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Global Warming and Its Potential Impact on Indian Agriculture

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ABSTRACT: ***The greenhouse effect is predicted to produce substantial climatic changes in some places as a result of global warming. Climate change is anticipated to have a significant impact on the hydrological cycle, including precipitation, evapotranspiration, soil moisture, and so on. The primary component of evapotranspiration (ET) is Crop water requirements, as well as future water planning and management, will be influenced by the hydrological cycle. The purpose of this study is to investigate the sensitivity of evapotranspiration to global warming in Rajasthan's desert areas (India). Various studies used the Penman–Monteith equation to calculate reference evapotranspiration, and the sensitivity of ET in terms of temperature, solar radiation, wind speed, and vapor pressure changes within a 20% range from typical long-term climatic conditions during 32 years (1971–2002). The current study did not take into account changes in precipitation or stomatal resistance to increasing CO2 concentrations. According to the reviewed literatures, increasing the temperature by 20 % degrees Celsius (maximum 8 degrees Celsius) increases overall ET consumption by 14.8 percent.***

KEYWORDS: ***Global Warming, Climate Change, Evapotranspiration, Indian Agriculture, Crop Yield***

1. INTRODUCTION

The monsoon season is dependent on agriculture, which is the backbone of the Indian economy. The Intergovernmental Panel on Climate Change (IPCC) predicted that the global mean surface temperature will rise by 2 degrees Celsius by 2050. Temperatures will most certainly climb, resulting in unpredictably changing weather patterns such as erratic showers. patterns, rising surface temperatures, and rising CO_2 levels in the atmosphere studies on research Weathering characteristics have a high effect (67%) when compared to other variables such as soil and climate. fertilizer management during the cropping season (33%). Crop output has been validated by researchers. For every 1°F increase in temperature, the temperature drops by 3-5 percent. The current study demonstrates that crop output is influenced by temperature and takes on a funnel shape throughout the year. Both characteristics are essentially linearly linked at lower temperatures, but they rise with significant scattering at higher temperatures. The findings might be useful in researching the impact of climate change on agricultural output. When carbon dioxide (CO_2) and other air pollutants accumulate in the atmosphere, they absorb sunlight and solar energy that has bounced off the earth's surface, causing global warming. Normally, this radiation would escape into space, but these contaminants, which may persist in the atmosphere for years to centuries, trap the heat and cause the earth to warm. Greenhouse gases are heat-trapping pollutants such as carbon dioxide, methane, nitrous oxide, water vapour, and synthetic fluorinated gases, and their impact is known as the greenhouse effect[1].

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Climate is a synthesis of weather conditions in a specific location, described by long-term statistics (mean values, variances, probabilities of extreme values, and so on) for the meteorologic elements in that area. Surface variables, such as temperature, precipitation, and wind, are typically measured. The term "climate" refers to the status of the climatic system in general. The Intergovernmental Panel on Climate Change (IPCC) published a report in 1995. Climatic variability refers to differences in climate data across time (a particular month, season, or year) compared to long-term climate statistics for the same calendar period[1]–[3].

Climate change has an impact on human existence on the planet. It controls food production and water resources, as well as energy consumption, disease transmission, and other factors. (National Research Council) elements of human health and well-being 2010 (United States). Nitrogen makes up the majority of the atmosphere on Earth. nitrogen (N) and oxygen (O_2) These gases, however, have little or no effect on radiation. emitted by the Earth's surface or that emitted by the sun Water vapour is one of the so-called greenhouse gases (GHGs). However, infrared light produced by the Earth's surface is absorbed and reemitted by carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and chlorofluorocarbons (CFCs), trapping heat in the atmosphere. This enhanced warming maintains the Earth's surface warmer (approximately 33 degrees Celsius) than it would be if GHGs were not there. So, what exactly is climate change? Climate change, according to the World Meteorological Organization, is defined as a significant change in the mean values of a meteorologic element, such as temperature and precipitation amount, over a period of ten years or longer, with significant economic, environmental, and social consequences[4].

Like other countries, India has begun to experience extreme weather occurrences that have resulted in climate change. As previously stated, one of the primary detecting parameters to modify the climate is global warming. climate. In India, the yearly mean temperature has increased. The temperature climbed at a rate of 0.42°C every year. The agricultural system in India is based on monsoons from the south-west and north-east Approximately 80% of the total on India, the south-west monsoon is responsible for precipitation. Any changes and uncertainties in long-term rainfall patterns may have an impact on agriculture and increase the frequency of droughts and floods on a regional scale. Rainfall increased significantly along the west coast, in north Andhra Pradesh, and in North West India, whereas it decreased significantly in portions of Gujarat, Madhya Pradesh, and surrounding areas, Kerala, and northeast India. The northwestern area of India is affected by western disturbances on a limited scale, since such disturbances have only a 20–30-day influence on rabi output Not just the monsoon, but also the temperature, has had an impact on agriculture. The southern portion of India had a rising tendency in extreme maximum and minimum temperatures, whereas the northern section had a decreasing trend [20]. Crop production is expected to decline as temperatures rise in the future, according to research [18]. As a result, research into the effects of temperature on agricultural production, stability, yield, and quality is required in order to boost the country's economy.

1.1 Effects of Global Warming on Indian Agriculture:

Agriculture is impacted by global Warming in a variety of ways. Warming tends to lower yields beyond a particular temperature range because crops speed up their growth and produce less grain

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as a result. Plants' capacity to get and utilize moisture is further hampered by rising temperatures. When temperatures rise and plants increase transpiration—that is, when they lose more moisture from their leaves—evaporation from the soil accelerates. Evapotranspiration is the term for the combined impact as shown in Figure 1. Because more rainfall is expected as a result of global warming, the net effect of increasing temperatures on water availability is a race between increased evapotranspiration and increased precipitation. In most cases, greater evapotranspiration wins the race. However, one of the main causes of climate change, carbon emissions, can benefit agriculture by increasing photosynthesis in many major C3 crops (such as wheat, rice, and soybeans). The evidence on the advantages of carbon fertilization, on the other hand, is far from conclusive. However, we do know that this phenomenon has little impact on C4 crops (such as sugarcane and maize), which account for around one-fourth of all crops in terms of value.

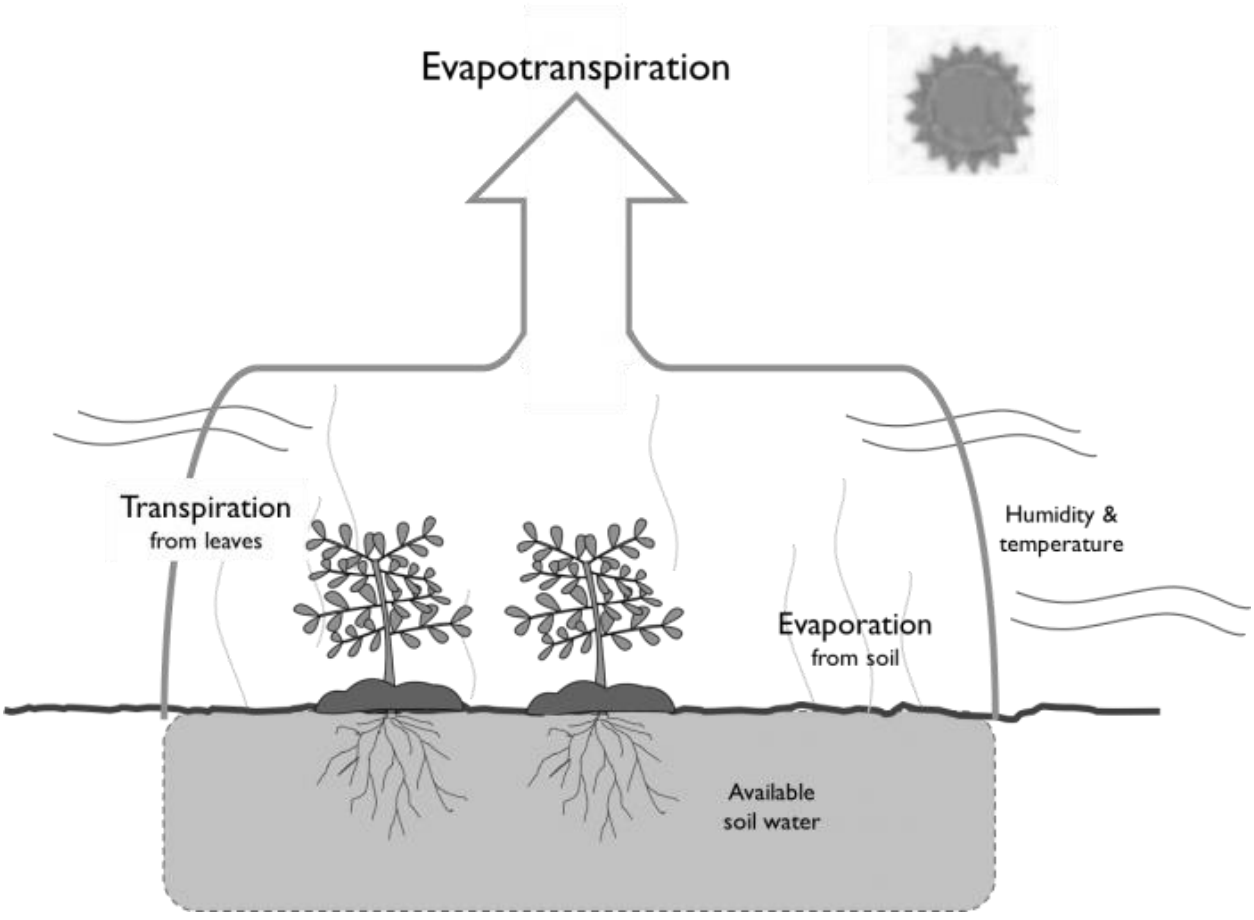

Figure 1: Illustrating the Mechanism involved in the Process of Evapotranspiration

According to studies, an increase in global surface temperature will have a negative impact on Indian agriculture. Heat waves, high temperatures, heavy and extended precipitation, and excessive cold are among climatic variables that affect farm production. These variables have both

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good and negative effects on crop yield. Almost every year, India has a number of weather events as a result of variations in climatic factors in various locations, resulting in lower agricultural yields. The unpredictable character of such weather occurrences has a negative impact on crop development and plant physiological systems. Drought years were observed in around 17% of India's years from 1901 to 2010, resulting in significant consequences on the country's agriculture, water resources, food security, economy, and social life. Photosynthesis and transpiration processes in crops may be affected by temperature and precipitation variations over a threshold value. Crop damage can occur as a result of excessive rainfall and flooding. Temperature and precipitation changes are expected to continue to have a significant influence on agriculture, according to studies. Crop output might be reduced by a slight increase in temperature (1-2°C), especially in seasonally dry tropical regions.

Based on the monsoon, Indian agriculture is separated into two primary seasons: Kharif and Rabi. Overall temperature rises are predicted to be significantly larger throughout the winter (rabi) than during the rainy season (kharif). Furthermore, by 2070, the average temperature in India is expected to climb by 0.4-2.0°C in Kharif and 1.1-4.5°C in Rabi. Food costs rise when agricultural production declines at the state and national levels. As a result, temperature may be a significant determining factor that leads to higher insecurity in Indian agriculture[5].

As a result, climate change has the potential to cause harm. to have a substantial impact on agricultural production Climate change has also had a role. In India, this is becoming a reality. The average temperature rises by 0.3–0.6 degrees Celsius every ten years. Since the 1860s, India has seen substantial warming as a result of climate change. This The current warming trend is comparable to previous global mean temperature rises. It's been 100 years. Rainfall patterns in India are expected to alter as a result of the western monsoon. Each year, the southern and central areas might have up to 15 more dry days, while the northern and northwestern parts could get 5 to 10 more days of rain. As a result, dry areas are predicted to get dryer, while wet areas are expected to become wetter[6].

1.2.Agents of Global Warming:

The increase in GHG concentrations in the atmosphere is mostly due to human and industrial activity. CO_2, the most common GHG, is rising mostly as a result of fossil fuel burning. CFC emissions are caused by industrial operations. Increased agricultural operations and organic waste management are thought to be contributing to the atmospheric accumulation of CH_4 and N_2O. The agents of climate change are GHGs created by diverse activities; a brief explanation of these agents is provided in the following paragraph[7].

1.2.1. Carbon Dioxide

Agriculture has a significant CO_2 fixation rate, although figures are difficult to come by due to the continual consumption of its products by humans and other secondary users. CO_2 fixation is thought to be essential in India since over 190 million hectares of land are used for agriculture. India's agricultural dry matter output is projected to be over 800 million t per year. This equates

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to the annual fixation of 320 Tg of carbon or 1000 Tg of CO_2. Only a small portion of this is kept throughout time, with the remainder being released back into the environment.

1.2.2. Methane:

Methane is a gas present in trace amounts in the Earth's atmosphere. The simplest hydrocarbon is methane, which is made up of one carbon atom and four hydrogen atoms. Methane is an extremely potent greenhouse gas. Methane is a combustible gas that is utilized as a fuel all over the world. Natural gas contains a significant amount of it. The global yearly production of CH_4 into the atmosphere from all sources is estimated to be 535 Tg per year. India's overall contribution to global CH_4 emissions is just 18.5 Tg per year1 from all sources. Although the yearly load of CH4 in the atmosphere is substantially lower than that of CO_2, its greater absorption contributes significantly to global warming. Agriculture, mostly constantly flooded rice fields and ruminant animals, is the primary source of CH_4 emissions (68%) in the United States. Global annual CH_4 emissions from rice paddies are less than 13 Tg per year, with India's contribution estimated to be only 4.2 Tg per year. Low CH_4 emissions from rice fields in India are mostly due to the low organic carbon content of the soils in the major rice-growing areas and the fact that they are not continually flooded.

1.2.3. Nitrous Oxide:

The stratosphere, which ranges from 15 to 50 kilometers in height, has the greatest amounts of ozone. It is created when O_2 is dissociated by UV light. It absorbs UV light that is damaging to the skin. Aerosols, man-made halogenated chemicals, and CFCs, on the other hand, have depleted the ozone layer in the stratosphere, leading to global warming. 196 nations have officially accepted the Montreal Protocol, which was signed in 1987. The ozone layer has begun to heal, but total recovery may take decades. However, ozone is considered a contaminant at the Earth's surface, causing harm to plants, animals, and humans, and it is the major component of smog. The energy sector (which includes fossil fuel combustion) is the most significant contributor to global warming, accounting for 61 percent of the overall contribution. Agriculture and related activities are responsible for 28% of global warming, followed by the industrial sector (8%), wastes (2%), and land-use changes 1% and precipitation regulates its concentration in the lower atmosphere. It isn't classified as a climate-altering substance[8].

1.2.4. Ozone:

Three oxygen atoms make up ozone (O_3), a highly reactive gas. It is a natural and man-made substance that exists in the high (stratosphere) and lower (troposphere) atmospheres of the Earth (the troposphere). Ozone has a positive or negative impact on life on Earth depending on its location in the atmosphere[9][2].

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the Montreal Protocol, which was signed in 1987. The ozone layer has begun to heal, but total recovery may take decades. However, ozone is considered a contaminant at the Earth's surface, causing harm to plants, animals, and humans, and it is the major component of smog[10].

1.2.5. Greenhouse Effects:

The greenhouse effect occurs when radiation from a planet's atmosphere warms the planet's surface to a higher temperature than it would be without the atmosphere. In the atmosphere of a planet, radiatively active gases (i.e., greenhouse gases) emit energy in all directions. A portion of this radiation is reflected back to the surface, warming it. The amount of greenhouse gases in the atmosphere determines the intensity of downward radiation, or the degree of the greenhouse effect. The temperature rises until the downward flow of energy is balanced by the intensity of upward radiation from the surface, which cools it[8].

2. DISCUSSION

One of the most serious problems of the twenty-first century is global warming. Global warming and its effects on climate change are being studied in depth as a multidisciplinary issue. Significant changes in climatic variables such as absolute humidity, precipitation, and net terrestrial and global solar radiation are expected as a result of the enhanced greenhouse effect. Atmospheric temperature is arguably the most widely used indicator of climate change on both a global and regional scale. Global temperatures have risen by 0.3–0.6 degrees Celsius during the late 1800s, and by 0.2–0.3 degrees Celsius in the prior 40 years.

Climate change is a fact of life. Improved photosynthesis, lower photorespiration, and decreased stomatal conductance may all contribute to increased crop growth and production. However, due to the shorter time of crop growth, a rise in temperature may reduce rice and wheat grain yields. With rising CO_2 levels, the protein content of legume grains may decrease. Because of enhanced mineralization and phosphatase enzyme activity in the rhizosphere, elevated CO_2 concentrations may increase the availability of soil N and P. C3 plants are expected to compete much more fiercely against C4 crops than they do today, and vice versa. Increased warmth and humidity can lead to a rise in the number of insects and illnesses. Because of the complexities of crop–environment interactions, a multidisciplinary strategy including plant breeders is necessary. To develop long-term solutions in sustaining agricultural output, crop physiologists, agrometeorologists, and agronomists must collaborate. Strategic research is needed to increase the resilience of Indian agriculture, which includes crops, natural resource management, horticulture, livestock, and fisheries, by developing and using enhanced production and risk management methods. Furthermore, there is a need for technology demonstrations of existing management methods for improving agricultural and livestock climate change resistance. Building the capacity of scientists and other stakeholders in agricultural research on climate resilience may also aid in the development of climate change solutions.

3. CONCLUSION

In dry locations, any change in evapotranspiration is expected to have a significant impact on agricultural and water resource planning. The current study presents a preliminary estimate of the anticipated change in evapotranspiration demand in Rajasthan's desert area, taking into consideration a wide range of climate change scenarios. Although the study's findings are estimations, they may be beneficial in the future for planning, developing, and running irrigation systems and crop planning. The likely change in evapotranspiration demand should be viewed in the context of the evapotranspiration estimation technique chosen. When particular climatic conditions on ET demand change, different techniques of calculating ET may respond differently. Climate change may affect not just temperature but also cloudiness, windiness, and humidity. The atmospheric demand for water vapour or its drying power is determined by these four variables. Furthermore, climate variations in soil moisture will vary the quantity of water accessible to plant roots and hence the amount that can be transpired.

Changes in evapotranspiration demand over time can have significant consequences for Rajasthan's dry zone. Even a 1% rise in temperature from base data can result in a 15 mm increase in evapotranspiration, resulting in an extra water need of 34.275 mcm for Jodhpur alone and 313.12 mcm for the entire dry zone of Rajasthan. The dry zone's total accessible surface water resources are 1361.21 million cubic meters. Although rainfall in the desert area of Rajasthan has been increasing at a rate of 0.5 mm/year over the last 100 years, enhanced evapotranspiration has been growing. Global warming demand might put a lot of strain on already overburdened water supplies. this region's natural resources Because this area lacks a permanent river system, any Water demand growth necessitates careful planning for future water resource development. in this area. The development of technology to reduce water losses requires further attention. in water reservoirs, rainwater conservation, and the creation of agricultural types that use less water. The current analysis gives a current perspective on the region's future water ain light of global warming.

REFERENCE

[1] S. Frank *et al.*, "Reducing greenhouse gas emissions in agriculture without compromising food security?," *Environ. Res. Lett.*, 2017, doi: 10.1088/1748-9326/aa8c83.

[2] R. K. Fagodiya, H. Pathak, A. Kumar, A. Bhatia, and N. Jain, "Global temperature change potential of nitrogen use in agriculture: A 50-year assessment," *Sci. Rep.*, 2017, doi: 10.1038/srep44928.

[3] D. B. Botkin *et al.*, "Forecasting the effects of global warming on biodiversity," *BioScience*. 2007, doi: 10.1641/B570306.

[4] L. R. G. DeSantis, R. S. Feranec, and B. J. MacFadden, "Effects of global warming on ancient mammalian communities and their environments," *PLoS One*, 2009, doi: 10.1371/journal.pone.0005750.

[5] A. J. Teuling *et al.*, "Evapotranspiration amplifies European summer drought," *Geophys. Res. Lett.*, 2013, doi: 10.1002/grl.50495.

[6] Y. A. Liou and S. K. Kar, "Evapotranspiration estimation with remote sensing and various surface energy balance algorithms-a review," *Energies*. 2014, doi: 10.3390/en7052821.

[7] C. P. C. Bong *et al.*, "A review on the global warming potential of cleaner composting and mitigation strategies," *J. Clean. Prod.*, 2017, doi: 10.1016/j.jclepro.2016.07.066.

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Volume 22 Issue 1, January 2020

[8] R. S and R. S, "Effect of Global warming on Indian Agriculture," *J. Climatol. Weather Forecast.*, 2017, doi: 10.4172/2332-2594.1000195.

[9] M. G. Schultz *et al.*, "Tropospheric Ozone Assessment Report: Database and metrics data of global surface ozone observations," *Elementa*, 2017, doi: 10.1525/elementa.244.

[10] Tommaso Perrone, "How agriculture and climate change are related: causes and effects," *Climatic Change*. 2014.