. Therefore, based on the above evidence collected from respondents the town mayor it is possible to conclude that rapid horizontal urban growth has an adverse impact on the socio-economic activities in the study area.

c) Recommendation

- Providing training service about the effect of urban expansion to the people is important issues.
- The biggest steps that come to be taken to off get current and future effects of urbanization on the people involve better city management and forward looking urban planning proper land use policy must be designed in way it facilitates the expansion of the town in proper plan trained. Better and more efficient urban planning must take place to control urban growth by considering both physical and human environment. To achieve these administers municipality officers and professional labor must have work together.
- The government must have responsible body to compensate for the people who displaced from their original land and who lost their agricultural land due to urban expansion.
- The awareness creation among public was very important to conserve the forest and other biodiversity of the surrounding area.
- Expansion of slum and squatter settlements are another socio-economic challenge due to urban expansion. Because of uncontrolled urban growth, the cost of the land is increasing accordingly. Therefore, poor people forced to construct house with a minimum
- Land is a basic resource, which has reached a stage of scarcity in certain areas today because of rapid urbanization. In study area however, rural urban migration and land speculation has been inefficiently exploiting the land for their speculation again. Thus, in order to control the problem, the city administration should enact properties and regulations regarding conversation of agricultural land to urban use.

VII. Acknowledgement

This study is carried out by the support of many people I am grateful for the people who have given me the help during this work and I want to express my gratitude to all of them. At first I want to thank my students of third year Geography and Environmental studies data collection process . I would like to give thanks to my staff for their communication about the issues of such research study. I also want to thank the voluntary who collect and post the geographic data online voluntarily distributed data are useful and were necessary for this study. In particular. I should give my thanks to Boloso Sore Woreda ,Areka town office workers, Kebele workers, and indigenous peoples. Their love encouragements and support enable me to finish this research study or design.

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Optimal Drinking Water Distribution System Designing using Network Analysis and Geospatial Technology

By Joginder Ahlawat & Saurabh Kumar Sah

Pt. N R S Government College

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Joginder Ahlawat [α] & Saurabh Kumar Sah [σ]

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I. Introduction

GIS has been regarded and proven as an efficient and powerful tool in the water distribution industry. American "Water Works Association" reported that near about of the 90% of water agencies are in United States are now partially using GIS to assist their daily operation (Venkatarao 2014). GIS is a state-of-the-art technology capable of efficiently performing all these data related processes. The first water company to implement GIS was Denver Waters (Deb and Agrawal, 1999). It wasn't really a GIS as known now days, in real it was an Automated Mapping/Facility Management (AM/FM). Anyway, it was the initiativestep in the use of computerized mapping information management system within the water works (Alperovits and Shamir, 1977; Bhave, 1985).

Nowadays the need of linking spatial, economic and physical information together is more frequent. This will be possible only because of the proper implementation of GIS techniques. The GIS system make us able not only to link geographical or spatial data with another alphanumeric data sets, but also helping us in updating it in a simple way to included data, through and appropriate graphic interface. The water pipe networks are obviously the imperative structures in urban and industrial areas and these networks are composed by a set and subset of elements e.g. pipes, motor pumps or compressors, valves etc. and all these are interconnected in order to transport fluid from supply sites to demand locations(Wu and Walski, 2005; Wu and Simpson, 2002). Remote sensing (RS) and GIS method on the contrary have updated the maps latest remote sensing data sets, integrates them in thematic cost layers in GIS environment and then computes all possible best fit routes along with associated costs (Coley, 2003). Apart from the shortening of 5-15 percent of the route length, the method also has the potential benefits like cadastral overlays on route for the gadget notification, precise location data on installations and organization of O & M (Fujiwara and Khang, 1990; Gessler, 1985).

GIS provides functionality for the development and effective preparation of accurate spatial information for input into the network design optimization models. It includes the network layout, connectivity, pipe characteristics and cost, pressure gradients, demand patterns, cost analysis, network routing and allocation, Connections and the effective color graphic display of results. GIS technology is increasingly being relied as a veritable capable tool of assisting decision makers and planners in selecting an optimal route when setting new pipelines in an area. This helps to reduce construction and operational costs, as well as minimize negative impacts to the environment during construction (Van et al., 2005; Dandy et al., 1996).

Traditional methods of designing of MC water distribution systems are limited because system parameters are often generalized; spatial details such as installation cost are reduced to simplified values expressing average tendencies; and trial and error procedures are followed, invoking questions as such as whether the optimum design has been achieved or not? In support of this an optimal design of drinking water distribution system must concentrate on two things first minimize the construction cost as well as maximize reliability of the final resolution. During the designing of water pipelines two steps are to be developed first is the optimal layout of the pipe network. Secondly, it is

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necessary to calculate the expected demand of the user consumers. Both steps can be done with the help of GIS (Niklesh and Khedikar, 2011; Eiger et al., 1994).

II. Study Area

Patna is located at 25.6155 °N latitude, 85.1355 °E longitude in typical tropical climate region of India. Patna district is in the eastern region of India, bordering Nepal in the North side, West Bengal in the eastern side, Uttar Pradesh in the West, and Jharkhand in the South (Fig. 1). Patna is located at an altitude of 53 meters and the total population of PMC accordingly to 2011 census is 16, 83200.The urban settlements covers roughly an area of 175 sq. km. Patna is a large city with a considerable population. Patna is famous for its glorious past, especially the period of Magadha and the Mauryan rule. Patna is hot and humid summer and cold in winters. Temperature range varies from a maximum of 43°C in summer to a minimum of around 5°C in the winters. Relative humidity can go up to 100% during summer. It receives medium to heavy rainfall in the monsoon.

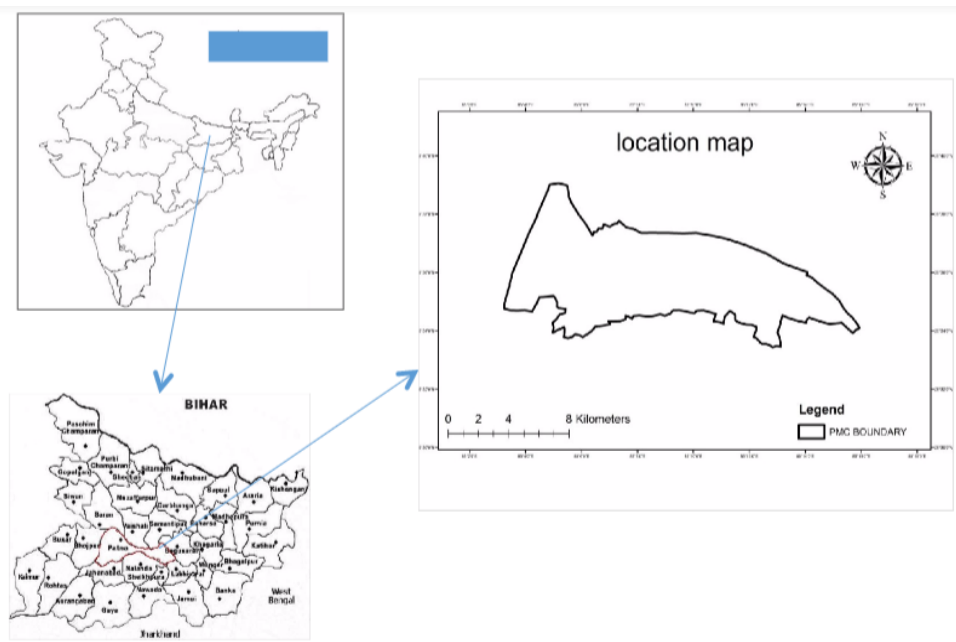

Figure 1: location map of the study area

III. Methods and Materials

a) Data Used

Geo Eye provides 0.41m (16 inch) panchromatic and 1.65m multispectral imagery in 15.2 km (9.4 mi) swaths. The vehicle or spacecraft is projected for a sun-synchronous orbit at an altitude of 681 km (423 mi) with an inclination angle of 98 degrees, with a 10:30 a.m. equator crossing time. Geo Eye can image up to 60 degrees off nadir.

LANDSAT has the tremendous ability to collect and transmit up to 532 images per day. It is deployed in a polar, sun-synchronous orbit and because of this it can scans across the entire globe's surface at an altitude of 705 kilometers +/- 5 kilometers. In this process it takes 232 orbits, or 16 days. It have the weighs of 1973 kg, is 4.04 m long, and 2.74 m in diameter. Unlike its predecessor satellites, Land sat 7 has a solid state memory capacity of 378 gigabits (roughly of 100 images). The main instrument equipped on board on Landsat7 is the Enhanced Thematic Mapper Plus (ETM+).Data from the LANDSAT satellites is collected in a continuous stream of data along with a near vertical path as the satellite moves from north to south directions. The LANDSET data is arbitrarily divided into nominal scenes which are about 24 second increments of spacecraft time apart, corresponding to a spacing of approximately 160km. This path/row designation is referred as the LANDSAT Worldwide Reference System (WRS). The rows have been positioned in such a way that the Row 60 coincides with the equator.

b) Network Analysis

Water distribution network comprise a plannar system of pipes or links (through that the water flow happened), connected together at nodal points which may be at different elevations. In general the complex system will also include pumps, reservoir and valves and more. A network node commonly has one of the two key functions; either it receives a supply for the system or it may delivers the demand required by consumers on the other hand. As a special case, it may satisfy neither of these requirements but merely serve as a junction between two or more pipes. The pressure head at the supply node is established by the presence of the pump or a reservoir. Resistance to flow (friction loss) which are the function of length ,diameter, flow rate and pipe material and roughness occur in the links as the fluid water around the network from supply node to demand nodes. The effect of minor losses may be including as equivalent pipe lengths. It is usual to specify a minimum acceptable residual pressure head at demand nodes and the pressure heads at the supply nodes must be of sufficient magnitude to satisfy these requirements. The differences between the total heads (measured with reference to a common horizontal datum) at a supply node and a demand node is equal to the algebraic sum of the head losses taken along any path of the network (Fig. 2).

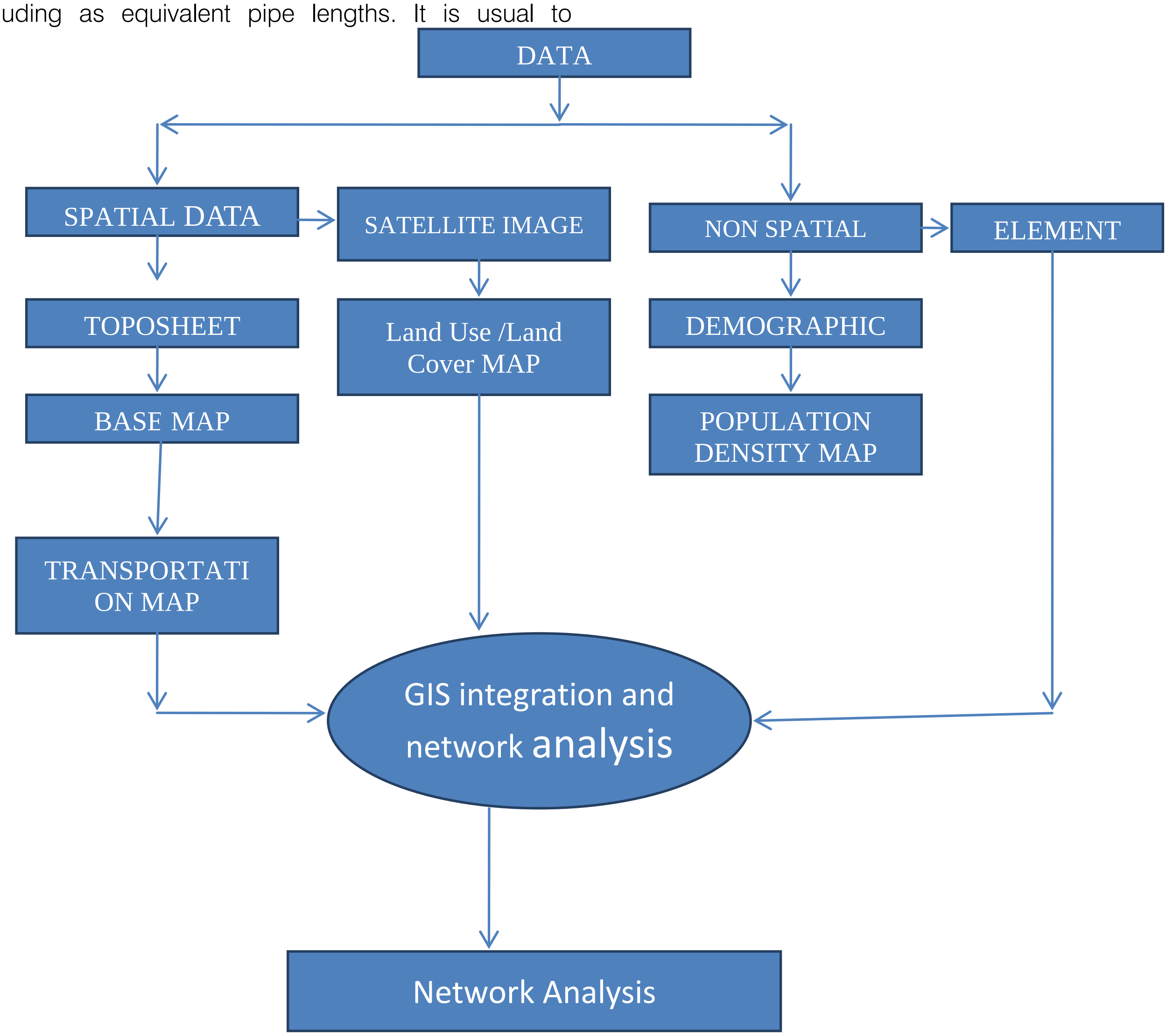

Figure 2: Flowchart for the methodology

Current study use the street network system which is created hierarchically based on levels of the roads, such as small roads, main roads, inter district and highway. Supplied water pressures may vary in different locations of a distribution system due to varied reasons. Water mains below the street may operate at a higher pressures and a water pressure reducer could be located at each point where the water enters a building or a house. In some poorly managed and maintained water supplies water pressure could below to limit that result only in a trickle of water or it may on so high level that it led to damage the plumbing fixtures. These fractures in fixtures ultimately cause the wastage of water and shortage at connection sites. Pressure in an urban water system is typically maintained either by a pressurized water tank serving an urban area and further by pumping the water up into a high tower which commonly rely on the gravity to maintain a constant pressure in the system or solely by pumps at the water treatment plant and repeater pumping stations.

Continuous water supply is taken granted to the masses in mostly developed countries but it is a severe problem in almost of the developing countries, where sometimes water supply is only provided for a few hours every day or somewhere it is a few days per week. It is estimated that the half of the population of developing countries receiving water on an intermittent basis. Conditions are worst in poor and backward countries.

c) Hazen Williams Equation

The Hazen–Williams equation is an empirical formula which relates the flow of water in a pipe with the physical properties of the pipe and the pressure drop caused by the friction. It is used in the designing of water pipe systems. It is named after Allen Hazen and Gardner Stewart Williams. The Hazen–Williams equation has the advantage that the coefficient C is not a function of the Reynolds number, but it has the disadvantage that it is only valid for water. Also, it does not account for the temperature or viscosity of the water. The results for the formula are acceptable for cold water at 60 of (15.6 oC) with kinematic viscosity 1.13 CST. For hot water with a lower kinematic viscosity (0.55 CST at 130 of (54.4 oC) the error will be significant.

$$hf = 0.002083 . L (100/C)^{1.83} . gpm^{1.85} / d^{4.8655}$$

Where,

C = friction factor

D = Inside diameter of the pipeline

gpm = gallons per meter of water

L = length of the pipe (ft)

hf = friction head loss (ft)

As for the calculation of Hazen William equation the Hazen William roughness constant the coefficient of c is been taken as 100 for the existing pipeline where cast iron is used to deliver the water whereas for the new water pipeline Hdpe pipes are used for long life plan and the coefficient of c for Hdpe pipe is 150. After the calculation for the existing pipe dia.3, 6, 8, 12, 16 inch total specific head loss (mm h20/100m pipe) is 47143691.7. Whereas for the designed one the specific head loss (mm h20/100m pipe) is 18506273.67.

IV. Result and Discussion

Patna Municipal Corporation (Patna Nagar Nigam), abbreviated PMC, is the main nodal agency for the governance and administration of Patna, entrusted with the development and management of about 110 km2area. The whole area is divided further into 72 wards, which accommodates the population size of 1.6 million. (Census, 2011). Municipal Commissioner is the executive administrative head of the Corporation, who is assisted by a large number of officers, belonging to different departments in the Patna municipal Corporation. The distribution system is the final barrier before the delivery to the consumer's tap.

a) Land Use/ Land Cover Map

Land use is the human use of land. Land use involves the management and modification of natural environment or wilderness into built environment such as fields, industries, parks and settlements. It has also been defined as the special arrangements, activities and inputs people undertake in a certain land cover type to produce, change, reshape or maintain it. Land use map is divided into seven classes such as water bodies, agriculture land, scrub land, high moisture land, settlements, vegetation and fallow land. In PMC area most of the part is covered by urban settlement and natural vegetation area along with agriculture field. In PMC area the upper part is classified as the high moisture land because of the river Ganges.PMC area is having very less fallow land and scrub land (Fig. 3).

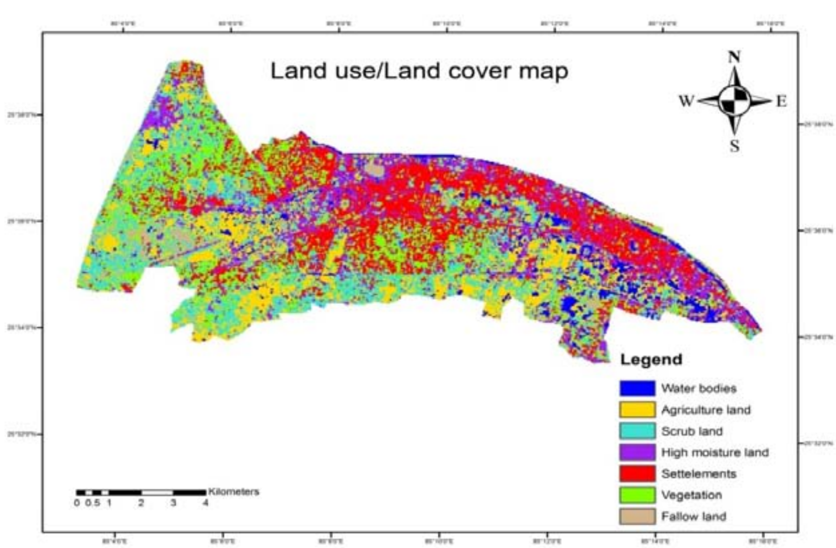

Figure 3: Land Use/ Land Cover Map

b) Population Density Map

Population density map is been prepared by Topo sheet. The variation of population can be seen from this map. Total population of 72 wards is 16, 83,200.The lighter shades of the area shows the less population whereas the dark one shows more populated area .The most populated ward is ward no.3 who's population is 21,539.The least populated ward is ward no.12 who's population is 1974.On an average rest of the ward is having population around 18,000-20,000 (Fig. 4).

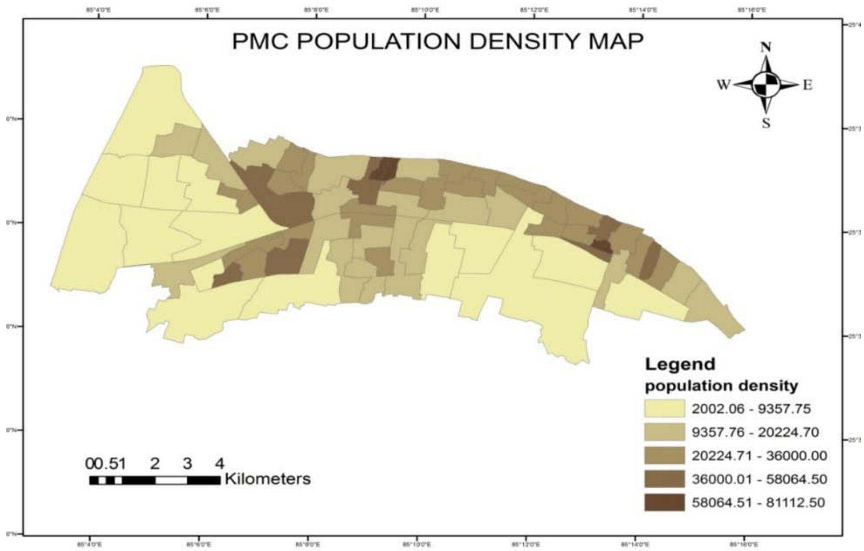

Figure 4: Population Density Map

c) PMC Water Distribution Map

Water pipe line map is been prepared from the high resolution image of GEO EYE 2012. Water distribution network consist of a plannar system of the pipes or links (over which the water flow), connected each other at nodes which may be at different elevations. The various number of pipes is been used for making the networking of water pipe line. The existing water supply systems of Patna city is based on the sources from the groundwater sources. It does not utilize the water of three rivers in the vicinity-Ganga, Sone and Punpun at all. Bihar Rajya Jal Parishad has developed and implemented the existing water supply system(Fig. 5).It is currently operated and managed by Patna Municipal Corporation. Distribution systems are composed of water mains, valves, hydrants, service lines, and storage facilities. This infrastructure is expensive in cost but long-lived. Because it is largely out of sight, distribution infrastructure tends not to be a top priority in the management and financing of water systems. But as populations shift and pipes corrode, substantial ongoing investments are necessary.

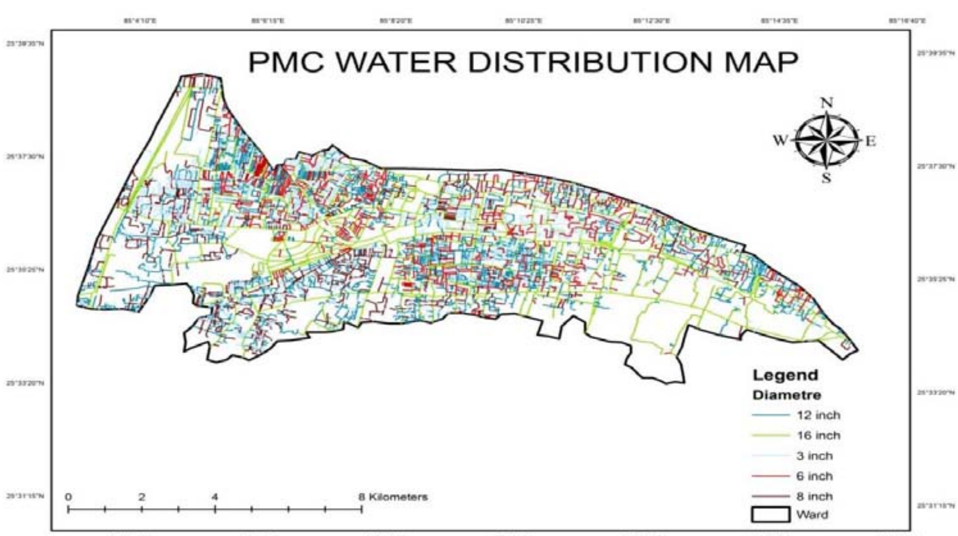

Figure 5: PMC water distribution

d) Shortest Path Analysis Map

The shortest path analysis map has been prepared with the help of the high resolution image of GEO EYE 2012.Here, the shortest path analysis used to find out the quickest, shortest, or even the most scenic route, depending on the impedance we choose to resolvethe issue. If the impedance taken as time, then the best fit route will be the quickest route but if the impedance is a time attribute with live or historical traffic, then the best fit route is the quickest route for a given time of day and date. Hence, the best fit route can be defined as the route that has the lowest impedance, or the least installation cost. The shortest path analysis has been done to find the shortest path between the supplier tanks to the last node the consumer tap. Shortest path analysis can be defined as the network analysis tool which will help to find the shortest path to deliver the water to the tap.The shortest route between source and destination points is searched iteratively over corridors of narrowing width using network analysis approach. The cost is computed as weighted sum of material cost of pipeline and the access cost of approaching the route. Thus the first rough route is obtained over entire rectangular area encompassing start and end points. The subsequent route search is limited to a broad buffer zone around the previous route.

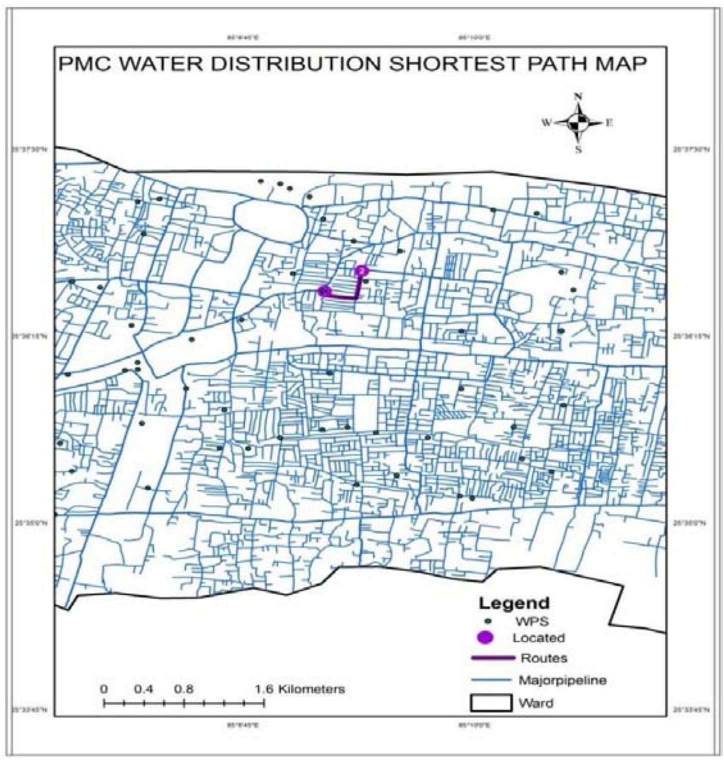

Figure 6: Shortest path analysis map

The shortest path analysis map (Fig. 6) shows the minimum distance from the pump to the consumer tap. The analysis helps to find the shortest path to deliver the water to the tap.

V. Conclusion

Water pipe line design of PMC area using geo-spatial technology has been done to provide the drinking water 24*7 at the consumer end. By incorporating the GPS location of the overhead tank in ARC GIS 9.3 and the details of the tank such as their pumping capacity, date of installation and their distribution pattern in the ward help to make an upgraded information about the existing water distribution. The specific head loss is calculated by Hazen William equation for existing pipe line as well as for design one shows the better result for the design one. After the calculation for the existing pipe dia.3, 6, 8, 12, 16 inch total specific head loss (mm h20/100m pipe) is 47143691.7. Whereas for the designed one the specific head loss (mm h20/100m pipe) is 18506273.67.An approach has been done to meet the demand supply gap as by removal of the pipelines which were very old and most of them are having leakage problem. Per capita demand of water supply has been calculated as157 lpcd. After 38% leakage loss only 97 lpcd is transported through pipes as old pipes are busted or having leakage problem due to excessive pressure. Removal of old pipes and installation of hdpe pipe help to fulfill the demand supply gap only 2 lpcd has to be achieved after the new installation. The pumps are not running to their full capacity after using new pipes 2 lpcd is achieved (increase of running hours of pumps). shortest path analysis has done to find the shortest path between the pump to the consumer tap as well as it will help to reduce the cost of the piping.

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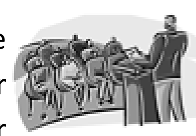

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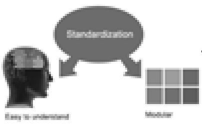

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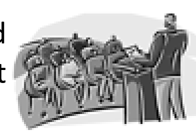

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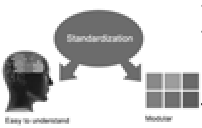

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Note :

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- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
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3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

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- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.
- Do not give permission to anyone else to "PROOFREAD" your manuscript.
- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

Criterion for Grading a Research Paper (Compilation) by Global Journals Inc. (US)

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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