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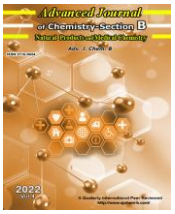

Original Research Article

Investigating Causes of Global Warming and Environmental Consequences

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ABSTRACT

The 80s showed the world that the human environment has been so destroyed and the growth of the population and the ever-increasing increase in human production power have given such dimensions to this destruction that the habitability of the earth has been threatened and the lives of human beings have been endangered. The researches that took place in this decade and the huge changes that took place in the natural conditions of the earth indicated that the earth is warming. Global warming has brought drought, famine, and water scarcity. The cold and snowy winters of the past are no more. Summers have become hot and long, and also the amount of annual rainfall has decreased. This heat damages agricultural products and causes shortage of water needed for agriculture and drinking water. In addition, the increase in the earth's temperature has endangered the living conditions of many animal and plant species, and a large number of them have disappeared so far. This increase also includes the risk of melting polar ice and icebergs. If this happens, the sea level will rise. As a result, many coastal cities and low-lying deltas of the world will go under water, including the city of Miami in the United States of America and the delta of Bangladesh.

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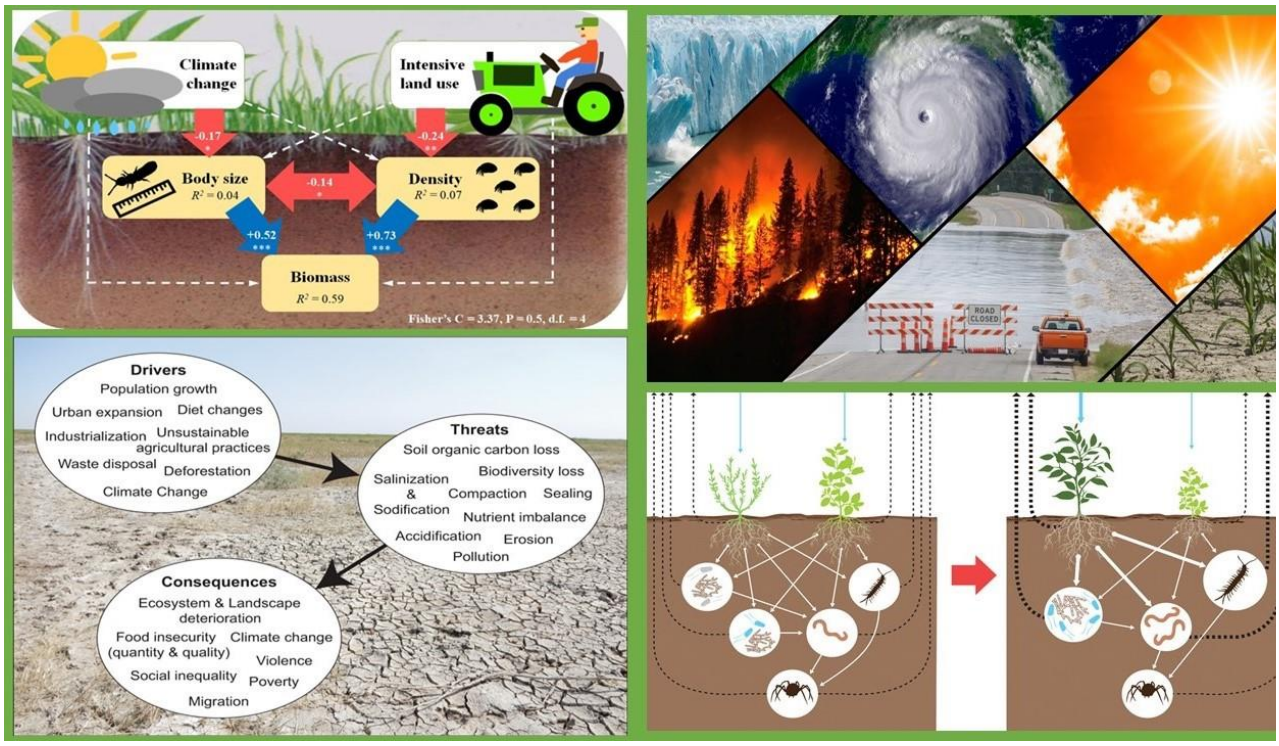
GRAPHICAL ABSTRACT



Introduction

Most of the atmospheric changes and phenomena result from the fact that the surface of the earth and the atmosphere that covers it are heated irregularly [1]. The reason for the irregularity in the warming of the atmosphere is that, firstly, there are some factors that have made the amount of solar energy that can be absorbed on the surface of the earth heterogeneous. Secondly, the differences in the type of land are effective in the absorption of solar radiation and cause major differences.

The amount of solar energy

Various factors are involved in the amount of energy received on the surface of the earth, which are:

1. Due to the curvature of the earth's surface and the deviation of the earth's axis in its rotation around the sun, the sun's radiation reaches the earth's surface at different angles related to time and geographic latitudes. The higher altitude of the sun leads to the greater the intensity of the sun's energy on the surface [2].

2. The thickness of the atmospheric layer through which radiation passes is variable due to changes in the angle of radiation. When the sun's energy passes through the atmosphere from a lower altitude, more energy is placed in contact with air molecules, and suspended particles in the atmosphere.

3. The number of particles and dust in the air changes according to time and place. The amount of dust in the middle of the oceans is much less than its amount on industrial cities. These particles are effective in absorbing, spreading, and reflecting the solar radiation that passes through them.

4. It is rare to find a point on the earth where the sunlight time does not change. In addition to the fact that the sky is cloudy for a long time, which prevents the radiation from reaching the surface of the earth, the length of the day is also very variable during the seasons. The length of

summer days is almost twice as long as winter days, and it has great effects on the amount of energy that reaches each place.

Composition of the earth's surface

The second main factor is the different and irregular absorption of solar energy by the earth due to the different composition of the earth's surface. Even if the sun's energy was received equally and uniformly on the entire surface of the earth, the greater difference in the composition of the surface of the earth would cause different absorption of energy amounts that would later heat the air. The difference in soil composition is very important in determining the weather and climate of the region [3]. The most notable difference is the difference between land and seas.

Water retains more heat than the earth and always loses heat with a delay compared with the earth. Therefore, sea water is warmer than the surface of the earth in winter and colder than the surface of the earth in summer (Figure 1). Is global warming happening? Several groups of scientists from the United States and England have collected a series of statistics related to the average temperature of the earth from a hundred years ago until now. Although specialists do not accept some of these numbers, the general trend is quite clear. The average temperature of the earth in the nineties of the 19th century was about 14.5 °C and in the 80s of the 20th centuries, it rose to 15.2 degrees.

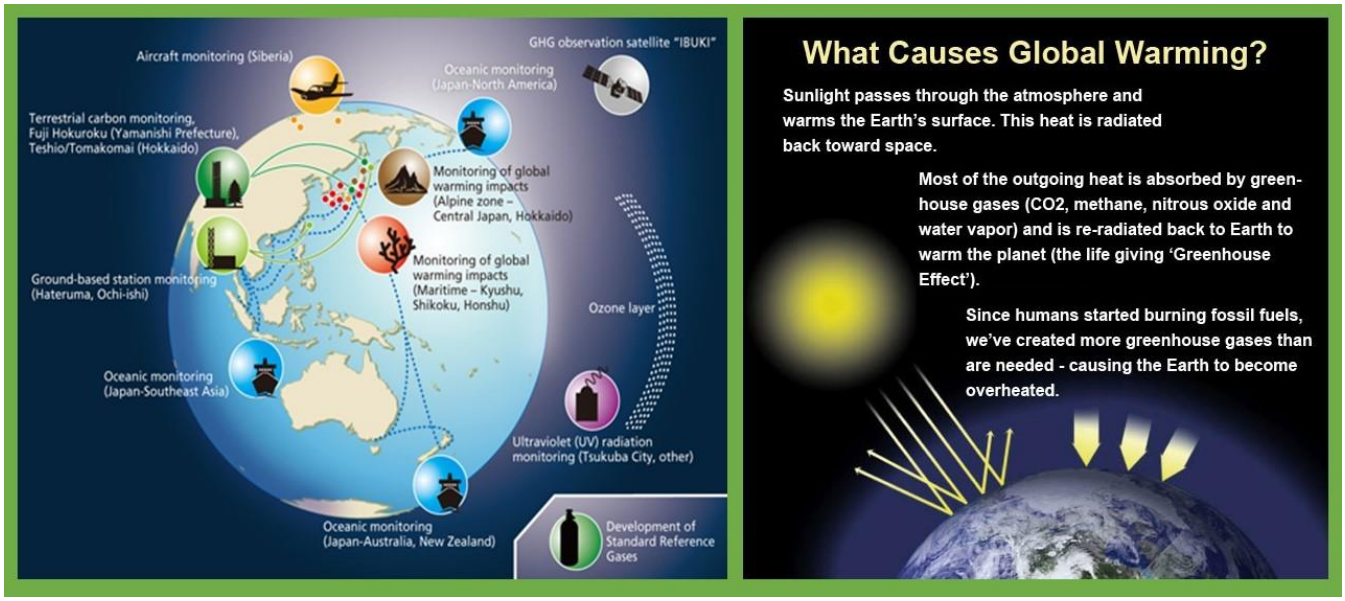


Figure 1. Global warming and climate change effects: Information and facts.

The temperature level was uniform between 1940 and 1970, but its sharp increase during the 80s was more than compensating for this multi-year calm. As mentioned earlier, 5 years of the hottest years of the last century were in this decade. The limited increase that has occurred so far in the earth's heat is important for scientists, but it is not so dangerous for society.

Between 2030-2050, the average temperature of the earth may be 1.5-4.5 °C (3-8 degrees Fahrenheit) more than the average temperature in recent decades or more than the average temperature of the earth in the last two million years, which is means that the earth is warming at a rate 5-10 times faster than it has been during the last century. If the global heat eruption that

started around 1970 continues, droughts, heat waves, and other unusual weather phenomena may increase by the end of the nineties so that even non-experts will notice that the climate is changing. Scientists believe that the speed of climate change will soon overshadow the natural variability of the earth's climate. In fact, this change can be compared with a nuclear war, because climate change, like a nuclear war, can cause the disintegration of a wide chain of human and natural systems. When the weather warms up quickly, all the works, including irrigation works, housing projects, and food production will be disastrously damaged [4].

Effective factors in global warming

In fact, global warming is "A day during which the average temperature of the air near the surface of the earth increases as a result of human activities or naturally." The solar radiation that reaches the earth consists of different wavelengths and each range of wavelengths transmits a certain amount of heat to the earth. The degree of air warming near the surface of the earth due to the radiation of the sun is determined under the influence of the following 4 main factors

- The amount of solar radiation that the earth receives from the sun,
- The amount of radiation that is reflected from the earth to space,
- Trap and keep heat by the earth's atmosphere, and
- Evaporation and condensation of water vapor in the atmosphere.

The light that reaches the earth from the sun warms the earth and its atmosphere. The earth's atmospheric system is such that a large amount of solar radiation entering the earth is re-reflected into the space in the form of long-wavelength waves. The water vapor in the earth's atmosphere along with the noble gases carbon dioxide and methane cause the earth's atmosphere to heat up because these gases absorb the heat waves reflected from the earth's surface and spread it again in the surrounding environment. The trapping and confinement of heat in the earth's atmosphere by these gases is somewhat similar to the heat confinement in a greenhouse. Therefore, such a phenomenon is known as the greenhouse effect [5].

Greenhouse Effect

There are many possibilities for a problem called (greenhouse effect). This phenomenon requires an increase in the concentration of carbon dioxide (CO_2) in the atmosphere. The increase of carbon dioxide due to human activities causes climate changes. In other words, it affects the temperature of the earth's surface. Carbon dioxide is not considered an air pollutant because CO_2 is a natural constituent of air. Carbon dioxide enters the atmosphere due to the activity of plants and animals. In this carbon cycle, plants use light energy through photosynthesis and CO_2 reacts with water to produce carbohydrates and oxygen. Carbohydrates are complex compounds of carbon, hydrogen and oxygen, such as sucrose (edible sugar), starch and cellulose. Carbohydrates are stored in plants and oxygen is released into the atmosphere. Plants are oxidized by natural decomposition, burning, or consumption by animals; it absorbs oxygen from the air and returns CO_2 to the atmosphere.

$$\text{Carb} + O_2 \rightarrow CO_2 + H_2O$$

These explanations show the carbon cycle in nature, which, if it is not disturbed by human activities, causes the amount of CO_2 in the atmosphere to remain constant. Humans disrupt the carbon cycle by cutting down trees and by burning fossil fuels and by turning limestone into cement. This first activity reduces the ability of nature to remove CO_2, and the latter causes the amount of CO_2 in increases the atmosphere. It is mentioned that CO_2 is produced by the burning of carbonaceous materials. Periodic changes occur due to the annual reduction of CO_2 through photosynthesis during the seasons. The greenhouse effect is the result of the interaction between the increase in CO_2 in the atmosphere

and the radiation that leaves the earth. Most of the emitted solar radiation including many wavelengths do not reach the earth's surface (Figure 2) [6].

Ozone in the stratosphere passes most of the ultraviolet light (with wavelengths shorter than visible) and atmospheric water vapor, CO_2, and a large amount of infrared light (wavelengths longer than visible) are radiated, which we feel as heat on our skin. Therefore, most of the light that reaches the surface of the earth is reflected back into space. Most of the remaining 2.3 is absorbed by materials such as rocks, cement, etc. This absorbed light is emitted as long-wavelength infrared radiation or heat (when the earth cools) [7].

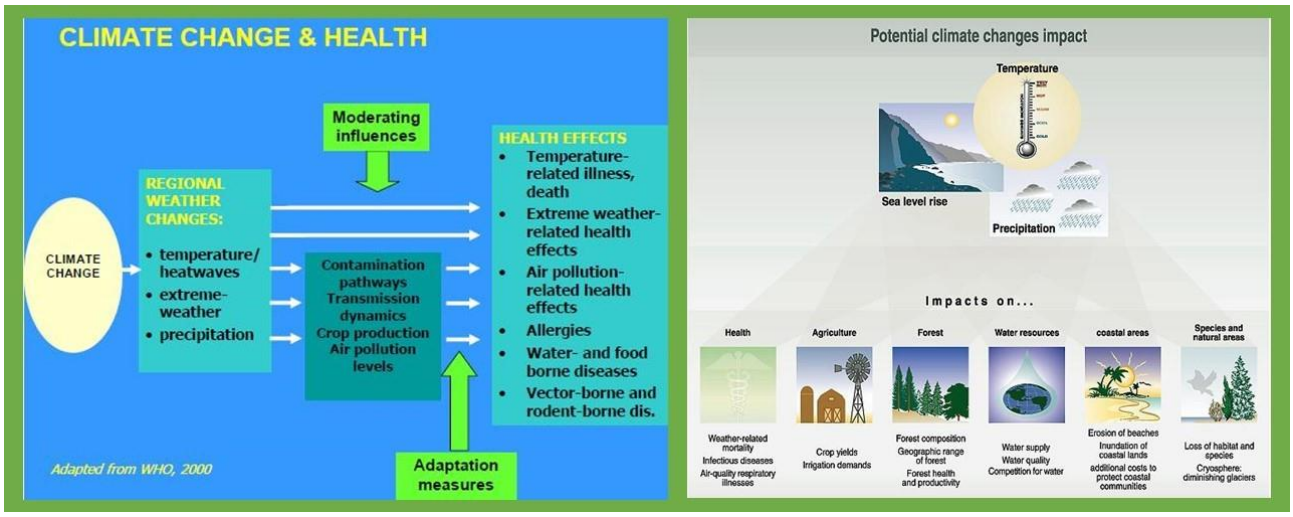


Figure 2. The effects of global warming and climate change | Health Knowledge.

Light with these long wavelengths is absorbed by atmospheric CO_2 and causes heating and release of heat, resulting in an increase in atmospheric temperature. CO_2 effectively acts as a one-way filter. It allows visible light to enter from one direction but prevents the passage of long wavelength lights in the opposite direction. Atmospheric water vapor also acts as a filter similar to CO_2, but water concentration does not change significantly due to human activity. Therefore, its contribution to the atmospheric temperature remains constant. The smooth one-way operation of CO_2 leads to an increase in the temperature of the atmosphere and the earth, and this is due to the greenhouse effect. Initially, it was thought that the high temperature inside the greenhouse was due to the one-sided operation of the glass, but nowadays it has been found that inside a greenhouse, the main factor preventing cooling is the same convection (air flow moving upwards or downwards due to heat). The recent calculations of the effects of convection, humidity, and cloudiness provide the possibility of an increase of about 0.8-2.9 ^{o}C for the CO_2 doubling. It is important to know that the greenhouse effect is a completely natural phenomenon and has been happening in the earth's atmosphere for millions of years. This phenomenon plays a vital role in the balance of the earth, and as a result of this phenomenon, the average temperature of the earth is equal to 15 ^{o}C, and in the absence of carbon dioxide gas as the main factor of the greenhouse effect, the average temperature of the earth's surface is reduced to -18 ^{o}C. Water vapor, carbon dioxide, methane, nitrogen oxides, chlorofluorocarbons, and ozone are gases that absorb heat waves returning from the earth's surface, which have a long thermal wavelength, and return them to the environment [8].

Table 1. The annual increase of greenhouse gases in recent years and their relative share (percentage) in the greenhouse effect caused by human activities

Annual growth rate (Percentage)	Relative share (Percentage)	Name of the gas
5	15-25	**Chlorofluorocarbons (CFCs)**
1	12-20	**Methane (CH_4)**
0.5	8	**Ozone (O_3) "Troposphere"**
0.2	5	**Nitrogen oxide (N_2O)**
---	40-50	**Total**
0.3-0.5	**50-60**	**Carbon dioxide (CO_2)**

Greenhouse gases and their production and release into atmosphere

Carbon dioxide (CO_2)

Carbon dioxide gas has attracted the most attention in connection with the increase in the average temperature of the earth. 50-60% of the greenhouse effect caused by human activities is related to this gas. To evaluate the recent changes of this gas in the earth's atmosphere, it is necessary to have information about the past life of the earth. The study of air bubbles trapped in Antarctic ice crystals shows that the concentration of carbon dioxide in the earth's atmosphere has varied from about 200 to 300 parts per million since about 160,000 years before the industrial revolution. The highest concentration of carbon dioxide in the earth's atmosphere other than the present time occurred in the interval between two glaciers, that is, about 125 thousand years ago [9].

Fluctuations in the concentration of carbon dioxide in the earth's atmosphere in the past periods of geology where samples of air bubbles trapped at a depth of 2038 meters of polar ice have been taken at the Vostoc research station in Antarctica. In 1958, the Maunaloa research and measurement station in Hawaii began to operate, and in the same year, the concentration of carbon dioxide in the atmosphere was determined by this station to be 315 parts per million. Currently, the concentration of carbon dioxide in the earth's atmosphere is more than 350 parts per million, which indicates a 10% increase in the concentration of this gas in the last 40 years. It is predicted that the concentration of carbon dioxide in the atmosphere will increase to 450 million parts per million by 2050, which will be 1.5 times the concentration of this gas before the industrial revolution.

There is a direct correlation between the production and emission of carbon dioxide and the increase in its concentration in the atmosphere. It is interesting to note that the annual increase in carbon dioxide emissions after the industrial revolution is approximately 4.3%, which is caused by the burning of fossil fuels, deforestation, and other human activities, which is equivalent to 8 times the annual increase in the concentration of carbon dioxide (0.5%) in the atmosphere.

With these explanations, it can be acknowledged that if all the carbon dioxide produced by human activities remained in the atmosphere, the concentration of this gas in the atmosphere would be much higher than the amount we are witnessing today. Therefore, it should be assumed that there are unknown factors in the lands and seas that prevent the excessive increase of this gas in the atmosphere by absorbing carbon dioxide from the atmosphere. However, the absorption and consumption of carbon dioxide from the earth's atmosphere is relatively less than the rate of its entry into the atmosphere, and the continuation of such a trend will increase the contribution of carbon dioxide

in increasing the temperature of the earth through the greenhouse effect [10].

The effect of increasing carbon dioxide in agriculture

Effect on photosynthesis: De-oxidation is vital for photosynthesis and there is evidence that increasing CO_2 concentration increases the growth rate of plants. Of course, in suitable growth conditions with sufficient light, heat, nutrients, and moisture, the production of organic matter increases. Of course, there are major differences between the photosynthetic mechanisms of different plants, which causes different reactions to CO_2. Species that have a C_3 photosynthetic pathway (such as wheat, rice, and soybeans) show a greater reaction to increasing CO_2 because increasing CO_2 causes a decrease in light speed in them. Of course, C_4 plants (such as sorghum, sugarcane, and millet) show less reaction to increasing CO_2 concentration. Since these plants are tropical crops and are widely grown in Africa, it is thought that the coefficient of CO_2 increase for temperate and humid tropical agricultural areas is higher than for semi-arid tropical areas. Therefore, the effect of climate change on the agriculture of some semi-arid tropical regions may be negative, this negative effect may not be compensated by the positive effects of increasing CO_2, as it is possible that such a situation occurs in other regions. In general, it should be noted that although C_4 plants account for only about 20% of the world's food production, corn alone accounts for 14% of the total production and about 75% of the total trade of food grains. Maize is an important grain used to compensate for malnutrition in areas where there is a possibility of famine, and any reduction in yield and the amount of food in these areas will affect them. 14 species of the most harmful dry weeds are C_4 plants that compete with C_3 plants [11]. The difference of plants in terms of response to CO_2 increase may reduce the competitive power of such weeds. Instead, C_3 weeds in C_4 crops can cause more problems, especially in tropical regions, although the final result depends on the relative response of the crop and weeds to climate change. Some world's pasture and forest grasses are C_4, which include the most important grasses of tropical and subtropical regions, as well as the regions of Central Asia and North America. Therefore, it seems unlikely that the increase in CO_2 will have much benefit for the world's major pastures.

Of course, this depends more on the parallel effects of climate change on the potential performance of these plants. In the studies conducted in controlled environments where the temperature, food ingredients and humidity were optimal, by doubling the air CO_2 concentration, the yield of C_3 grains such as wheat, barley, rice, and sunflower increased by 36% on average. Regarding the effect of increasing CO_2 on possible changes in yield quality, the amount of nitrogen in plants will probably decrease and the amount of carbon will increase. This will lead to a decrease in the amount of protein as well as a decrease in the nutritional value of plants for humans and domestic animals [12].

Antiperspirant effect of CO_2 (improvement of water consumption efficiency): What is important is the effect of increasing CO_2 on the closing of the pores. This situation will reduce the plant's water requirement by reducing transpiration (per unit of leaf area) and improving what is called water use efficiency (the ratio of crop biomass to water consumed due to evaporation and transpiration). Doubling the CO_2 concentration in the air causes the stomatal size of C_3 and C_4 plants to increase by about 40%; decrease, and as a result, sweating is reduced by 23-46%. This can be harmful for the plant in environments such as dry regions, where moisture is the limiting factor for growth. Of course, this work has some ambiguities.

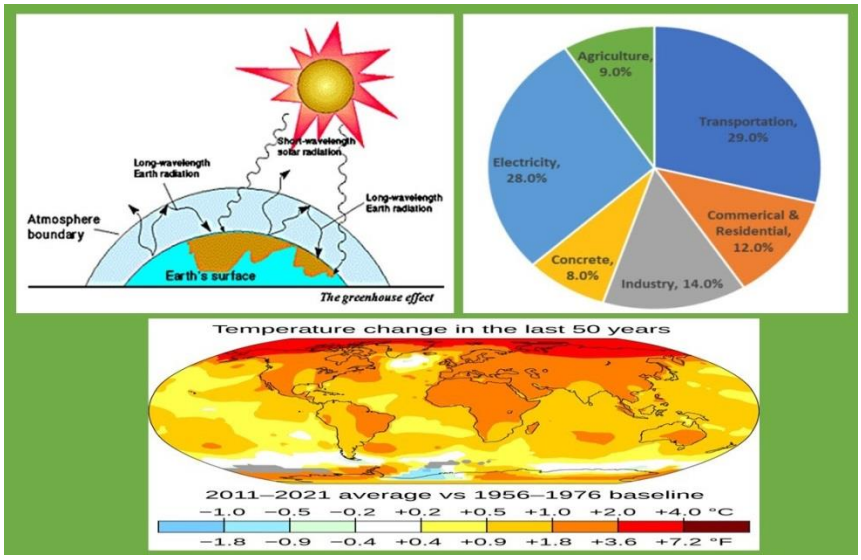


Figure 3. Environment for Kids: Global Warming

For example, as a result of increasing CO_2, how much should the plant leaf surface increase to compensate for the decrease in transpiration per unit of leaf surface (Figure 3). Therefore, despite the existence of evidence that all indicate that the increase in CO_2 has been completely beneficial, the negative effects that are indirectly caused by the increase in CO_2 are also modified by the effect of other factors, and it is still not possible to make a definite opinion about the positive or negative effects of increasing the CO_2 concentration had a statement [13].

Methane (CH_4): Until 1991, the concentration of methane gas in the atmosphere was increasing by approximately 1% per year, but due to unknown reasons, the annual increase in the release of this gas into the atmosphere stopped in 1992. According to various experts, the control of this gas leakage in the Russian natural gas system is one of the reasons for this stop. According to the studies, the share of methane gas in the greenhouse effect caused by human activities is about 12-20%. The sources of production and consumption of this gas, like carbon dioxide, are still not well defined. The activity of wood-eating termites and the decay of organic matter in oxygen-poor swamps are the natural and main causes of methane gas release into the atmosphere, and the production of coal, natural gas, and agricultural activities (cattle farming and rice cultivation) are among the factors caused by human activities of this gas production.

Chlorofluorocarbons (CFCS):

Chlorofluorocarbons are extremely stable compounds used in spray cans as propellants and in refrigeration and ventilation systems in the cooling unit of devices. The annual growth rate of the concentration of CFCs in the atmosphere is approximately 4%, and it is estimated that 15-25% of the greenhouse effect caused by human activities is related to CFCs in the atmosphere. CFCs have a great ability to raise the average temperature of the earth because one CFC molecule is able to absorb infrared rays reflected from the earth thousands of times more than one carbon dioxide molecule. After all, because CFCs are very stable, they remain in the atmosphere for a long time, and even if the production and consumption of these compounds is greatly reduced or completely banned, their concentration in the atmosphere will not decrease much for many years [14].

Nitrogen oxide (N_2O): The concentration of nitrogen oxide in the atmosphere has increased

in recent decades, and probably 5% of the greenhouse effect caused by human activities is related to this gas. The use of chemical fertilizers and the burning of fossil fuels are considered as the main cause of this increase in concentration, so reducing the consumption of these substances will reduce the release of this gas into the atmosphere. However, this gas has a high stability, even if the release of this gas is reduced or stopped, the increase in its concentration in the earth's atmosphere will continue for at least several decades.

Consequences and environmental effects of warming

Impact on agriculture and land use: Until 1991, six case and national studies (in Canada, Iceland, Finland, Russia, Japan, and the United States) have been conducted regarding the possible effects of climate change on the agricultural production. These studies are based on the results of the experiments conducted regarding the performance response to the climate change and the effects that climate change has on production. In general, it is thought that warming will cause a decrease in yield and drying of the major grain growing areas. A change in temperature (whether or not the level of precipitation remains constant) will affect the moisture available to the plant. The effect of this phenomenon is small at the beginning of the growing season, but in the middle of July, the soil moisture will decrease significantly, which basically means an increase in the water requirement of some crops.

Possible changes in climate crises such as the frequency of droughts, storms, heat waves, and severe frosts are among the most important factors affecting agriculture. Some advanced simulation models indicate that climate warming will increase the intensity of storms and tornadoes. This is important for agriculture in low geographical latitudes and especially coastal areas. In general, even if the minimum and maximum temperature does not change, the average monthly temperature change may greatly change the occurrence of hot and cold days. For better understanding of this issue, we should know that under the conditions of doubling CO_2, the number of days when the temperature in Atlanta and Georgia (USA) drops below zero from 39 days to 20 days. While the number of days when the temperature reaches above 90 ^{o}F (32 ^{o}C) will increase from 17 to 53 days [15].

Therefore, it is likely that the frequency and extent of the areas whose agricultural products are destroyed due to significantly increase of heat stress. The effect of global climate changes on food products is not limited to crops. Climate changes will have significant effects on the production of milk, meat, and wool. This will be achieved mainly through the effect on the production of pastures and grasses. It is expected that the direct effects of global climate changes on livestock will not be large. Meadows form a continuous field. On one side, there are vast pastures whose original vegetation has been changed and instead of them, and on the other side, meadows have been preserved by regular grazing or regular cutting, fertilization, and the use of herbicides.

Effect on pest population

One of the first significant effects of global climate change may be the change in population dynamics and the status of crop pests. This issue can not only be caused by its direct effects on the distribution and abundance of the pest population, but it may also happen through the effect on the host plants and their competitors and natural enemies.

Direct effects of climate on population

Here, the direct effect of changing temperature and humidity on the survival, development, and reproduction of insects is studied, and humidity and temperature are two climatic factors that affect the physiology of insects, and their effects are mostly mutual and therefore they can be

divided into was easy to check together. Insects are inherently dependent on the surrounding environment and their physiological processes are affected by the temperature of the environment. In general, there is a specific temperature range that the insect can continue to survive. The upper temperature range at which death occurs depends on the type of insect, the length of time the insect is exposed to it, and its interaction with other factors, especially relative humidity [16].

For many species, the lethal temperature for a short period of time is between 40 and 45 °C. Of course, if the insect is exposed to temperatures slightly lower than this temperature for a longer period of time, it may cause the stop of feeding and development and finally the death of the insect. At relatively low humidity, relatively large insects may cool themselves by evaporation, allowing them to survive at higher temperatures for a short period of time. Low lethal temperatures vary greatly in different insects. Many species die quickly in dry environments at temperatures above the freezing point, and the reason for this is probably a change in their natural metabolic processes, which causes the production of toxic substances. In addition, some species may survive for a significant period of time at low temperatures, but eventually die of starvation.

Regarding the development of insects and pests under the influence of temperature, it can be mentioned that the number of days needed to complete the development of the insect depends on the curve of the thermal dependence of the insect and the thermal regime. Knowingly, there are temperatures in which no growth takes place. Above this threshold, the growth rate increases gradually and after that, in a range of temperature, the growth rate increases linearly and reaches its maximum or desired value. The subsequent increase in temperature leads to a rapid decrease in growth rate and its proximity to the upper lethal limit. The optimal thermal limit for the growth rate of insects is usually in the range of 22-38 ^{o}C, the lower range of which is 12-22 ^{o}C less than the optimal level. Air humidity can also affect the growth rate of many insect species. The optimal conditions for many insects are between 60-80% relative humidity. In many species of insects, with the decrease of relative humidity, the duration of development gradually increases, and this issue may be combined with the creation of an optimal temperature lower than that which occurs in high relative humidity [17].

Indirect effects of climate on pest population

These effects include the effects that climate change has on the host plant, on the natural enemies of pests, and on interspecies competition.

Effects of climate change on the host plant

The effects of increasing CO_2 on the production of crops will be positive because three-carbon and four-carbon plants react to the increase in CO_2 by increasing the efficiency of its consumption. In addition, the rate of photosynthesis increases in CO_2 increasing plants, but the amount of nitrogen in their leaves decreases. The mentioned changes may cause the insects to consume more plant material to provide the amount of nitrogen they need. Such an increase in consumption has been observed in insects that feed on leaves. Researchers have observed that in the laboratory conditions, the larvae of some insects (Lepidoptera) react to the reduction of nitrogen levels in two ways:

- In the form of increased nutrition and
- In the form of reduced growth rate.

Therefore, the increase in plant production due to the increase in CO_2 can be balanced by increasing the feeding of insects from plants. If the climate becomes drier and warmer, the period of drought stress will increase. This issue is true even considering the improvement of water consumption efficiency caused by the CO_2increase. In general, plants that are under

stress have less growth and are therefore more sensitive to pest outbreaks. The growth of plants is under the adverse effect of moisture stress, and thus it will lead to a decrease in the availability of materials for insects, and this issue can reduce the population of insects. The texture of the leaves may also change, and increasing the thickness and waxing of the leaf surface can reduce its palatability or digestibility for the insect. The leaves of plants change color under stress, and this can be a problem for pests that find their hosts through the signs of the light spectrum. Another effect is on the phenology of the host plant. In this way, the climate change is effective on the growth rate of the plant and its flowering and fruiting time. In order for a pest to attack a plant successfully, the critical time of plant growth should be coordinated. As a result, any factor that affects this coordination of the pest and the host plant is important. Warming conditions may lead to the earlier opening of flower buds in perennial plants such as fruit trees [18].

If the amount of heat required is provided earlier, the flower buds will open earlier. Faster opening of flower buds can temporarily disrupt the relationship between the pest and the host plant. An example of such a situation can be seen in the apple flower beetle, Anthonomus pomorum, which lays its eggs in apple flower buds. Usually, immediately after hatching, the larvae make a closed chamber from the petals. If the spring is hot, the apple trees flower earlier, and therefore, the flowers open naturally to make the chamber by the larvae. This is due to the fact that adult beetles are less affected by warming and therefore laid their eggs only a little earlier than usual, which is relatively late in relation to the plant's growth stage.

Effects of climate on natural enemies of pests

The role of diseases in controlling pest outbreaks is well-known. The effect of climate change on various diseases is different. Many insect viral diseases become inactive when they are exposed to sunlight and especially ultraviolet rays. However, these diseases are less affected by temperature, air humidity, soil humidity, and chemicals. As a result, if the sunlight is increasing, the probability of the spread of viral diseases decreases, and if there are many clouds, the viruses may remain active for a longer period of time, and thus there is a greater sensitivity to pests and control them more. Just as climate change directly affects the dynamics of pest populations, it also affects the number of pest species. Therefore, the behavior of natural enemies and the rate of egg lying are affected by temperature, air humidity, and wind. An increase in temperature increases the rate of growth and reproduction. Certainly, if natural enemies show relatively more reaction compared with pests, there is a possibility of controlling more pests through them.

The balanced effects of heat on aphids and their natural enemies show the heat effect on pest control by their natural enemies. For example, at temperatures below 10 °C, the increase in the population of pea aphid is more than the amount that can be controlled. Of course, at temperatures higher than about 11 °C, this natural enemy is able to reduce the population of aphids. Parasitic insects are often used in biological control, but there are many cases that have not been successful due to lack of climatic compatibility. Therefore, if climate change provides equal conditions for the external parasites, natural pest control can be reduced. On the other hand, changes may create suitable conditions for interference, in which case better natural control will take place [19].

Competition between species

A particular plant is usually attacked by a set of pest species, and these species and their relative abundance are often different in various climatic conditions. Any of these pests may attack the plant at different times and define different ecological niches. Of course, in cases where two or more species overlap and interfere with each

other in terms of time and place, inter-species competition has occurred and this issue can have many effects on the dynamics of species competition. In addition, the effects of competition between species can be different in relation to weather conditions [20].

Effects of climate change on soil

The increase in global temperature will cause an increase in the pattern of rainfall, soil moisture, and other weather factors related to the production of agricultural products. Research conducted using global air flow models in the Northern Hemisphere shows that in some areas of Canada and Russia, soil fertility has increased and the production of agricultural products will increase. However, in geographical latitudes lower than these regions, due to the decrease of summer rainfall and as a result of the 20% decrease in raw moisture, the production of agricultural products will decrease (Figure 4). Global warming will cause more permafrost to melt. This soil is always frozen and covers vast areas in Russia, Canada, and Alaska. Due to the cold and slow climate, the decomposition phenomenon has a layer of decayed plant material on its surface, which are produced during the short summer of the region. The intense melting of this soil and the decomposition of plant material in it will increase the release of methane greenhouse gas in the soil of this region.

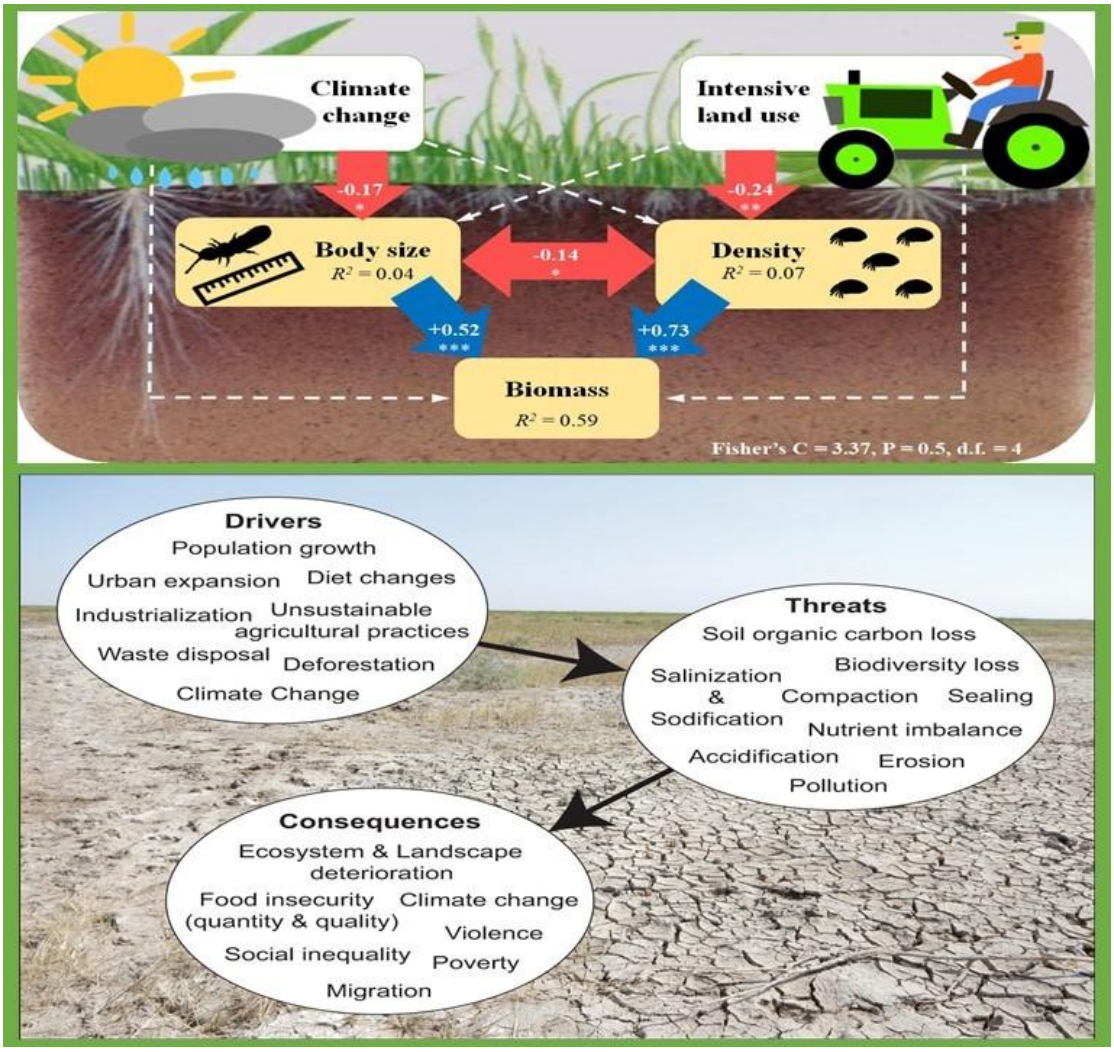


Figure 4. Climate change and intensive land use reduce soil animal biomass via dissimilar pathways

Effects of high CO_2 concentration on fertility, physical conditions, and soil fertility

The high concentration of CO_2 in the atmosphere, as explained earlier, will increase the growth rate and water consumption efficiency of agricultural plants and natural vegetation if other limiting factors are not present. The high optimum temperature for the growth of some plants under the conditions of increased CO_2 will lead to opposite effects and will neutralize some effects of increased temperature, including increased plant respiration at night. As summarized in the following figure, the increase in production is usually associated with more plant residues, higher root weight, more root exudates, increased mycorrhiza colonies, and increased activity in iso spheres or soil microorganisms, including nitrogen fixation in a symbiotic way. This will have a more positive effect on nitrogen supply for crops or natural covers. Increasing root activity and microbial activities in the soil will increase the CO_2 partial pressure in the soil air and also increase the CO_2 activity in the soil water. This leads to an increase in the release rate of nutrients (K, Mg, and micro elements) due to the aeration of soil minerals. Similarly, more activity of mycorrhiza will cause better absorption of phosphorus by the root. These effects will be intensified by the better absorption of nutrients by the roots of crops, which is caused by the higher density of the root system, which, in turn, is caused by the CO_2 increase in the air.

More microbial activity leads to an increase in the rotation of nutrients by soil organisms. More root production (at the same temperature) will increase the content of organic matter in the soil, which will cause temporary stagnation and rotation of more nutrients in the soil. The increase of N/C ratio in plant residues under high CO_2 conditions, as reported by some researchers, may lead to slower decomposition and as a result slower return of nutrients from soil plant residues. This will provide more time for earthworms and termites to mix the soil. Although higher soil temperature increases the content of soil organic matter, it also stimulates microbial activities. The increase in microbial activities due to the increase in CO_2 concentration and temperature increases the production of polysaccharides and other soil stabilizing substances. The rise of crop residues, root dry matter, wood, and organic matter in the soil increases the activity of large organisms, including earthworms, and subsequently, the permeability and the number of soil channels increase due to the increase in biological and fixed pores. Higher stability and faster permeability will increase soil resistance against erosion and, as a result, soil fertility loss. In addition, increasing the ratio of soil channels reduces the loss of nutrients through leaching in heavy rainfall conditions.

This is due to the improved availability of soil nutrients due to the uniform mixing of fertilizer and nutrients. Of course, fertilizers and elements spread on the soil surface do not have this condition, but these elements are removed due to runoff or washing [21].

The occurrence of these changes increases the resistance of the soil against the collapse of the building, the loss of nutrients due to the compaction of the soil, the change of season, and the variability of rainfall. It also makes the soil resistant to some unfavorable changes in the speed and direction of soil formation processes. If the partial pressure of CO_2 in the soil air rises and the partial pressure of CO_2 reaches the level that causes damage to the roots, part of the benefits of increasing CO_2 will not be realized. Moisture-friendly crops such as rice or hemp and vegetation adapted to humid lands have their own gas exchange mechanisms and will not be affected by this problem. The positive effect of CO_2 on the speed of aeration and plant access to soil nutrients occurs in soils that have a suitable and significant amount of minerals that can be aerated, but in soils where aeration has already

been done deeply and intensively, or in very poor soils.

Soil PH response to climate change

The PH of most soils does not change rapidly as a result of climate change. The exception that may exist in this field is the soils containing acid sulfate, which is widely seen in some coastal plains and surface deltas. If these soils are exposed to long dry seasons, their PH will change. Even these soils mostly have a clay texture with medium to high cation exchange capacity, the amount of acid released in these soils is generally higher than the fast buffer capacity of the soil. Therefore, the PH value may temporarily reach 2.5 to 3.5 and a small part of the clay mineral is decomposed. Usually, in long term, due to its buffering properties, the PH reaches 3.5 to 4. Depending on the efficiency of the sink in washing the excess acid, the period of high acidity and the period of aluminum toxicity may last from less than a year to several decades [22].

In calcareous soils, soil PH may vary between 7 and 5.8 depending on the partial pressure of CO_2 in the soil. This PH range preserves basic cations against leaching. In these soils, a small percentage of lime is uniformly distributed. The buffer property is weaker in non-calcareous soils, but it depends on their cation exchange capacity. In soils, where the clay content of its surface layers is variable, this characteristic decreases due to acidification.

It should be remembered that the simple models that predict that the leaching of $CaCO_3$ will accelerate under the conditions of doubling the concentration of atmospheric CO_2 are generally not correct. In most of the soils, the decomposition of organic matter maintains the CO_2 concentration in the soil air at a higher concentration than its amount in the atmosphere. The solubility of $CaCO_3$ is mostly determined by the concentration of CO_2 in the soil and the amount of activity of CO_2 in soil water, not the CO_2 concentration in the atmosphere. In those conditions that accelerate the climate change, the soil may become acidic quickly after a long period of time, despite little apparent change, but on the other hand, in some European soils, due to be exposed to acid rains for several decades, this phenomenon occurs in a shorter period. The soil may be steadily depleted of basic cations, but the PH change may occur more rapidly.

Dynamics of soil organic matter and climate change

The amount of soil organic matter in intact vegetation is influenced by climate and vegetation, and also it is relatively constant. In these systems, the entry of carbon in the form of dead organic matter is equivalent to the exit of carbon in the form of carbon dioxide. If the scenario of future climate change is true and is combined with the transfer of vegetation and residues, the conditions affecting the survival time of organic matter in the soil will change to some extent. Paying attention to the stability of soil organic matter reservoirs in relation to the change of environmental conditions originates from the change of land use from forest to agricultural land or grassland and the effects of forest management. Studies show that in most temperate and tropical regions, soil organic matter circulates rapidly and is in a stable balance with plant residues, therefore, the dynamics of these reservoirs and their sensitivity to changing environmental conditions is the center of the effect of climate change on soils [23]. Researchers have divided soil organic matter into three active, passive, and inactive components, whose circulation time is years, decades, and centuries. Plant materials introduced into the soil consist of two components, i.e. compounds with low molecular weight (metabolic) which are rapidly decomposed by microorganisms and structural compounds such as lignin and cellulose decomposed at a slower rate. The active component consists of microbial biomass and their metabolic products. Slow and inactive components are more or less resistant to microbial attack due to the physical and chemical

stabilization processes (which are largely affected by soil characteristics). The rate of decomposition of plant residues follows a specific pattern when the slope of this curve is mainly affected by the quality of resources and physical factors.

Many researchers have shown that in tropical temperate regions, clays play an important role in stabilizing soil organic matter and usually the amount of soil carbon is a positive function of the amount of soil clay. The physical mixing of organic materials in a clay environment protects the components of the bacterial cell wall and organic polymers from enzymatic attack. The difference in the amount of carbon between different soils is due to the stabilization of microbial products rather than the difference in the decomposition rate.

In general, warm soils with medium loam tend to be in contact with high-quality residues that have high rates of primary decomposition. As contact with soil nutrients slows down the progress of the next stages of decomposition, the survival time and accumulation of soil organic matter are direct functions of increasing the amount and type of clay and the concentration of polyvalent cations. Therefore, the entry of underground organic matter (caused by roots and its exudates) is more important for the dynamic of soil organic matter than it is important in the fall of residues.

As the environment gets colder, the rotation of increasing organic materials is concentrated on the profile surface and is separated from the horizons of the mineral elements below. Therefore, in active and slow reservoirs, the accumulation of soil organic matter is an inverse function of the residue quality. Fixation of a small part of the soil organic matter forms the inactive component, and thus the carbon has a similar age [24].

Ice melting and sea level rise

The rise of sea level is another serious and potential problem that is one of the possible consequences of the shrinking of the earth. Although today it is impossible to determine the level of sea level rise, there is a consensus about the occurrence of this phenomenon. Scientists provide two main reasons for this event:

- Increasing the temperature of seas and oceans and
- Melting of polar ice.

According to the predictions of various models prepared, the amount of sea level rise in the waters of different regions of the earth will fluctuate between 20 and approximately 200 centimeters. In the next century, and more likely, this amount will be between 20 and 40 centimeters. Such an increase will have important environmental effects and it can be predicted that in the coastal areas the water will advance by 50-100 meters and these areas will be exposed to erosion.

In addition, buildings and other port facilities will be vulnerable to sea waves and storms. Changing the location of bays and salt marshes towards the coasts and the mixing of salty sea water with underground reserves of fresh water is one of the other consequences of rising sea and ocean levels, which threatens the lives of coastal dwellers, and finally, rising sea levels will threaten the lives of hundreds of millions of people who live in it threatens low-lying coastal areas living in developing countries. Coastal ecosystems were affected by natural climate changes, and the intensification of these changes will have a greater impact on them [25].

Since such factors intensify each other's effect on field environments. Therefore, in predicting the effects of climate change on high coastal areas, direct human effects on these areas and vice versa should be taken into consideration (Figure 5).

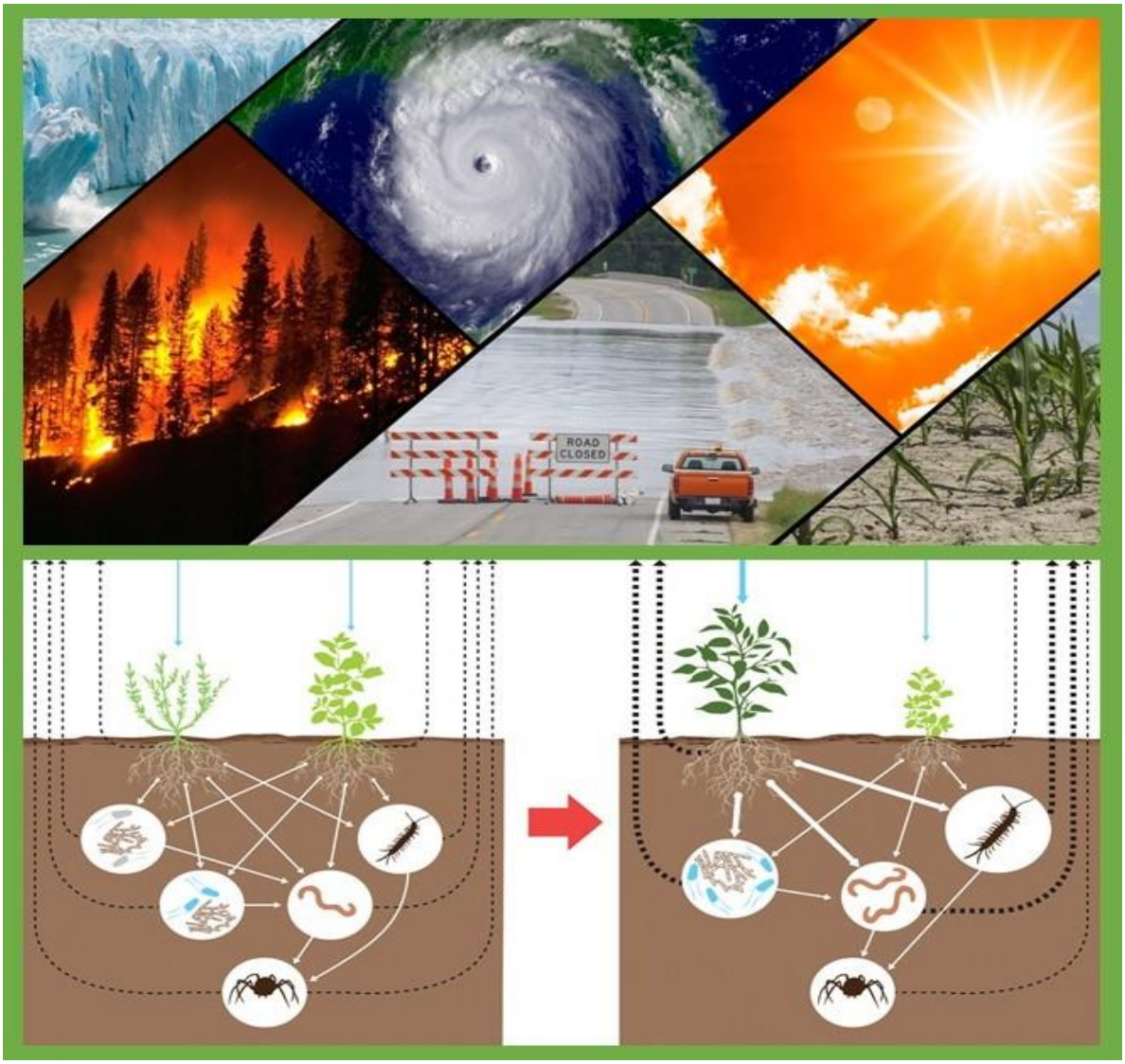


Figure 5. Global warming and climate change effects: information and facts

Therefore, how the coastal areas react to human interventions and the quality of these areas' response to any climatic changes or water level fluctuation is of considerable importance. The effect of coastal ecosystems on the order of greenhouse gases may be important from two aspects. One is the high level of biological fertility in these areas, which plays a role in the global concentration of these gases, and the other is the changes in gas flows caused by the rise and fall of the sea level during glacial periods, which acts as a feedback mechanism in the climate system. The effects of changes in the sea level are the occurrence of occasional and permanent floods, coastal erosion, and salt intrusion into fresh waters, as well as changes in the characteristics of waves and tides [26].

The effects of moderate erosion of the sea level and the increase in the frequency of occurrence of critical conditions related to storms should not be ignored. In the global cycle of materials between the atmosphere and the biosphere, the processes of transformation and transfer of materials in coastal areas play an important role. The increase in the sea level may cause a drastic decrease in the biological recycling time of

elements such as C and N in the sea, because the organic materials transferred from the land to the continental shelf are stored and oxidized more efficiently. Relatively good studies have been done regarding the materials that enter the coastal waters from the rivers, so that there is approximately the global amount of some specific elements, organic carbon, nutrients, and also various pollutants. There is not much information about the atmospheric transfer of materials to coastal areas. Although many studies have been done in connection with the processes related to dust transfer from land to water, some regional studies have shown that the amount of transporting some materials through the atmosphere is more than rivers [27].

Ozone decrease and UV-B increase and its consequences

Ozone is a form of 3 atoms of oxygen that are weakly bonded to each other. Ozone is a strong oxidizer and reacts with many substances in the atmosphere. In the air we breathe, ozone is a pollutant produced by photochemical reactions caused by the sun from nitrogen oxides, hydrocarbons, and diatomic oxygen. However, ozone in the earth's atmosphere creates a valuable protective shield for life on earth against solar ultraviolet radiation. The highest concentration of ozone in equatorial regions is approximately 25 kilometers from the surface of the open seas and in polar regions approximately 15 kilometers from it.

Ultraviolet rays (UV) have wavelengths in between $0/4\mu m - 0/1\mu m$ and are divided into UVC, UVB, and UVA rays. UVC is strongly absorbed in the stratosphere and does not reach the earth's surface. UVA has the longest wavelength in the spectrum of ultraviolet rays and has the ability to destroy the life of cells. This wavelength remains unchanged in stratospheric ozone and is transmitted to the surface of the earth. The most attention related to the problem of the ozone layer is related to UV-B radiation. This type of radiation has moderate energy and is strongly absorbed by stratospheric ozone. Thinning and loss of ozone in the stratospheric layer and increasing the amount of UV-B passing through the stratospheric layer and reaching the earth's surface is extremely dangerous for the life of terrestrial organisms because this radiation is biologically active.

Consequences of increasing UV-B on organisms

The loss of the earth's protective shield (ozone layer) has potentially dangerous environmental effects, which include the following:

- Destruction and breaking of food chains in terrestrial and marine ecosystems;
- Increasing cataract disease;
- Analysis of the immune system of the human body.

Recently, in a study of skin lesions caused by UV-B rays in Toronto, Canada, it was determined that these skin lesions increased by 35% from 1989 to 1993 (the time of ozone depletion). In recent years, ozone over the polar regions has been destroyed by about 50%, and most of the UV-B rays reach the surface of the oceans in this region, while the decrease in primary production in the world's oceans has been suppressed for some time as a result of the loss of ozone. The scope of the effect of ozone destruction on human health has been carefully discussed. The bad effect of this phenomenon in the increase of different types of diseases at the epidemic level is agreed upon by all. The increase of different types of skin cancers is the most serious foreseeable risk in this field.

The ultraviolet rays of sunlight damage the human eye and cause cataracts, clouding of the lens of the eye, and reduced vision. Today, people use glasses to protect their eyes. Exposure to the sun's ultraviolet rays damages the body's immune system and reduces its efficiency. For example, experts have stated that ozone weakens the immune system of people who are exposed to the AIDS virus, and as a result, in most cases, the

time interval between infection and the progress of the disease and death is reduced. In addition, the efficiency of the body's immune system may cause the appearance of many types of diseases in humans [28]. Various environmental pollutants in the air and climate have made humans more vulnerable with their biological synergistic effects.

Consequences of increasing UV-B on crops

In recent years, there have been many investigations and evaluations about the direct effects of increasing UV-B and ozone on the earth's surface on crops and the other dry plants. This summary is based on experimental studies. In the analysis of UV-B studies, Krapa and Kickert mentioned that very different reactions have been observed for the same crops in research conducted at different times and places. In many cases, these differences are related to the difference in the sensitivity of the cultivar or variety of the tested crop. Another reason for these differences may be related to the type of UV-B lamp used in the system where the plant is exposed to UV-B and the spectrum of the radiation factor considered for the calculation of the biological and effective UV-B flow.

The results of experiments conducted in the growth chamber, greenhouse, and field conditions regarding the UV-B effect on the growth of a specific plant are often contradictory. These differences are caused by the differences in microclimate radiation and heat energy balance in the mentioned systems, but also due to the difference in the environmental conditions in which the plant grew [29].

For example, the leaf cuticle acts as a barrier against UV-B rays, and plants grown in greenhouses have a much thinner and less developed cuticle than plants grown in the field. Therefore, greenhouse plants may show more sensitivity. However, in the majority of greenhouse and growth room studies, the most important factor determining the intensity of photosynthetic active radiation (PAR) to which the plant has been exposed. For example, Beigner *et al.* (1981) found that the sensitivity of studied soybean cultivars to UV-B increases by lowering the PAR level (1.8 total solar radiation) because in these conditions, the activity of photo regeneration processes is minimized. Recently, studies have been conducted at Lancaster University using a growth chamber in which high UV-B was irradiated with light intensity approximately equal to 2.3 full sunlight. In these artificial conditions, which were close to the field conditions in terms of light intensity, vegetative growth, and photosynthesis rate of chickpeas were not affected by the increased level of UV-B. However, it has been observed that the performance decreased to some extent due to the harmful effects of UV-B in different growth stages on reproductive growth processes. Vegetative growth of a group of barley varieties was not affected by the UV-B increase, but damage was observed in Scot cultivar which contains a small amount of flavonoids. These observations confirm the results of other researchers (Figure 6).

For example, Biklak *et al.* did not observe any harmful effects of UV-B on the photosynthesis rate of wheat and oat in mixed cultivation, but the competitive strength of wheat increased due to the inhibitory effect of UV-B on the longitudinal growth of oat. Increasing flavonoid production has been reported as a protective method in many species and cultivars.

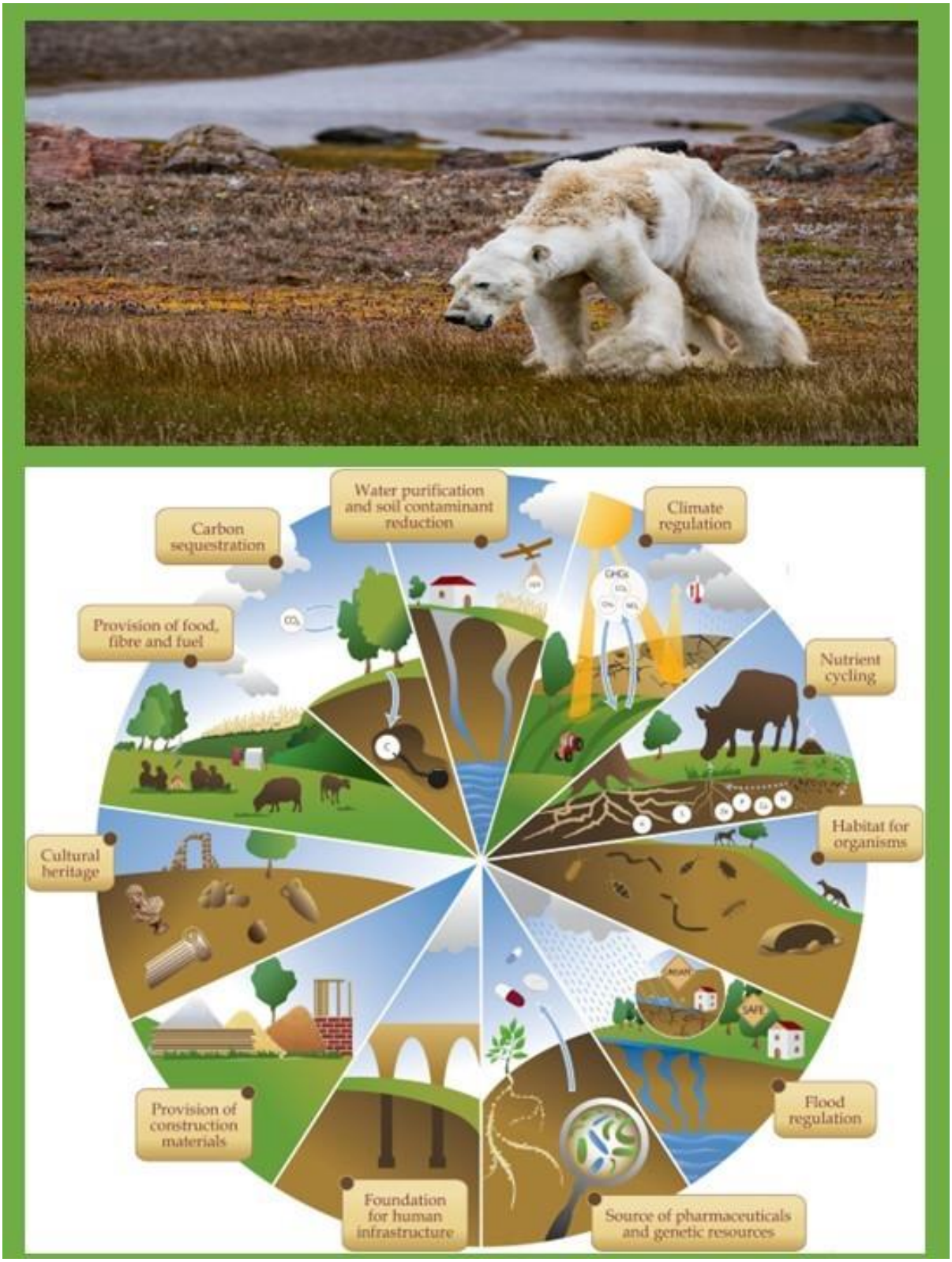


Figure 6. Global Warming Archives-CG Competition Point.

Most of the information available about the O_3 effects on plant growth and production under field conditions. They have been obtained by using open chambers. Although these growth chambers are acceptable for the study of gaseous pollutants, Runkles-Wright (1997) and Mining and Krapa (1992) mentioned that the use of these chambers and conducting experiments in them to obtain the effect of different O_3 treatments faces serious limitations. Due to the significant differences in microclimate and the potential difference in the amount of O_3 between the growth chamber and the open environment of the farm, the results obtained using these growth chambers are doubtful. However, most of the results obtained from the experiments clearly show that O_3 has adverse effects on the growth or production of agricultural plants [30].

As mentioned earlier, any change in the amount of UV-B rays and the amount of O_3 is only a part of the climate change of the earth. In terms of the direct effects of climate change on crops, the main focus is on the increase in atmospheric CO_2 concentration. Although any increase in UV-B and O_3 leads to destructive effects on agricultural plants in a wide geographic scale, on the other hand, the increase in CO_2 concentration will have a beneficial nutritional effect. According to the theory of Krapa and Kickert, the analysis of the available articles shows that sorghum, oats, rice, peas, beans, potatoes, lettuce, cucumbers, and tomatoes among the plant species react a lot to the joint effects of all three environmental changes (UVB, O_3, and CO_2).

The major limitation that exists in this type of evaluation is the fact that most of our knowledge has been obtained from information studied the plant's reaction with only one variable and not with all three variables. In addition, there is also a limitation caused by not paying attention to the effects of temperature modification of the thermal regime. According to the obtained statistics, the most populous regions of the world, i.e. the People's Republic of China and South Asia, are also the biggest consumers of rice and cotton. Although rice is highly sensitive to UV-B, cotton has been found to be sensitive to O_3. Both the regions of Chennai and India are currently among the regions containing high amounts of O_3, and it is likely that this situation will remain in the future.

Consequences of increasing surface UV-B and O_3 on the spread of crop pests

According to Runkelsey and Krapa (1994) and Mining Tiedman (1995), the available evidence clearly shows that the effects of UV-B on the prevalence and development of crop plant diseases depend on the plant variety, plant age, pathogen inoculation level, time, and length of the period that the plant it depends on being exposed to UV-B. Everett et al. (1990), in their research, three cultivars of cucumber (Cucumis sativus) in a greenhouse without shade, before, and after inoculation with Colletotrichum loginarium (anthracnose) or Cladosporiom cucumeriom (scab) were exposed to effective UV-B radiation biological with a daily concentration of 11.6 k/m. Exposing the susceptible variety to UV-B for 1 to 7 days before inoculation caused more severe disease spread by both pathogens. Exposing the plant to UV-B after inoculation with the pathogen had much less effect. Although the severity of anthracnose disease increased in resistant cultivars under conditions of severe inoculation with the pathogen due to exposure to UV-B (both before and after inoculation), these conditions were observed only on cotyledons. Biggs *et al.* (1984), based on the study of cultivars and UV-B effect, stated that the increase in disease severity due to the UV-B radiation is more in sensitive cultivars than in the resistant cultivars.

On the other hand, the severity of leaf spot disease and the mixture of beetroot propagated clones increased after exposure to UV-B. Carnes *et al.* have found that an anthracnose-resistant cucumber variety was exposed to harmful UV-B concentration. Mycelium growth of

Colletrotrichum legirarium was only partially reduced, but mushroom spore germination was greatly reduced. Onzokrizek (1980) showed that Cladosporium cucumerinum spore germination significantly decreased due to UV-B radiation. In the same way, it seems that the sprouted tubes of Diplocarpon rosae are sensitive to UV-B before penetrating the leaves of the plant. This type of changes in the direct and destructive effects of UV-B on microorganisms is well-known.

In their studies on cucumber and mushroom, Everett *et al.* concluded that the effect of UV-B on the host is apparently more important than its effect on the fungus itself, because there was no difference in disease severity between plants that were exposed to UV-B only before inoculation were placed or plants that did not receive UV-B before and after inoculation. There is a similar range of reactions regarding the effects of O_3 on pathogens. The O_3 effects on the plant, the pathogen, or both may lead to stimulation or prevention of disease prevalence or severity. Dowding emphasizes the importance of exposure to O_3 and the period of exposure to the disease on the O_3 effects on the establishment of the disease. Like UV-B in the case of many fungal pathogens, the potential effects of O_3 on fungal spores are minimal, and pathogens become vulnerable after establishment because their carbohydrate energy reserves decrease rapidly after germination.

The mutual effects between O_3 and leaf surface have been studied by Duadnig. These traits include the chemical properties of the cuticle, leaf surface characteristics, secreted substances, and stomatal reactions. The growth and development of pathogens on the host plant may be reduced by the direct effects of O_3 because the toxic effects of O_3 have been observed on the cultured tissue free of any kind of microbes. The changes were created in the host plant due to O_3 may have the profound effects on the optimal growth of the pathogen. Probably, there are similar interactions between bacterial pathogens and plants. Of course, this type of contamination usually depends on the successful entry of bacteria into the host plant through wounds or insect bites.

The spread of pathogen on the host plant affects its sensitivity. The first reports in the field of protection against pathogen and pathogen contamination are about bean and sunflower rust disease (Puccinia halianthi and Uromyces phaseoli). There are also several reports that show that infection with viruses, bacteria, and fungi reduces the sensitivity of the host plant to O_3. On the other hand, it has been observed that nematode contamination increases the O_3 effects on the host plant. Although there is considerable evidence that shows that plants exposed to O_3 reduce the contamination and sporulation of fungi such as rust on the plant, there are further examples in which the contamination of plants damaged by O_3 increases with the pathogen.

At present, there is no complete understanding of the mechanism of mutual effects between the pathogen and the host environment, but in general, it can be mentioned that the intensity of contamination in the case of pathogens for which damage to the host plant's cells and disruption of the mechanisms of substance transport in the plant is beneficial for them after exposing the plant to O_3 increases, while the pathogens whose degree of contamination depends on the health of plant tissues will suffer from these phenomena. Leaf-eating pests and spider worms are the most important causes of crop losses, but the UV-B effects on the mutual relationship between these pests and plants are not well-known. Although there is a lot of information about the effects of air pollutants, only a small amount of findings is related to the role of O_3. Similar to diseases, studies related to pests can be further conducted regarding the effect of O_3 on pest prevalence, pest population dynamics (as a result of changes in the plant), and also the mutual effects of pest prevalence on plant response.

The resistance of the host plant to the attack of the pest may be changed through metabolic changes that affect the diet, behavior of the insect, growth, and fertility of the pest. Changes induced by O_3 in primary and secondary metabolites may be quantitative and qualitative. Although there are many evidences that show that these changes can affect the growth and development of the pest, there are few research projects on the specific effects of O_3. Trumble *et al.* reported that tomato wireworm spread faster on damaged plants in O_3. In addition, reproduction and lifespan of female worms were not affected. Researchers have found that the Mexican bean beetle prefers soybean plants that have been treated with O_3, and this preference increases as the duration of O_3 treatment increases. This trend leads to an increase in the growth rate of larvae, which has also been shown in the studies of Chapleka and colleagues.

Other examples have been studied by Runkles and Cheron. It seems that there is only one report in this field that the pest attack changes the O_3effect on the host plant. Rosen and Runkles showed that the combination of a very low amount of O_3 (0.02 ppmv) with infection with the greenhouse whitefly act as aggravating factors in causing chlorozobiosis of bean leaves. These researchers stated that this effect may be the result of O_3 reaction with high ethylene production in the plant. Ethylene is produced as a result of butterfly damage to the plant. In short, the available information on these biological interactions with UV-B and O_3 was scattered and this is an obstacle to clarifying the complexities of these relationships, as an issue that should be resolved in future systematic research.

Studies have also been conducted on the interaction between high O_3 and plant pests. Lincoln *et al.* found that the feeding rate of the pest increases with the increase of atmospheric CO_2. This depended on the amount of water and nitrogen in soybean leaves. On the other hand, the recent studies show that larvae feeding on leaves do not perform well in high CO_2 due to the increase in the ratio of carbon to nitrogen. It is necessary to expand these studies so that not only the increase or decrease of the pest population is determined, but also the population change among different species under the conditions of high CO_2 concentration. The dynamics of population and community changes is the cause of inter-species and intra-species competition over the resources needed for the growth and production of rival species.

This process is also affected by biotic and abiotic factors. By examining the range of sensitivity of specific species and varieties to UV-B and O_3, we should accept that mixed cultures will show different reactions to both of them. In O_3 stress, numerous studies show that the community composition will change in favor of tolerant species. There are few researches about the effects of UV-B or O_3 on interspecies competition, and there are even fewer studies on intraspecies competition in monocultures. In both O_3 and UV-B stress, the distance between the plants in monoculture and mixed culture will affect the amount of receiving each of them. In the case of UV-B, this role is due to the density and shading of the canopy, which determines the amount of gas flow into the foliage.

Conclusion

Most of the studies related to the effects of climate change on the coastal ecosystems indicate changes in the distribution of certain species or their vital communities. There are many evidences regarding the migration of marine creatures from their habitats and this can be correlated with the changing process of climatic variables of the region such as temperature. Of course, understanding the reason for changing the structure of communities is very difficult. Because first of all, the ongoing changes in the climate can lead to extensive ecological changes, which indicates the sensitive and dynamic nature of their food chain in relation

to the climate and climate-related factors such as salinity and the amount of food. Secondly, it is difficult to separate the effects of climate from the effects of human activities. Despite the fact that the sea level changes are much higher than its average speed in the Holocene period (which was caused by the thermal expansion of sea water and ice melting due to climate warming).

The average sea level is different from the sudden and intense increase of the sea level in a certain area. One of the other important factors, especially in estuaries, is the increase in the fluctuation range of tides caused by natural or human changes. The direct effects of sea level rise vary from one region to another, but currently its intensity is higher in the Mississippi Delta, the Nile, and the North Bay of Bengal, and it has caused the destruction of agricultural lands, valuable resources, swamps, and freshwater riots. Such changes happen in estuaries. The advancing speed of sea water depends on coastal processes, speed, and strength of sea water.

In the case of coral islands, coral hills can rise or sink in harmony with the rise of sea water. It is estimated that the rising speed of coral hills is 10 m.m. per year. Of course, many obstacles such as indiscriminate exploitation of sea dunes and increasing turbidity of the water adjacent to the dunes reduce the capacity of the dunes to prevent the islands from eroding. Natural plant and animal communities play an effective role in the response of coastal areas of sea water. Coastal protection is probably the most effective way to minimize the adverse effects of sea level rise. Alluvial lands and local mangrove forests play an effective role in the accumulation of sediments and can cause incremental adjustment of the sea level. As the sea level rises, salt penetrates into the coastal soils and underground water, so that the preservation of such plant communities depends on the presence of spaces with less salinity, so that plants that have less tolerance to salinity can expand. In the conditions that agriculture or other land occupations have caused the occupation of coastal areas, there is no place left for the expansion of the above plants and the remnants of such communities are under threat.

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