LUPINE PUBLISHERS

Open Access Journal of Bio-sensors & Renewable sources

Review Article

Climate Change Threats to Ecosystems

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Received: January 24, 2020 **Published:** January 30, 2020

Abstract

This paper discusses about the projected changes in the Climate system and the risks for ecosystems. It also discusses about the drivers to climate change and the possible measures to overcome them.

Keywords: Climate; ecosystem; environment; risk

Introduction

There is a huge accumulation of thermal energy in earth's climate system in the upper oceans, deeper oceans, in the ice, land, and also atmosphere. And as a result of this, it is expected to have serious consequences on the physical systems that are there on the earth like the glaciers, snow, ice, permafrost, rivers, coastal areas, sea level rises, erosion of coastal areas, and also terrestrial ecosystems, biological systems, marine ecosystems, wildfire, and also managed systems like livelihoods, food production, economics and health. All these factors are influenced by these sorts of changes that have been happening, which are attributed to our continued emissions of carbon dioxide and other greenhouse gases in the process of energy harvesting which is needed for our economic prosperity.

Projected Risks to Ecosystem from Climate Change

This issue of global warming has been under worldwide study of scientist across the world under the form of IPCC continuous study with improvements and revisions over the past 3 decades. The report of 2014 has a very detailed analysis of climate change, and it has a lot of analysis on observed changes and the causes in the atmosphere climate, future climate change risk and impacts, and also it suggests certain pathways for adaptation, mitigation and sustainability development. So, all these aspects are important when we deal with global warming [1].

More than 99.8% of the total energy that we get is coming from the sun, and a small amount is coming from the heat released by the core of the earth. So, sun is the main provider and probably the only provider of energy for us in large quantities that are required by us. So, the sun energy can be considered in terms of watts per meter square, 300 watts per meter square of the surface area of the earth, this varies in a number of ways but on the average, this is what it is, and it is been fairly constant over the several decades at least. 340 watts per meter square is incident at the upper reaches of the atmosphere, and then as it goes through the atmosphere it gets modulated in a number of ways by our atmosphere, by what is happening on the earth surface, and what is happening, what has happened before also as we will see. So, out of the 340, 79 watts per meter square is absorbed in the atmosphere, and a net of 100 watts per meter square, so that is about 30% is reflected back into the outer space, and 185 so slightly more than half is reaching the ground, and 24 of that is reflected back as shortwave radiation, reflected from the Antarctic ice, Arctic ice and a number of, from the land, from the ocean known as the albedo. So, all of this contribute to the reflection of the incident light without any modulation. And so we have only less than half 161 watts per meter square coming on to the surface, where it gets transformed in a number of ways it gets absorbed into the surface, it leads to evaporation from the land, from the sea, and then it also contributes to sensible heating of the atmosphere, and then it is also, it maintains a certain temperature of the earth surface because of its temperature, it emits radiation to the extinct of 398 watt per meter square. And this is reflected back into the atmosphere, and a significant portion is emitted back 342 is emitted back into the earth surface, and a net amount of 239 is what is lost into this space [2].

So, what is lost into space as thermal radiation, as long wave radiation plus what is reflected shortwave radiation is almost balanced by what is coming here 340. There is a small difference, that is 0.6 watt per meter square is supposed to be the imbalance

which is going into the earth surface, this-this has been the way for centuries, but it is not always been like that, there were times, of course, when the oxygen concentration was minuscule, and carbon dioxide concentration was as much as 10%, so this 10,000 ppm. So, it is not that life things have been the same way as there are a number of causes for this climate change, natural and also human-related anthropogenic, so there are natural fluctuations in the solar output.

Drivers of Climate Change

Aerosols, the minute particles that are present in the atmosphere contribute a significant amount in terms of capturing the solar shortwave radiation and also reflecting it and then also in the long wave range. These aerosols can be generated by us by human activities, they can also be generated by natural activities like volcanic eruptions and then winds, storms, and a number of fires, natural fires, all these things can generate aerosols. And then we can also have clouds, we know clouds are found in many different ways, and then we can have ozone which is a substantial gas which interferes with this process, and we have heard of ozone fluctuations caused by number of factors, and then we have that culprits that we are interested in, the greenhouse gases and large aerosols, some of which, many of which are contributed to by our human activities [3].

And then we also have vegetation changes on the earth surface, and ice and snow cover during winter time, during summertime, as it changes as the cover changes, then we can have changes. Ocean color, wave height are also causes for the surface albedo, that is amount of wave that is reflected, 340 watt per meter square as the amount that is coming into the upper reaches, and example what is reflected by the earth surface is 24 watt per meter square. So, it is only about tenth of what is reflected by natural causes on the earth surface.

Complication arises from a number of physical phenomena that happen, for example we can have snow, ice, albedo effect, long wave radiation, and the lapse rate so that is the rate at which the temperature decreases, clouds, water vapor, emission of non CO_2 greenhouse gas and aerosols, air-sea carbon dioxide exchange, air-land carbon dioxide exchange in the process of vegetation growth and all that, bio geophysical process, and peat and permafrost decomposition as temperature of the air changes, of the atmosphere changes, then these kind of vegetal matter can decompose giving rise to emissions of this GHG gases. So, there are all these factors which contribute to, which are affecting the way the temperature evolves as a result of increase or decrease in concentrations of these GHG gases [4].

As a result of minute changes in the temperature of the atmosphere, temperature of the upper layers of the oceans and the land and so on. So, out of this we can see there are some positives which mean that as a result of this we will have increase in temperature, and then there are also negatives which can decrease, which can lead to decrease in air temperature. As a result of all these things there has been continual change in the atmospheric concentration over millions of years, well before man was born. There have been natural causes which led to large-scale changes in carbon dioxide concentration, coming back to a closer range of 0 to 3 million years ago. So, we can see sea level changes, atmospheric concentration changes and variations of the order of between 200 to 400 ppm and we can see global sea level variation compared to present level of zero. They have been significant decreases of the order of -100 meters, so sea level has been rising and falling, rising and falling by tens of meters, naturally, well before man has had his footprint or evil hand into this [5].

If we look at the changes that are happened in the last 150 years in terms of temperature change it has gone up from -0.6 to about 0.2, so it is about 0.8 degree centigrade over the last 100 years, over the last 150 years, but worrying trend is that over the last 50 years it is been rising at a fairly large rate. And sea level change in the last century has been from -0.15 to about 0.05, so that is about 20 cm it has risen. So, on the face of it, when we look at these figures whether it is carbon dioxide concentration or sea-level change, temperature changes, 1, 2 degrees, what is the big deal because there are seasonal changes which are much more rapid and much higher. This is something that on the face of it, it looks like this, but consequences of this, on the whole, are supposed to be much more much more harmful, and some of these are predicted by the global climate models because of the complexities that are involved in the agents that contribute to change of climate and the number of different factors that come into picture [6,7].

There has been a consorted attempt going back to 40, 50 years towards developing global climate models, and early studies have linked only the atmosphere, land and ocean surface, but gradually we have other factors like aerosols coming into picture, the carbon cycle, vegetation, the dynamic vegetation and some atmospheric chemistry, land ice, all these factors have been gradually included into this.

When we look at carbon dioxide concentration we really have to understand how much carbon dioxide there is, how it changes when we look at this carbon cycle we have here stock of carbon in, so that is amount of carbon stored in different state of the upper parts of the earth surface and the atmosphere. And then we also have fluxes, because amount that is there in any particular reservoir is not constant, it is being continuously exchanged with other reservoirs so that there is a carbon cycle. So, we have atmosphere, and atmosphere and the ocean surface are in constant exchange of carbon dioxide because carbon dioxide can dissolve in the sea water and then go into bicarbonate form, or bicarbonate is getting converted into carbonate forms. And carbon dioxide can also be taken by vegetation on the surface, and when vegetal matter or animal matter decomposes or when we have a wildfire, we can have carbon dioxide generation. And then we can have volcano, volcanic eruptions giving rise to both direct evolution of carbon dioxide, but also, more importantly, some other minerals which come out on to the surface and lead to carbon dioxide absorption, there is a possibility [8].

The volcanic eruptions also cause distribution of very fine scale aerosols into the atmosphere which play which interact with

incoming solar radiation from the sun and also outgoing solar radiation from the earth and then lead to accumulation or release of this. And then we have vegetal matter becoming deposits and then forming the earth surface, earth crust, and then all these things, these are all and fossil fuel reserves that are there may be a kilometre, 2 kilometres inside the, from the earth's surface, these are all carbon reserves.

So, carbon is found on the earth crust and in the atmosphere in many, many different forms. In gaseous form, in dissolved form in water, in transformed solids in the form of vegetation, and also in terms of fossils, in terms of carbonates and rocks. So, there are all these kinds of things, and each of these has a timescale, of interaction so that if we were to release a certain amount of carbon dioxide into the atmosphere now, then it gets slowly, slowly evacuated by these natural processes. If our rate of release of carbon dioxide is significant, is large then there can be accumulation, and that is what we are seeing here, and this is what is actually the cause of concern for us as shown by climate models [9].

And these climate models show that there is going to be a continued increase in the carbon dioxide concentration, for example carbon dioxide concentration from the year 2000 is of the order close to 400 ppm, but if the current rate of emission of carbon dioxide continues for the next 100 years then it may go up to 1000 ppm, which mean trouble. So, if we retain it at our current levels and not go through the increases that we have seen, then it may lead up to doubling of carbon dioxide concentration.

So, there are other scenarios which say that they will continue to grow up, but if we take very strong action in terms of reducing carbon dioxide emissions and going towards near carbon zero emissions then over the next 50 years they continue to grow but gradually decrease like this. So, back into this and bringing it back towards is to 300 to 400 ppm level is a humongous task for which we have to go into almost carbon zero type of emissions [10].

Conclusion

As energy, environment and sustainability are needed, we cannot take short-term measures which lead to chaotic problems at a later stage. When given that we have to develop our energy usage and increase it by a factor of 3 - 4 over the next 40 - 50 years, given that so much development still needs to be taken, we need to look at the sustainability of measures that we need to consider. Sustainability has a strong component, not only coming from energy and security, but also from environment. So, we should be looking towards energy and environment and we should not be looking for energy or environment.

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