Carbon Sequestration, Its Methods and Significance

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ABSTRACT

Carbon sequestration is the process of removing carbon from the atmosphere and depositing it in reservoirs. Basically it is the process of capturing of atmospheric carbon dioxide and storing it to mitigate global warming and climate change. This storage is also known as carbon pools. Carbon pool refers to a system or mechanism which has the capacity to accumulate or release. It can be natural or human induced. Examples are forest biomass, wood products, soils, and the atmosphere. Carbon pools in a forest are a complex mix of live and dead organic matter and minerals. Human induced carbon pools are geological storages of carbon dioxide.

Human induced carbon pools are characterized with Carbon capture and storage (CCS) technology. Carbon capture and storage is a combination of technologies and techniques that enable the capture of CO2 from fuel combustion or industrial processes. Then transportation of CO2 is being done through pipelines, CO2 is stored underground in depleted oil and gas fields and deep saline formations. CCS can, therefore, have a unique and imperative role to play in a sustainable low-carbon economy. In this light, this paper will discuss or give answers to the questions - what is carbon sequestration?, how it is being formed?, What are the modes and methods for CCS?, and the importance of carbon sequestration.

Keywords: Global Warming, Climate Change, Carbon Sequestration; CCS Technology;

1. INTRODUCTION

Earth is getting more and more warmer than ever, reason is human activities. Human activities have caused an imbalance in natural carbon cycle, consequently greenhouse effect and global warming came into being. When fossil fuels are burnt for transportation, heating, cooking, electricity, and manufacturing, we are effectively realizing more carbon into the atmosphere than it is being removed naturally. Ultimately we are causing more carbon concentration into atmosphere. As a result we are proceeding on the path of global warming and climate change.

Global warming and climate change refer to an increase in average global temperatures. Natural events and human activities are believed to be contributing to an increase in average global temperatures. This is caused primarily by increases in “greenhouse” gases such as Carbon Dioxide

(CO2). Climate change is a global threat that needs urgent action from global community. All countries will be affected by climate change and its impacts, particularly developing countries. If temperature is taken as an climate change indicator, it has been found that earth's average temperature has risen by 1.4°F (0.72°C) over the past century. It is projected that it will further likely to rise another 2 to 11.5°F over next century (NCAR, 2014). Therefore it is important to understand Carbon cycle, climate change and how climate change can be mitigated?

1.1 Carbon cycle

Carbon cycle refers to the movement of carbon, in its different forms, between the biosphere, atmosphere, oceans, and geosphere. ***(i) Carbon exchange between atmosphere and vegetation*** - Plants absorb CO2 from the atmosphere during photosynthesis, and release CO2 back in to the atmosphere during respiration. Another major exchange of CO2 occurs between the oceans and the atmosphere. The dissolved CO2 in the oceans is used by marine biota in photosynthesis. ***(ii) Burning of Fossil Fuel-*** Other important processes is fossil fuel burning. In fossil fuel burning, coal, oil, natural gas, and gasoline are consumed by industry, power plants, and automobiles. In this process carbon directly goes to the atmosphere from its source point. ***(iii) Change in Land use & Land cover -*** Changing land use also affect carbon cycle in broad term which includes essential human activities e.g. agriculture, deforestation, transportation activities etc. (ETEGCC, 2004) In modern world alterations in land use & land cover and ever increasing usage of energy for the purpose of development is the focal reasons for global warming and climate change.

1.2 Climate change

Global warming and climate change refer to an increase in average global temperatures over a very long period of time. As discussed in carbon cycle, natural events and human activities are believed to be contributing to an increase in average global temperatures, This is caused primarily by increases in “greenhouse” gases such as Carbon Dioxide (CO2) (Shah, 2013). Small changes in the average temperature of earth so far, can transform into large in coming hundred years. Moreover these climatic changes will have great potential to create negative impacts on environment and mankind. Therefore it is essential to mitigate climate change for advance minimization of its dangerous impacts. Current evidence suggests that to avoid the worst impacts of climate change, we should aim to limit the global average temperature rise to 2°C (35.6°F), not beyond that. This requires to undertake immediate reduction in global greenhouse gas emissions in all the sectors.

1.3 indicators for climate change

There are several indicators on the basis of which climate change can be measured. These indicators are as following:

Table 1. Indicators for Climate Change

1.	Global Green House Gas emission	11.	Change in precipitation pattern
2.	Atmospheric concentration of green house gases	12.	Tropical Cyclonic activities
3.	Change in Sea level	13.	Increase in the occurrence of extreme events
4.	Change in Ocean heat	14.	Change in Arctic Sea ice
5.	Change in sea surface temperature	15.	Glaciers melting
6.	Change in Ocean Acidity	16.	Change in length of seasons
7.	Submergence of land into sea	17.	Length of growing season
8.	Climate forcing**	18.	Bird wintering ranges
9.	Change in Snow fall pattern	19.	Heat related deaths
10.	Change in Temperature pattern		

***** Climate forcing refers to the amount of energy earth receive from sun and the amount of energy earth radiate back into space***

All extra carbon dioxide in the atmosphere is increasing overall temperature of earth on day to day basis, causing global warming. It is changing climate in unpredictable ways, from floods and hurricanes to heat waves and droughts. To try and reduce the risk of global warming and extreme weather events, It is required to reduce the amount of how much fossil fuel we are burning. This isn't an easy process. In the 1997 Kyoto Protocol, it was decided that carbon emission in the atmosphere will be reduced by 5% below 1990 levels between 2008 and 2012. Several measures can be found out to reduce carbon from atmosphere and thus to reduce adverse impacts of climate change. One of the measure is carbon sequestration, which is cheap and simple as well as costly and complex. That is natural carbon sequestration and geological carbon sequestration.

2. CARBON SEQESTRATION

Carbon sequestration is the process of capture and long-term storage of atmospheric carbon dioxide to mitigate global warming and to avoid dangerous impacts of climate change. In other words, it also refers to the process of removing carbon from the atmosphere and depositing it in a reservoir. This carbon storages or reservoirs are also known as carbon pools.

Carbon pool refers to a system or mechanism which has the capacity to accumulate or release. It can be natural or human induced. Examples are forest biomass, wood products, soils, and the

atmosphere. Carbon pools in a forest are a complex mix of live and dead organic matter and minerals. Human induced carbon pools are geological storages of carbon dioxide. The quantity of carbon in a pool is known as carbon stock and any change may be expressed as 'stock change'. The process of carbon sequestration can be understood well with the help of following figure 1.

The use of forest is also a financially viable technique to reduce emission from atmosphere. It could also bring significant benefits to the local communities involved and consequently helps in reducing poverty at the same time. Forestry projects can bring social, economic, and local environmental benefits to millions of people. (Clyde, P., 2012)

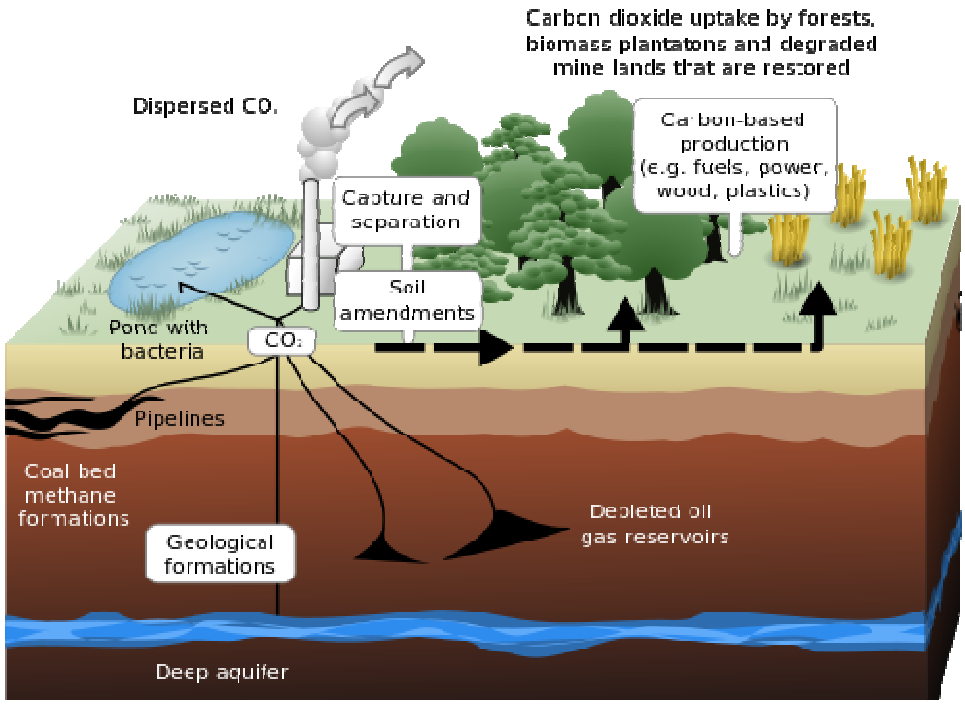

Figure 1. Carbon Sequestration, Its process and Types

3. IMPORTANT SOURCES AND METHODS OF CARBON SEQUESTRATION

3.1. Forests as sink - Aforestation / Reforestation / Plantation / Agro forestry

Above mentioned all the practices works as carbon sequester. Trees are natural sequesters of carbon, they take carbon from atmosphere, utilize it in the process of photosynthesis as well as they store it in the form of biomass or wood. For this process of carbon sequestration to be succeed it is essential that carbon must not return to the atmosphere from burning.

3.2. Wetland restoration

Wetland soil is an important natural carbon pool or sink. Wetlands conserves 14.5 % of the soil carbon found in world. But only 6 % of the world's land is composed of wetlands.

3.3. Oceans as sink

Oceans absorb CO2 from the atmosphere because the concentration of CO2 in the atmosphere is greater than that in the oceans. This difference in partial pressure of CO2 results in the gas being absorbed into the worlds oceans. (Raghuvanshi et al., 2006)

3.4. Subterranean injection or Geological sequestration

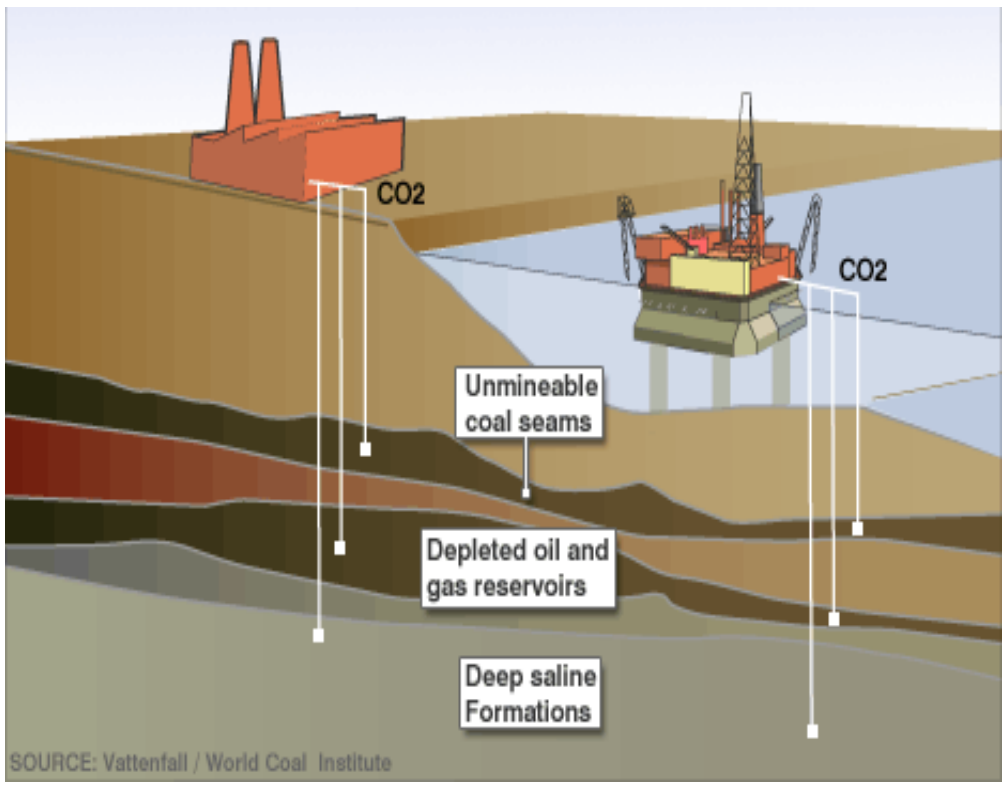

Figure 2. Geological Options for CO2 Storage

Source : World Coal Institute

Carbon dioxide can be injected into depleted oil and gas reservoirs and other geological features, or can be injected into the deep ocean, this is known as subterranean injection (Figure 2.). The location of different Carbon Dioxide injection points in the world has been given in Figure 3.

Figure 3. Major carbon dioxide injection project locations in world

Source : Global CCS Institute,(N.D.), Australia

4. WHY CARBON SEQUESTRATION IS IMPORTANT?

1. Carbon dioxide capture and sequestration could play an important role in reducing greenhouse gas emissions into the atmosphere

2. It enables low-carbon electricity generation from power plants.

3. As reported by INCCA in their report, 'Green House Gas Emission2007', 38% of CO2 emissions in India is done from electric power generation. This carbon share can be reduced by using carbon sequestration technology.

4. Carbon sequestration technologies can dramatically reduce CO2 emissions by 80-90% from power plants that burn fossil fuels.

   for instance - if it is Applied to a 500 MW coal-fired power plant, which emits roughly 3 million tons of CO2 per year, the amount of GHG emissions avoided (with a 90% reduction efficiency) would be equivalent to:

   - Planting more than 62 million trees, and waiting at least 10 years for them to grow

- Avoiding annual electricity-related emissions from more than 300, 000 homes

5. Another reason of importance is, forests, which acts as carbon sinks and store Co2 in large amount.

The use of forest is a financially viable technique to reduce emission. It could also bring significant benefits to the local communities involved and consequently helps in reducing poverty at the same time. Forestry projects can bring social, economic, and local environmental benefits to millions of people. (Clyde, P., 2012)

5. CONCLUSION

Carbon Sequestration can assist significantly in maintaining the natural carbon cycle. Therefore, requirement is that we need to implement this practice properly. There is a need to go for natural sequestration first, thus conservation of existing forests and more and more reforestation is required. Only then we will be able to reduce carbon emission and corresponding harmful impacts. Later on there is an immigrate requirement to install carbon capture and store mechanism in every thermal power plants. So that carbon emission can be managed at its point source.

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