5. LIGHTNING.

5.1 Introduction.

Lightning is a massive electrostatic discharge between electrically charged regions within clouds, or between a cloud and the Earth's surface (http://en.wikipedia.org/wiki/Lightning). The charged regions within the atmosphere temporarily equalize themselves through a lightning flash, commonly referred to as a *strike* if it hits an object on the ground (http://en.wikipedia.org/wiki/Lightning). There are three types of lightning flashes and these include that one from a cloud to itself (intra-cloud or IC); from one cloud to another cloud (CC) and finally between a cloud and the ground (CG). Lightning occurs approximately 40–50 times a second worldwide, resulting in nearly 1.4 billion flashes per year (Oliver, 2005).

Ground elevation, latitude, prevailing wind currents, relative humidity, proximity to warm and cold bodies of water are the factors that affect the frequency, distribution, strength, and physical properties of a "typical" lightning flash to a particular region of the world. (http://en.wikipedia.org/wiki/Lightning). The most studied lightning flash is the cloud to ground because this is the one that affects man although the cloud to cloud and the intra cloud are the most common. Lightning's relative unpredictability limits a complete explanation of how or why it occurs, even after hundreds of years of scientific investigation. A typical cloud to ground lightning flash culminates in the formation of an electrically conducting plasma channel through the air in excess of 5 km tall, from within the cloud to the ground's surface. The actual discharge is the final stage of a very complex process (Uman 1986). A typical thunderstorm has three or more *strikes* to the Earth per minute at its peak (Uman 1986). Lightning primarily occurs when warm air is mixed with colder air masses resulting in atmospheric disturbances necessary for polarizing the atmosphere.

About 70% of lightning occurs over land in the tropics where atmospheric convection is the greatest. This occurs from both the mixture of warmer and colder air masses, as well as differences in moisture concentrations, and it generally happens at the boundaries between them (http://en.wikipedia.org/wiki/Lightning). Because the influence of small or absent land masses in the vast stretches of the world's oceans limits the differences between these variants in the atmosphere, lightning is notably less frequent there than over larger landforms(http://en.wikipedia.org/wiki/Lightning). The North and South Poles are limited in their coverage of thunderstorms and therefore result in areas with the least amount of lightning (http://en.wikipedia.org/wiki/Lightning). Lightning is usually produced by cumulonimbus clouds whose bottoms are 5–6 km (3–4 miles) above the ground and that are themselves up to 15 km (9.3 mi) in height.

On Earth, the place where lightning occurs most often is near the small village of Kifuka in the mountains of the eastern Democratic Republic of the Congo (Wondermondo, 2010), where the elevation is around 975 m (3,200 ft). On average, this region receives 158 lightning strikes per 1 square kilometer (0.39 sq mi) per year (National Oceanic and Atmospheric Administration, 2008). Other lightning hotspots include Catatumbo in Venezuela and also in Singapore (National Environmental Agency. 2002). According to United States National Lightning Safety Institute, an estimated 24,000 people are killed by lightning strikes around the world each year and about 240,000 are injured.

5.2. Lightning in Uganda.

Since 2007 lightning has killed 191 people and injured 727 in Uganda (Table 5.1). Gulu, Lira, Hoima, Jinja, Kalangala and Kisoro were districts with most occurrences, deaths and also those injured. 98 people were killed and 494 injured in 43 districts across the country in 2011. In 2012 38 people were killed and 38 injured in 19 districts and in 2010, 23 people were killed and 109 injured in 10 districts. On 28th June 2011 lightning killed 19 school children and injured 70 in a Primary School in Kiryandongo District (www.newvision.co.ug/D/8/12/622472). The locations were most people were killed or injured include classrooms, taking shelter under trees, grazing cattle in the field, walking in the open and inside houses. Most of the people were struck in the afternoon during storms.

Year	No of people killed	No of people affected	No of districts
2004	3		1
2007	10	20	3
2008	15	62	8
2009	7	4	5
2010	23	109	10
2011	98	494	43
2012	38	38	19
	191	**727**	**88**

Table. 5.1 Lightning incidents in Uganda. Source: Analyzed from data from Department of Meteorology.

Some communities in Uganda associate lightning with superstition and witchcraft. However, the science of lightning begins with rain clouds which contain water drops and ice particles. When the water and ice rub on one another they become charged and the top of the cloud becomes positive (+ve) and the bottom negative (-ve). These positive and negative charges get attracted to each other causing lightning between the cloud and cloud (Intra cloud lightning) (**Plate 5.1).** The negative charges below the cloud create a positive charge in the ground and as these negative charges grow stronger it jumps into the ground causing lightning spark seen during storms. This spark can strike anything that stands high above the ground or mountains (**Plate 5.2**). These can be people, animals, buildings and trees.

Plate 5.1: Intra-cloud lightning is the most common type of discharge. This occurs between oppositely charged centers within the same cloud. (NASA).

Plate 5.2 Cloud-to-ground lightning is the most damaging and dangerous form of lightning. Although not the most common type, it is the one which is best understood. (NASA)

5.2 Lightning imaging sensor.

NASA has pursued lightning research because it has a direct effect on day to day of many activities. Lightning strikes have also struck their spacecrafts during their launch. The Lightning Imaging Sensor (LIS) is a space based instrument used to detect the distribution and variability of total lightning (cloud-to-cloud, intra-cloud, and cloud-to-ground lightning) that occurs in the tropical regions of the globe. This lightning sensor consists of a staring imagery which is optimized to locate and detect lightning with storm-scale resolution (4 to 7 km) over a large region (600 x 600 km) of the Earth's surface. The TRMM Satellite travels a distance of 7 kilometers every second (nearly 16,000 miles per hour) as it orbits the Earth, thus allowing the LIS to observe a point on the Earth or a cloud for almost 90 seconds as it passes overhead. Despite the brief duration of an observation, it is long enough to estimate the flashing rate of most storms. The instrument records the time of occurrence, measures the radiant energy, and determines the location of lightning events within its field-of-view. ***Figure: 5.1 a) shows lightning flashes map for Uganda from the Lightning image sensor (NASA) while (b) shows the lightening map from the actual lightening strikes in Uganda.***

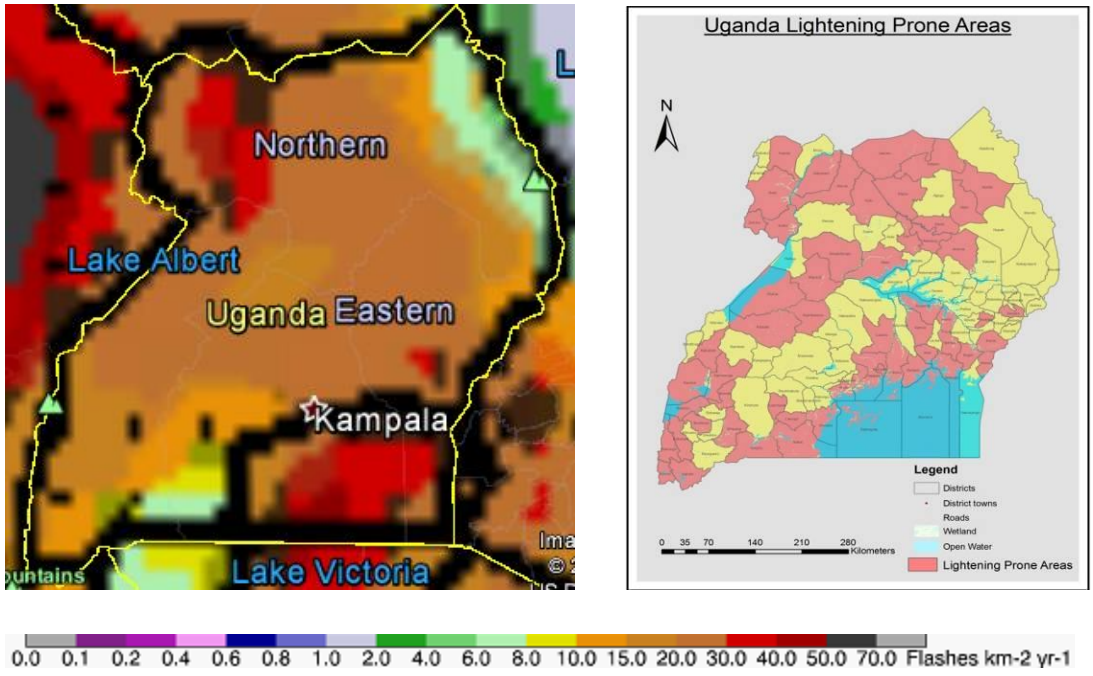

Figure: 5.1 a) Lightning flashes map for Uganda from the Lightning image sensor (NASA) (b) Lightning map from the actual lightning strikes in Uganda. Note: the scale bar is for map (a).

The satellite map in figure 6.3 (a) shows that the Lake Victoria area, Adjumani, Amuru, Nwoya, Moyo and Kiryandongo have very high risk to lightning within a range of 30 to 40 flashes km^{-1} yr^{-1}. This is in agreement with map (b) showing areas were lightning has killed people around the Lake Victoria, Kiryandongo, Adjumani, and Amuru. The rest of the country is still at high risk to lightning with a range of 15-30 flashes km^{-1} yr^{-1}. Karamoja region has the lowest risk from lightning with range of 6-15 flashes km^{-1} yr^{-1}. The whole country except for the Karamoja is very

vulnerable to lightning strikes. The strong recommendation is sensitization of all communities on lightning safety.

5.3 Confirmation of lightning strikes in communities.

Lightning in Bukedea district usually affects trees, animals and houses. In 2011 at Malera trading centre three people were killed and five cows at Kabarwa Primary school were also killed. Lightning conductors have not been installed as yet (Plates 5.3 and 5.4). Kumi District is also prone to lightning strikes. In May 2013 lightning killed two cows. In 2005 one cow was killed and the tree on which it was tied was also burnt (Plate 5.5). In Karapa one person was struck by lightning and admitted in hospital. Also in Akinde one person was struck but the date not known. In Butaleja three children were killed by lightning about ten years ago while on the way from school near the bridge. In 2012 one person was struck by lightning in Kapisa and died. Still in the same district the year 2013 at Nanjale two people were struck and injured by lightning.

In 2011 lightning struck Runyanya Primary School in Kiryandongo, killing 19 pupils and 70 were hospitalized. The school is in the open so vulnerable to lightning strikes Overlooking Murchison National park. According to one of the teachers in the school it happened in the afternoon and most of the children affected were girls. Some had taken shelter in the church and classrooms when they were struck. Almost every corner of this school was prone to lightning even the toilets because some pupils who were there where not spared by the spark. Lightning conductors have been installed on the roofs of the school by a charity organization (***Plate 5.8 and 5. 9***). This should be done for all the other schools in this region.

Plate 5.3 Houses that were struck by lightning killing three persons in Bukedea District.

Plate 5.4. Kabarwa Primary school where cows were hit by lightening in Bukedea District.

Plate 5.5. A tree that was struck by lightning and killed a cow in 2005 in Kumi.

Plate5.6. Classroom where children were killed,

Plate 5.7. Iron sheets destroyed by lightning at Runyanya Primary school.

Plate 5.8. Installed lightning conductor at one of the roofs at the school.

Plate 5.9. The commissioning of the lightning conductors at the school.

5.4. Safety precautions against lightning.

Information on effects of lightning is compiled by the department of meteorology and it is a commendable effort because all the data and information required is with them. There has also been an effort to give the early warning on lightning during the seasonal outlook. However, because the limitations in the accuracy of predicting weather in some seasons there is bias in the use of information in the seasonal outlook. More should be done to correct this attitude.

There are three ways in which lightning may strike you: direct strike where the lightning hits you and goes to earth through you, jumped is where the lightning hits another object and jumps sideways to hit you and the ground strike where the lightning strikes the ground then travels through it hitting you on the way.

5.5. The safety tips:

- Install lightning protection conductors on buildings.
- Get inside motor vehicles during strong storms (avoiding soft top convertibles). Cars are safer than standing outside due to the metal body of the car.
- Move away from wide open spaces or exposed hilltops.
- Move away from water.
- Move away from the open space of the shore or beach. Studies have shown that proximity to water is a common factor in lightning strikes.
- Do not take shelter under tall trees.
- If you are exposed to the elements with nowhere to shelter try to make yourself as small as possible by crouching down with your feet together, hands on knees and head tucked in. This technique keeps as much of you off the ground as possible as lightning will not necessary target the highest object in an area, but the object providing a path with the least resistant to ground.
- When camping, avoid placing your tent at the highest point in the area, especially if thunderstorms are expected over night. If you are in a tent during a storm avoid touching or being close to tent poles if possible.
- Avoid using objects that can attract or conduct a lightning strike, if possible avoid touching or using such items and move away if necessary. These include bathroom taps, central heating radiators, light switches, telephones, televisions, computer systems or any mains powered appliance, umbrellas, metal fences, golf clubs, bikes, fishing rods, sailing boat masts, antennas, metal objects.
- Avoid using mobile phones during storms.