

Field: Biological Production and Environment

Achievement: Contributions to solving global environmental issues based on the analysis of nitrogen and other substances' cycles

Prof. Peter Vitousek

Born : January 24, 1949

Professor of Biology, Stanford University

Summary

Since the Industrial Revolution, human economic activities have continued to expand, making the earth a relatively smaller place. Prof. Peter Vitousek, an expert in ecosystems ecology, has been studying the material cycle of such nutrient elements as nitrogen and phosphorus in the ecosystem. Based on the aforementioned research, Prof. Vitousek has made pioneering achievements in the field of "biogeochemistry," which analyzes how various factors influence the ecosystem. From his achievements, he has pointed out the serious effects human activities have on the global environment as well as potential solutions for solving global environmental issues.

Environment from the perspective of the material cycle

Living organisms survive by adapting to the environment, but at the same time they affect the environment in one way or another. The academic field which sheds light on the interrelationship between the environment and living organisms is ecology. The English word "ecology" was coined in 1866 by a German biologist Ernst Haeckel. Thus, the concept of ecology has quite a long history.

Furthermore, what led to further development in ecology was the great discovery in the field of chemistry in the 19th century of the nitrogen cycle. Nitrogen is an essential element which constitutes protein, but most living organisms are unable to use the nitrogen in the atmosphere. Nitrogen-fixing bacteria which have the ability to fix the nitrogen from the air, and produce ammonium and its derivatives and which are then consumed by plants. In turn, animals which consume the plants are able to use the nitrogen, and through the food chain, nitrogen accumulates in the ecosystem. Thereafter, through the activity of denitrifying bacteria, nitrogen is again released into the atmosphere, and the cycle continues.

Within the study of ecology, ecosystems ecology focuses mainly on the energy-matter interaction which occurs between living organisms and non-living matter. This academic field has presented numerous methods of ecological analysis one after another.

The ever-changing ecosystem

Prof. Vitousek, is presently known as a leading authority in the field of ecosystems ecology, but he first obtained a Bachelor of Arts in political science in 1971. Thereafter, he took an interest in ecology and earned Ph.D in biological science in 1975. With such a diverse perspective, Prof. Vitousek has been seeking to find a new field of research in ecosystems ecology from that time. He has found that while conventional ecosystems ecology focused their research on the material cycle at the present time, his thought was, "just as society and economics undergo changes with time, the material cycle must also undergo changes with time. That is an essential part of the ecosystem."

The subject of research chosen by Prof. Vitousek in the 1980's was the Hawaiian Islands in the North Pacific. The Hawaiian Islands were formed by volcanic activity, and its characteristic is that it is situated in a straight line according to the order of formation. Through the study of the material cycle of the respective islands, Prof. Vitousek thought that the dynamics of the material cycle could be clarified.

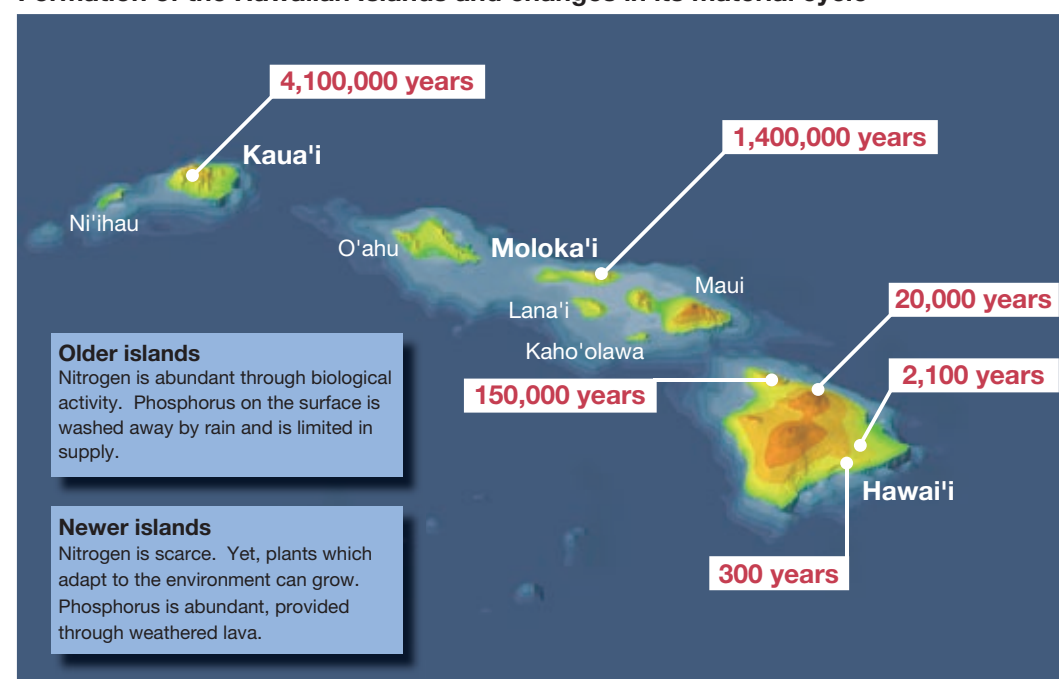
The result was more than anticipated. Prof. Vitousek focused his research on the nitrogen and phosphorus cycle which are growth elements of plant life. However, on new lava islands which have only been in existence for a few hundred years, the plants only received a small supply of nitrogen from the lava. On the other hand, the older the islands became, the more nitrogen had accumulated in the ecosystem. In contrast, with regard to phosphorus which is supplied from the earth, the older the island, the more deficient it became, as it would have been washed away. In this way, it was observed that the material cycle in the ecosystem is not as stable as it was once thought to be, and that it is changeable, being affected by various environmental factors.

Among such factors that have the greatest influence at the present time are human activities. Prof. Vitousek made clear that plant life on the islands adapt to the material cycle, so when exotic plants are imported, the material cycle is altered, endangering them even to the point of extinction. In addition, the agriculture of the indigenous cultures after being influenced by the Europeans resulted in substantial effects on the material cycle of the ecosystem.

The sizable impact of human activity

The foregoing research proved to be very influential on Prof. Vitousek's later research activities. The reason being, the changes in the material cycle of the Hawaiian Islands is the epitome of what has been happening on a global scale. Prior to the 19th century, nitrogen of the ecosystem was primarily taken in from the atmosphere by means of nitrogen-fixing bacteria from the soil. However, with the invention of chemical fertilizers in the beginning of the 20th century, an enormous amount of nitrogen, the same amount or more, would immediately be released into the environment. According to Prof. Vitousek's article compiled in 1997, the quantity of artificially-fixed nitrogen is up to 140 million tons per annum. Of that quantity, intensive legume cultivation in farms constitutes 25 to 40 million tons, 80 million tons are from chemical fertilizers and 20 million tons are from fossil fuels. Prof. Vitousek, in numerous study reports, continues to point out how nitrogen excess resulting from human activities have caused river and coastal pollution, acidification of soil and groundwater and decrease in biotic diversification. Subsequently, Prof. Vitousek has contributed substantially to establish a new field of research

Formation of the Hawaiian Islands and changes in its material cycle



called biogeochemistry and analytical methods thereof.

In the 1980's, various factors which threaten the global environment such as global warming, depletion of the ozone layer, acid rain and desertification were coming into light, making Prof. Vitousek's fear a reality. In order to clarify what issues face mankind, his endeavor was to reveal how much humans dominate the various services provided by the ecosystem to the planet earth. It was found that of the photosynthetic production of the terrestrial ecosystem, approximately 30-40% is used directly or indirectly for human activities. This and other changes in the ecosystem are something not perceivable by the human eye. Prof. Vitousek has revealed such through the material cycle data. His studies not only sound a warning about the profound effect that human activities have on the ecosystem, but provide an essential indication for policymaking pertaining to environmental issues.

Human domination of earth's ecosystems

