

BIO-GEOCHEMICAL CYCLES: THE JOURNEY OF THE NUTRIENTS AND THEIR IMPACT ON THE VARIOUS TYPES OF ECOSYSTEMS

Dibya Prakash Lahiri

Research Scholar, Vivekananda Institute of Professional Studies, New Delhi, India

ABSTRACT

Environment in itself is a sphere or a dimension which has a greater impact on the development of the world and all the creatures that fall under its power and ambit. The environment provides for a greater outlook and a view which is in perception as to what constitutes the environment. The cyclic movement in the environment which intends to provide the best way forward for the elements to imbibe and have a control over the replenishments into the resources can be best understood with the components which constitute between the two, Biotic and Abiotic. Geochemical cycles hold an important position in movement and creating a construed set of changes which help in keeping the environment intact in terms of movement as well as providing for the best solutions that will be helpful in letting the environment or the entire structure dry. The paper talks about the various Bio-Geochemical cycles that have been present in the ecosystem and their impact on all the forms of ecosystem that they are present. The paper talks about the various forms of eco-system that exist and their direct influence and they were affected for a long time by the various Bio-Geochemical cycles. Likewise, the paper also intends to talk about the importance of the ecosystem and their consequential depletion that has taken place over the period of time. The paper also intends to talk about the various policies that have been introduced by the Government to prevent the depletion or a change that has degenerated the quality of environment as well as the disturbance that exists in the various cycles of Bio-Geochemical elements and to reduce their impact over the period of time. The paper concludes with the perspective as to how the implications of these cycles will be helpful and shape out to improve what change humans with their own initiation hold on to.

KEYWORDS: *Various Bio-Geochemical Cycles, Quality of Environment, Ecosystem and a Structure*

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INTRODUCTION

The Environment, a term in itself is an ecosystem and a structure that plays an important role in continuing the life system on Earth. As defined by many, “the complex of physical, chemical, and biotic factors (such as climate, soil and living things) that act upon an organism or an ecological community and determine its form and survival.”¹ Environment constitutes of multiple components that pertain and combining them together that will help the sustenance of the planet. The two important components that the Environment constitutes itself with: Biotic Component and Abiotic Component. The system of environment is such that it pertains to constant movement and development that helps itself in replenishing

¹ Marriam Webster, Environment, para 2.

and moving the subsistence which helps in creating the powerful impact that holds and has an involvement with the constant changes which is in dire need as stagnation in environment is essential in terms of providing for a way out. The constant movement between the Biotic Component and Abiotic component is influenced by the various cycles that help in maintaining and regulating the path and the movement. Such cycles are known as the Chemical Cycles. These cycles play an important role as there are various levels of understanding and interactions that take place from time to time. These cycles vary from level to level which moves ahead

BIO-GEOCHEMICAL CYCLES

As a layman, Bio-Geochemical cycle may seem to be a complicated terminology which lays an idea of constituting a greater variation of study to ultimately guide and propagate the structure and understanding the cycle and its process. Bio-Geochemical inscribes itself into three individual words that in turn curtain themselves out:

- Bio- Biosphere
- Geo- Geological Components
- Chemical- The elements that move through a cycle.

The meaning of Bio-Geochemical cycle basically means the idea and concept of the chemicals and elements that are present around and on Earth continuously move and replenish themselves. Since the universe is conceptualised to atoms being the fundamental element that creates everything and they are indestructible, thus there is a cyclic movement between the elements present with a constant binding to remain on or around the planet.

Earth in itself absorbs certain amount of energy from the sun which, however is released out in the form of heat, the rest of the elements that pertain and take active part in terms of providing for the best way possible, keep themselves intact on planet Earth.

The main elements present on the surface of Earth are as follows:

- Carbon
- Hydrogen
- Nitrogen
- Oxygen
- Phosphorus
- Sulphur

Each of these major elements present on the surface of Earth speak of the indistinctiveness and carry out their process of energetic movement in any of the form that helps them in creating their structure which is helpful in retaining them within the sphere of Earth.

All the elements have their own cycles which help in carrying out the process of replenishment.

TYPES OF BIO-GEOCHEMICAL CYCLE

The cycles themselves have been categorised their strata based on the structural form of their element which are Gaseous state and Solid State, the initial plan is to provide the idea to give out the best possible structure that entails the fundamental belief of the cycles that will be carried out. The Cycles are:

- Gaseous Cycles: Oxygen, Nitrogen, Hydrogen and Carbon
- Sedimentary Cycles: Sulphur and Phosphorus

The functioning of these cycles work as following:

Water Cycle

Water in itself is one of the most important elements on Earth which has a variation of such a drastic level along with its various purpose of consumption for all the beings around on the planet. The idea of the Water Cycle plainly speaks for the movement of water wherein it shifts its position from one form to another form with which it can exist on the surface of Planet Earth.

Stages of Water Cycle

- **Evaporation:** The first process which is indulged in the Water cycle is the process of Evaporation under which the water dries up from the surface of Earth through the kinetic energy to the clouds. The process of evaporation places itself below the boiling point.
- **Sublimation:** Sublimation is the process through which the solid form of water directly gets converted in water vapour. This phenomenon occurs where there is low pressure and dry winds which can be found on the mountain peaks. The sublimation process requires lesser energy to convert directly from Ice to vapour due to lower pressure.
- **Condensation:** The water which evaporated a while ago turns back into water, which is efficient in nature. The water vapour turns into water. The droplets are visible once it is converted.
- **Precipitation:** Precipitation mainly refers to the process which any product condensation of atmospheric water that falls on to the surface of Earth as a result of the existence of the Gravitational Force.
- **Infiltration:** As the term suggests itself, infiltration mainly refers to the seeping of water into the soil of Earth varying on the type of soil and material that is present.

NITROGEN CYCLE

One of the inert gases present in the atmosphere with the largest content present, Nitrogen cycle plays an important role in converting the Inert gas into usable Nitrogen for the organisms especially the Plants who take gain the most. The cycle in itself is not only converting to usable Nitrogen but it also must take place and provide for a way back to be sent to the Atmosphere. The processes for the conversion are on various levels and not just one type of cycle.

Nitrogen Fixation Process

The first way with which Nitrogen can be utilised in the form of converting it directly from the surface of atmosphere into the usable Nitrogen which comes in the form of Ammonia. The Nitrogen then comes down in various forms either through Lightning, rain or gets sufficient support from the Nitrogen Converting Symbiotic bacteria which are Rhizobium, Azotobacter and Diazotrophs which fix the Nitrogen in the soil. The above mentioned Bacteria contain the important Nitrogen converting enzyme known as Nitrogenase that makes it soluble for the utility through Nitrogen Fixation.

Types of Nitrogen Fixation

- **Natural Nitrogen Fixation:** This process mainly involves the direct conversion of Nitrogen through the Lightning process, gets converted into Nitrogen Oxide which can be further utilised by the Plants.
- **Industrial Nitrogen Fixation:** The utility of the industrial fertilisers which contain higher amount of Nitrogen can be used in such cases. The producers develop the product in such a manner with which they are able to provide for various ways that indulge in the fixation of Nitrogen through chemicals which become soluble in nature.
- **Biological Nitrogen Fixation:** The utility of the Symbiotic Bacteria help the lot in fixation of Nitrogen such as Rhizobium or Azotobacter.

Nitrification

Another important step which is involved here is the process of Nitrification under which the Nitrogen which comes into the form of Ammonia is converted into the soluble content called Nitrates which help the plant in turn to grow. The Nitrites are formed through the process of Oxidation of Ammonia. The Nitrites are mainly converted by the Bacteria which are produced by Nitrosomonas. However, one must always know the fact that Nitrites and the presence of Ammonia Gas in themselves can turn out to be highly toxic for plants, for which they must need a bigger prospective picture which comes through the next important step. The next step involved in this process is the conversion of Nitrites into Nitrate by a substantive symbiotic Bacteria which is called Nitrobacter. The Nitrobacter plays down on the last straw which gives the conversion of Nitrites into Nitrates.

Assimilation

Another step that takes place in the process of fixation of Nitrogen Is the process of Assimilation wherein the various form of Ammonia, Nitrite Ion, Nitrate Ions or Ammonium hold on to such power.

Ammonification

The next step indulged in such actions is the process of Ammonification wherein the plants and animals have died and their decomposed material which has a high Nitrogen content gets mixed into soil and seeps deeper into the soil.

Denitrification

The stage which provides in for giving the soluble Nitrogen back into the air. The soluble Nitrate gets converted back to Inert Nitrogen through the absence of Oxygen with the help of the Denitrifying such as Clostridium and Pseudomonas. At the final stage, the Nitrogen returns to the Atmosphere in various forms including Evaporation.

Oxygen Cycle

The most important element present on the planet for its existence has discovered and produced a circle or cycle of its own which plays out an essential action which has been observed over the period of time. As one is aware, Oxygen holds 21% of the total population or proportion in the Atmosphere which is right after the Inert Gas Nitrogen followed by another Inert Gas named as Argon. The Oxygen cycle is considered to be one of the most important aspects as it increasingly moves into the process from the Atmosphere back to the surface of Earth as well as back to the Atmosphere.

The cycle of Oxygen moves into all the three surfaces which are Atmosphere, Lithosphere and Biosphere wherein the process continues itself through the interconnection it holds with the Carbon Cycle.

There are several stages of Oxygen Cycle, they are as follows:

- Ñ Plants during the process of photosynthesis release oxygen in the atmosphere as a by-product.
- Ñ The animals and organisms that hold the oxygen and breathe through/ sustain on oxygen move ahead with the breathing.
- Ñ Carbon dioxide which has been released by animals, is consumed by the plants in the process of photosynthesis and again release oxygen through the by-product of photosynthesis.

CARBON CYCLE

Carbon is one of the fundamental elements that are present in all the Living beings as well as an essential component constituting several of the resources which are important for the consumption of the living beings. The Carbon cycle is the process which shows the movement of the element in both its individual componential as well as in its combined state. One can say that the Carbon cycle mainly intends to combine and connect Carbon to the various surfaces of Earth such as Hydrosphere, Lithosphere, Biosphere, Pedosphere as well as Atmosphere.

Carbonic Cycle Steps

There are several steps that is present in the Carbonic cycle, which play a multi-varied role in terms of connecting and providing the best way out which will be helping the various structures of the complicated stern present. The various steps which are present as follows:

- Carbon present in the Atmosphere is easily absorbed by plants for the process of Photosynthesis in the form of Carbon Dioxide.
- The severance of the cycle is such that the animals consume these plants and thus accumulate the Carbon in their body.
- Some of the plants and animals die and the decomposition process carrying out leads these carcasses and all other products down into the soil and some amount of Carbon gets converted into Fossil.
- The Fossil fuels are thus then utilised by the Humans for various purposes that in turn provide and move ahead with the concept of Fossil Fuels burning and the Carbon is released back into the atmosphere.

Carbon Cycle on Land

The Carbon Cycle on land, the Carbon is presenting itself in the form of Carbon Dioxide which is mainly an end product of the Respiration as well as the toxins released through the Industrial wastes. The concept which runs the Carbon Cycle is the chain which speaks for being going from producers to consumers.² The end role of the consumers is to provide for a way which will be effective into commencing the full-fledged idea by the Decomposers and send it back to the Atmosphere.

Carbon Cycle in Water

Carbon cycle in water plays an essential role in terms growing the amount of Carbon which exists on the bed. It is said that the ocean is the Carbon Sink wherein there are various forms of Carbon provider exists. The Marine animals generally utilise the Carbon which exists and converts them in Soluble Calcium Carbonate which is utilised for various purposes. After a long period of time, the organisms die and the Carbon further in itself turns out to be of various purposes one under intense pressure and constant soluble movement leading to the formation of Limestone under the Ocean Bed.³

PHOSPHOROUS CYCLE

One of the most essential components of the living organism constitutes of the Phosphorous which holds a great value in the Human Lives. Phosphorous in itself provides for a major component in the DNAs and RNAs of the Humans as well as plays a major role in ATP present inside the human body.⁴ Approximately 80% of the total component of Phosphorous is found in Teeth and bones.

However, one must know the fact that as much as valuation the Phosphorus element holds for human body, the building up of Phosphorus and mixing with the soil is a long hour process and it takes time for the Element to mix well.

The process for Phosphorus Cycle is as follows:

- Weathering of rocks which flow down the River.
- Absorption of Phosphorus by plants through the dissolved solvents present in the soil or through the fertilisers that farmers use.
- Carnivores can gain the element Phosphorus by eating the Plant eating animals.

Return of Phosphorus back to Ecosystem

The returning of plants back into ecosystem comes into existence when it comes to their death. The plants and animals decompose into the soil and water. With the mix into soil and water, there is again the scope of Phosphorus resorting to weathering and thus they again start the Phosphorus cycle.

² The Food Chain Concept.

³ Formation of Limestone Bed.

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SULPHUR CYCLE

Sulphur is the most abundant element present on the surface of Earth as well as constitutes majority of the share of protein inside the Human Body which essentialises the growth as well as developed the human body. Sulphur is basically found in the composition of amino-acids methionine, cysteine and cystine.

Sulphur in itself takes the positioning in the atmosphere through the burning of fossil fuels as well as on the surface of Earth seeks to provide for ways wherein they remain Solid that they are in the form of Rocks and Minerals.

The Sulphur Cycle

- The Sulphur mixes into the Environment through Rocks and Stones in the form of weathering.
- Sulphur comes into contact with the air and provide for a way to convert themselves into Sulphate.
- The Sulphurs are then further developed and converted into microbes and they consumed in the organic.
- The Sulphur is consumed by animals but accordingly they moved up the food chain through their understanding.
- Post the death of animals, the Sulphur present inside their body gets fully converted into a residual form and mixes with the soil.

Types of Eco-systems in the Environment and the effect of these cycles in case of their disturbance

Eco-system is one of the essential components of the environment wherein all the living beings make their presence and carry out their day-to-day function. The idea is to provide for a way which shall be helpful in terms of giving out the processes unhinged as well as do not bring about a disturbance which might be hampering the functioning of the eco-system.

As one can understand and see, these Bio-Geochemical cycles play an essential role in terms of developing the eco-system and play out as a component of the same. These ecosystems can range and provide for various ways for the cycles to carry themselves out and ensure there is no net change in their working conduction.

Types of Ecosystem and the impact on them due to the changes incurred in the cycle of these systems

The ecosystem categorically distinguishes itself into two main sub-systems:

- Terrestrial Ecosystems
- Aquatic Ecosystems

Terrestrial Ecosystems

The land-based ecosystem is mainly providing a way out for the various living beings to exist on the surface of Earth and have different Geological Zones. There are essentially four types of Terrestrial Ecosystems:

- Forest Ecosystem
- Grassland Ecosystem
- Desert Ecosystem
- Tundra Ecosystem

Forest Ecosystem

The forest ecosystem essentially refers to the structure wherein the forests covered in trees with their sheds falling around which provide for an environment that mainly refers to the animals and covers over the period of time.

Grassland Ecosystem

The Grassland ecosystem mainly consists of the vegetation which primarily constitutes itself with grasses, herbs and shrubs that play an important essence in terms of providing for a surface and structure that entails a habitation for animals. Temperate Grasslands as well as Tropical grasslands are the two main categories found in this ecosystem. The shorter grasslands which mainly consist of the herbs and shrubs.

Tropical Grasslands or Savannas mainly consist of the shrubs to trees which are comparatively taller in terms of length of the grasses. The Tropical Grasslands can be found in the African region.

Tundra Ecosystem

Tundra Ecosystem mainly consists of the area which lacks the presence of Greenery in terms of Grasses and Trees, mainly containing snow and ice which frosts over the land most of the year. The ecosystem can be mainly found in the region of Arctic and places where mountains hold their structure.

Desert Ecosystem

As the term suggests itself, desert ecosystem mainly refers to the area which is mainly diffused with sands and salt surrounding itself throughout the year. The water in these is scarce and they receive very less rainfall. The days and nights are substantively hotter and colder respectively.

Aquatic Ecosystems

Like the terrestrial ecosystem, the water also has been strengthening itself with creating an ecosystem of its own, the ecosystem which is effective as well as efficient enough to create a niche wherein the mammoth quantum of animals and plants can be seen and found. The possibility of ecosystem creating itself goes on to show the critical importance it holds which likewise is a conclusive effect and a resultant of what can be called a balance in terms of providing the best way forward under the rational environment development.

The Aquatic Ecosystem mainly falls in two categories that are as follows:

- Freshwater Ecosystem
- Marine Ecosystem

Freshwater Ecosystem

The idea of Freshwater ecosystem is mainly inferred with the bodies that carry more inclination towards the inclination of the fresh sources. The categorisation of the freshwater ecosystem is mainly of three types:

- Lentic
- Lotic
- Wetlands

Lentic: Lentic ecosystem mainly refers to the areas that consist of Ponds, Lakes, and Wells which are confined to a compiling area.

Lotic: Lotic ecosystem mainly refers to the moving fresh waters such as rivers.

Wetlands: The third sub-category of the freshwater ecosystem which consists of the idea of providing the land to be stagnated and less mobile for a long period of time are the Wetlands.

Marine Ecosystem

The marine ecosystem mainly refers to the water bodies which contain of the higher proportion in terms of salt which means salt water and its components.

Covering over 70% of the Earth's surface, the Marine ecosystem is a widened focal area which presents itself of the highest intention with the richness filled in minerals, salts and contains the highest amount of the fossil fuels under their bed.

Oceans and Seas mainly are the prime components of the Marine Ecosystem.

Effect of the Bio-Geochemical Cycles on the various ecosystems

One might contain with the fact that the essentiality which these cycles hold in terms of providing a safe and satisfied structure that hold on to the power of giving the basic relief to the structure and systems present and surrounding the planet Earth. However, one must know that these cycles in themselves constitute to be the main focal factor that condenses the ecosystems which we or any of the Biotic/Abiotic components sustain on.

With the increase in human population, there has been drastic industrialisation as well as circumstances that have prevailed in exploring the natural resources which will help in providing an increase in job opportunities along with the idea of creating a structure that will help ensuring the long run growth. However, the constant exploration of the mining, factory opening and utility of the resources is considered essentially to be one of the foremost structures that are involved in disrupting the cycles that act as the backbone for the sustenance of life on Earth. One must always keep in mind the essential factor that directly affects the structure of the understanding of the loss of Bio-diversity on the surface is holding the deficiency every time. The cooling and warming of the surface of Earth is directly affected by the cycle and its disruption, since the essential elements such as Carbon, Sulphur and Phosphorus are known to warm up the surface temperature of Earth.

Disruption of the cycle in itself gives a cyclic destruction of the Lithosphere, Atmosphere and Hydrosphere. The crucial conclusion that one beholds as a result of the destructive action of Deceasing of the Marine Ecosystem, Ocean Acidification as well as Soil Acidification. These destructive conclusions are a result of the constant bullying which is done against the nature as well as provide for a way that endures and harms the structure of ecosystem which is in its motion.

Not only does the cycle disruption harm the land and water, the next bigger consequence that they hold is the destruction of Atmosphere. With the rapid increase in the movement of the Carbon cycle, there is a direct impact on the creation of higher emission of Carbon dioxide which moves forward with the idea of harming the layer of Atmosphere that conclusively provides a sourcing for the Ozone Layer depletion. It is suggested that there was a direct depletion of 60 per cent of the total Ozone layer depletion compared to the average downfall that is expected in terms of providing the

structure and variation that comes in to action over the areas of continent such as Antarctica and North America.⁵

One can distinctively observe and not avert themselves from the fact that the disruption of such cycle goes beyond the idea of harming the structure of ecosystem as well as questions a big time towards the Habitability of the human beings. Thus, there is a dire need to provide solutions and ensure that there remains a prospective and progressive improvement in the cycles and regulating themselves. The drastic intervention of the Government is of utmost importance as one can see how the impediment of these destruction has resulted in the pollution and health hazards that are inductive towards the citizens of the country as well as the reports which suggest the terrible conditions of the cities of the country which have become a global phenomena and turn out on the Global charts.⁶

Stand of the Indian Government towards Committing the Improvement of these Cycles

The Government of India has taken note of such actions which are effectively harming the structure of these ecosystem and made note of the importance of the fact that the country which is home to many a habitats needs an aggressive charge of actions to prevent any further deterioration of the ecosystems.

In the recent structure, the Government of India has mainly focused on creating research in the Water bodies to observe the periodic effect of the cycles and how they act detrimental. The recent approach involves the involvement of several parties into giving an outlook which includes National Institute of Oceanography, Central Marine Living Sources, Central Marine Fishery Research Institute as well as other companies that are inclusive of the understanding of the marine structure which is including the solutions which shall act upon as the pavement to improve the conditions.

The Government has planned out on increasing the research projection which includes multi-disciplinary research in the field of developing the research at the specific structures as well a place which include the core physical, biological and chemical inducing actions which will prevent further actions that can be used for their accountability in creating the worst case Pandemonium of all the transgressing calamities in the country. The research in itself for the first time wishes to provide a direct connection to improve the Bio-Geochemical cycles of the country.

Opinion

The environment which is responsible for the sustenance of life line of all the present Biotic and Abiotic component gives itself of an energy and structuring which influences and provides for a way out to affect or improve the condition of the various beings on Earth. Drastic development is a need of the hour with the rising population as well as the dire need to find alternative solutions which goes on to show the need of disrupting these cycles. The cyclic change must be observed with the understanding that the resources are not entitled to provide themselves with the functioning which can be taken for granted. Constant efforts have to be imbibed to maintain the cycle as well as the awareness which is the need of the hour which can be holding on to the perspective as well as creating a belief that there are no two ways to handle issues which involves constant dodging of ideas, rather one way solution which is to formulate, implement and seek for outcomes.

⁵Joseph C. Farman, British Antarctic Survey, 1985.

⁶Bhiwadi ranked as the most polluted city in the world, IQ Air Report 2021.

CONCLUSION

Environment plays an important role in terms of providing a structure that helps in creating a strengthening living of the people as well as move ahead with the idea of creating a structure which is liveable. The Bio-Geochemical cycles act as an essential component which mainly intend to provide a way or a solution which is impactful. The policy making and decision making system needs a change but rather it must be an action which is going to give twin winning goal with the idea of providing the best possible solution that holds on to the idea of creating a structure which is efficiently effective and benefits on a drastic change. The ecosystems can be very well balanced once there is a change and a pull towards creating the better structure which can be played along the lines of sustainable development. However, one must have a specific inclination towards providing a better structure of origin and give a way that will be helpful in terms of rectifying the propositions which can be called out with the help of constant efforts and motivation to provide for a way that will be effective and helpful on the longer run. The effort has to come from within as well as the understanding of the ideas which is to be sent around the people. The cycles can be prevented but they cannot be reclused likewise as they are one of the essentials that help in the development of what needs to be prevented and not sorted out of the way as a burden or a liability.

