International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Weather Parameters and Assessing the Impact of it on Human Health

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Abstract

Weather refers to the atmospheric conditions at a particular location observed over a short period of time**.** These conditions are also called as weather parameters. Weather parameters like Temperature, Humidity, Wind, Precipitation, .Atmospheric Pressure, Cloud Cover, Visibility and many more have a vital role in shaping the health, comfort, and daily functioning of human and other living organisms. In this paper the effects of important weather parameters including the temperature, humidity, atmospheric pressure, wind, precipitation, solar radiation, and ultraviolet exposure on human health have been discussed in detailed. . Each parameter interacts with physiological processes occurring in living being and humans, and also environmental conditions around the surrounding to influence disease patterns in humans, affecting the thermal comfort for living organisms, psychological states, and social systems. It is observed that extreme temperatures and humidity can cause heat stress to all living organism including humans, whereas pressure changes are often linked to joint and migraine issues. Similarly, excessive rainfall and strong winds causes physical hazards and increase in the waterborne diseases and respiratory issues. The above discussion discloses the necessity of monitoring weather parameters as part of public health issues and urban and rural areas planning, especially in the context of increasing climate variability. By understanding the impact of weather condition relationships, policymakers and health experts can better anticipate and mitigate the risks associated with adverse weather conditions.

Keywords: Weather parameters, Meteorological Variables, Climate impact on human.

1. Introduction

Weather and its parameters are fundamental environmental conditions that regularly and continuously affect life of all living organism including humans, both directly and indirectly. It basically is related to the conditions in which people live, work, and carry out daily and regular activities. Variations in the in weather parameters like temperature, humidity, wind, atmospheric pressure, and solar radiation and many more can influence physical health, mental well-being, productivity, and overall quality of life of humans . These effects of weather conditions are often more pronounced in populations, including the elderly, children, and those with pre-existing bad health conditions.

In recent years, regular and drastic weather and climate conditions including global warming and climate patterns have heightened the variability and extremity of local weather conditions.in India now a days Heat waves and elevated temperature is also regularly reported by environmental reporting agencies like Central pollution control board (CPCB), heavy rainfall is also observed in certain parts of the country , sudden cold spells, and poor air quality parameters like PM 10,PM 2.5, SO_X, NO_X etc. events are

becoming more frequent and severe especially in metro cities like Delhi NCR and many industrial areas having very high population density, vehicles loads, higher consumptions of fuels, and producing huge quantities of environmental pollutants, . As a result, understanding how specific weather parameters affect human health and life has become increasingly important. Such kind of knowledge is essential for guiding public health policies for people wellbeing, designing adaptive infrastructure for future, and preparing communities for weather-related risks. This paper proper explores the relationship between various weather and climate parameters and their impact on human and the living organism well-being, by analyzing exact and regular analysis of key atmospheric variables. The study aims to highlight how environmental monitoring and climate-responsive planning can contribute to healthier, more resilient societies in India and world.

2. Important Weather Parameters

Weather parameters are the measurable atmospheric conditions that includes temperature, pressure, wind speed, humidity, pollution parameters like Particulate matters, air quality parameters like Sox (Oxides of Sulphur) , NOx(Oxides of Nitrogen), CO (Carbon mono oxides), O_3 (Ozone gas), and many more that define the current state of the weather at a specific time and place. Unlike climate parameters, which deal with long-term averages, weather parameters change hourly or daily.

3. Important Weather Parameters and their Definition / Role

A list of selected Important Weather Parameters their definition /role is given in the following table along with relevant references[1-5].

S. No.	Weather Parameter	Definition / Role	Reference
1	Temperature	Measure of the thermal state of the atmosphere at a given location.	Oke, T.R. (1987). *Boundary Layer Climates*. Routledge.
2	Humidity	Amount of water vapor present in the air (relative or absolute).	Monteith, J.L., & Unsworth, M.H. (2013). *Principles of Environmental Physics*. Academic Press.
3	Atmospheric Pressure	Force exerted by the weight of the air above a surface.	Stull, R.B. (2000). *Meteorology for Scientists and Engineers*. Brooks/Cole.
4	Dew Point	The temperature at which air becomes saturated and dew forms.	WMO (2018). *Guide to Meteorological Instruments and Methods of Observation*. Geneva: WMO.
5	Wind Speed	The rate of air movement across the Earth's surface.	Stull, R.B. (2000). *Meteorology for Scientists and Engineers*. Brooks/Cole.
6	Wind Direction	The direction from which the wind originates, expressed in degrees or cardinal points.	Huschke, R.E. (Ed.). (1959). *Glossary of Meteorology*. AMS.
7	Precipitation	All forms of water, liquid or solid, that fall from clouds and reach the ground.	WMO (2018). *Guide to Meteorological Instruments and Methods of Observation*. Geneva: WMO.

S. No.	Weather Parameter	Definition / Role	Reference
8	Cloud Cover	Fraction of the sky obscured by clouds, measured in oktas.	Huschke, R.E. (Ed.). (1959). *Glossary of Meteorology*. AMS.
9	Visibility	The distance at which an object or light can be clearly discerned.	WMO (2018). *Guide to Meteorological Instruments and Methods of Observation*. Geneva: WMO.
10	Solar Radiation	Total energy from the sun received per unit area.	Monteith, J.L., & Unsworth, M.H. (2013). *Principles of Environmental Physics*. Academic Press.
11	UV Index	Index indicating the strength of ultraviolet radiation from the sun.	Stull, R.B. (2000). *Meteorology for Scientists and Engineers*. Brooks/Cole.

4. Instruments Used to Measure Weather Parameters

S, No.	Weather Parameter	Instrument Used	Description
1	Temperature	Thermometer	Measures air temperature using mercury, alcohol, or digital sensors (Oke, 1987).
2	Humidity	Hygrometer	Detects moisture in the air; includes dry/wet bulb and electronic sensors (WMO, 2018).
3	Atmospheric Pressure	Barometer	Records atmospheric pressure; mercury and aneroid types are standard (Stull, 2000).
4	Wind Speed	Anemometer	Measures wind velocity using rotating cups or ultrasonic transducers (WMO, 2018).
5 6	Wind Direction	Wind Vane (Weather Vane)	Indicates the direction from which wind originates (Huschke, 1959).
7	Rainfall	Rain Gauge	Measures the amount of precipitation over time (Monteith & Unsworth, 2013).
8	Cloud Height / Coverage	Ceilometer	Uses laser or infrared sensors to determine cloud base height and sky condition (WMO, 2018).
9	Visibility	Transmissometer / Visibility Sensor	Determines horizontal visibility, especially in fog and smog (WMO, 2018).
10	Dew Point	Dew Cell / Psychrometer	Measures the temperature at which air becomes saturated (Monteith & Unsworth, 2013).
11	Solar Radiation	Pyranometer	Measures global solar irradiance on a flat surface (Monteith & Unsworth, 2013).
12	UV Radiation	UV Radiometer / UV Sensor	Measures intensity of ultraviolet solar radiation (Stull, 2000).

S, No.	Weather Parameter	Instrument Used	Description
13	Snowfall	Snow Gauge / Snowboard	Collects and quantifies snow accumulation (WMO, 2018).
14	Evaporation Rate	Atmometer / Evaporimeter	Measures water evaporation from surfaces or soil (Monteith & Unsworth, 2013).

Impact of Weather Parameters on Human Beings

Weather significantly influences human life, shaping health outcomes, behaviors, and the functionality of essential systems such as agriculture, transportation, and public health. Parameters like temperature, humidity, wind, and precipitation interact with biological and societal factors to create both beneficial and harmful effects. As climate variability intensifies, these impacts are becoming more pronounced and unpredictable.

4.1 Temperature and Related Diseases

Temperature is a fundamental weather parameter that significantly affects all physiological activity and biochemical reactions occurring in human body, and it is related to human health conditions**.** An extreme variation of temperature affects many biochemical reactions catalyzed by enzymes, it also alters the digestive process of our body parts, most of hormonal activity requires a certain limiting temperature range for their proper functioning. Following list of diseases shows the clear effect of temperature on human health.

4.1.1 High Temperature-Related Diseases (Heat Stress)

High ambient temperatures can overwhelm the body's ability to regulate heat, leading to following diseases.

S. No.	Disease/Condition	Description
1	Heatstroke	A life-threatening condition where the body temperature exceeds 40°C. It may cause confusion, seizures, or unconsciousness.
2	Heat Exhaustion	Characterized by heavy sweating, dizziness, weakness, and nausea due to fluid and electrolyte loss.
3	Dehydration	Excessive water loss impairs cellular function, especially dangerous for children and the elderly.
4	Hyperthermia	Elevated body temperature from failed thermoregulation.
5	Skin Rashes (Heat Rash)	Caused by blocked sweat ducts during hot and humid conditions.
6	Cardiovascular Stress	Heat places extra load on the heart, increasing the risk of heart attacks, especially in older adults.

4.1.2 Low Temperature-Related Diseases (Cold Stress)

Exposure to extremely cold conditions can slow body functions and lead to following diseases.

S.No.	Disease/Condition	Description
1	**Hypothermia**	Body temperature drops below 35°C, leading to shivering, confusion, and slow metabolism.
2	**Frostbite**	Freezing of skin and underlying tissues, often affecting fingers, toes, ears, and nose.
3	**Chilblains**	Painful inflammation of small blood vessels due to cold exposure.
4	**Respiratory Infections**	Cold air can irritate the airways and worsen conditions like asthma, bronchitis, or pneumonia.
5	**Seasonal Flu**	Viruses like influenza spread more readily in cold and dry air.

4.1.3 Impact on Health and affected population

People with chronic illnesses (e.g., heart or lung disease), Children and old aged persons, Outdoor workers, athletes, and homeless individuals face greater risk are more affected by temperature changes [6-8]

5. Humidity

Humidity refers to the amount of water vapor present in the air the surrounding environment. It is normally expressed as relative humidity (RH)—the percentage of water vapor in the air compared to the maximum it can hold at a given temperature. Humidity plays an important role in the body's thermoregulation process. High humidity inhibits increasing susceptibility to infections and respiratory discomfort (Monteith & Unsworth, 2013). Additionally, humidity have very much concerned for contributes to the survival and transmission of pathogens, affecting disease patterns in various regions affecting the people living there.

5.1 Humidity and Related Diseases

.Both high and low humidity levels can negatively affect human comfort**,** respiratory health**,** and disease transmission.

5.1.1 High Humidity and Diseases

Excessive humidity (RH > 60%) creates an ideal environment for microbial and pathogenic agents' growth**,** making it easier for bacteria**,** viruses**,** mold, and fungi to infections that lead to diseases.

S. No.	Disease/Condition	Description
1	Fungal Infections	Humid environments support fungal growth, leading to skin infections like athlete's foot, ringworm, and candidiasis.
2	Allergies	Mold spores and dust mites thrive in moisture-rich air, triggering asthma and allergic rhinitis.
3	Heat-related Illnesses	High humidity reduces sweat evaporation, making it harder for the body to cool down, increasing the risk of **heat exhaustion** and **heatstroke**.
4	Respiratory Issues	Damp air can worsen asthma, COPD, and bronchitis by irritating airways and increasing mucus production.

5.1.2 Low Humidity and Diseases

Low humidity (RH < 30%) leads to **dry air**, which negatively impacts the **mucous membranes**, **skin**, and **respiratory system**.

S. NO.	Disease/Condition	Description
1	**Dry Skin and Eyes**	Lack of moisture causes dry, itchy skin and irritation in the eyes.
2	**Sinusitis**	Dry nasal passages increase the risk of sinus inflammation and infection.
3	**Respiratory Infections**	Dry air impairs the function of nasal cilia, reducing the body's ability to filter out viruses (e.g., flu and cold).
4	**Worsened Asthma**	Low humidity can lead to airway constriction and worsening of asthma symptoms.
5	**Nosebleeds**	Caused by drying and cracking of the nasal membranes.

5.1.3 Impact on Health and affected population

A poorly ventilated or excessively air-conditioned space commonly affects the children, infants and old aged people, and also patients having (asthma, COPD)[9-11].

6. Atmospheric Pressure and Related Diseases

Atmospheric pressure (also called barometric pressure**)** is the force exerted by the weight of the air in the Earth's atmosphere. It normally ranges from about **950 to 1050 hPa** (hectopascals). Changes in this pressure, especially **rapid fluctuations**, can significantly affect human physiology.

6.1 Health Impacts of Atmospheric Pressure Changes

Both **l**ow and high barometric pressure, as well as sudden changes, has been linked to a variety of health issues, particularly affecting the respiratory**,** cardiovascular, and nervous systems**.**

6.1.1 Low Atmospheric Pressure (e.g., during storms, at high altitudes)

S. No.	Disease/Condition	Description
1	**Altitude Sickness**	Occurs at elevations >2500 meters due to reduced oxygen pressure; includes symptoms like headache, nausea, fatigue, and shortness of breath.
2	**Hypoxia**	Low oxygen levels in tissues, which can affect brain and heart function.
3	**Migraine & Headaches**	Drop in pressure can trigger headaches or migraines in sensitive individuals.
4	**Joint Pain (Arthritis)**	Many people with arthritis report worsened joint pain when pressure drops.
5	**Sinus Congestion**	Pressure differences can lead to sinus pain and nasal congestion.

6.1.2 High Atmospheric Pressure (e.g., during stable dry weather)

S. NO.	Disease/Condition	Description
1	**Barometric Pressure Headaches**	Sudden increases in pressure can cause tension-type headaches or migraines.
2	**Respiratory Discomfort**	High pressure may trap pollutants closer to the ground (temperature inversion), worsening air quality and respiratory issues.
3	**Increased Blood Pressure**	Some studies suggest high pressure may slightly raise blood pressure in sensitive individuals.

6.1.3 Pressure Sensitivity in Chronic Diseases

People with asthma**,** COPD**,** cardiovascular disease, and neurological conditions often report increased symptoms during change in atmospheric pressure.[12-14]

7. Wind and Related Diseases

Wind is the horizontal movement of air caused by differences in atmospheric pressure. Wind plays a crucial role in dispersing heat, moisture, and pollutants in the environment. While gentle breezes are often harmless or beneficial, strong or polluted winds can contribute to a range of health issues, especially in vulnerable populations.

7.1 How Wind Affects Human Health

Wind can influence health both directly **(e.**g., by causing injury or exposure) and indirectly (e.g., by spreading allergens, pollutants, or pathogens).

7.1.1 Strong Winds and Injuries

S. No.	Health Issue	Description
1	**Trauma/Injury**	High-speed winds from storms, cyclones, or tornadoes can lead to blunt injuries, flying debris injuries, and falls.
2	**Respiratory Distress**	Dust and sand carried by strong winds can irritate the lungs, eyes, and throat.
3	**Hypothermia**	Cold winds (wind chill) can accelerate body heat loss, leading to low body temperature, especially in winter.

7.1.2 Windborne Allergens and Pollutants

S. No.	Disease/Condition	Description
1	**Allergic Rhinitis (Hay Fever)**	Wind can carry pollen over large distances, triggering seasonal allergies.
2	**Asthma Attacks**	Dust, smoke, and industrial pollutants lifted by wind can provoke asthma

S. No.	Disease/Condition	Description
		symptoms.
3	**Eye Irritation & Conjunctivitis**	Windblown particles can cause eye redness, itching, or infections.
4	**Silicosis**	In desert or dry regions, wind can carry silica dust, which over time can lead to chronic lung disease.
5	**Valley Fever (Coccidioidomycosis)**	In arid areas (like SW U.S. or parts of India), fungal spores lifted by wind may cause a respiratory illness.

7.1.3 Indirect Effects: Disease Spread and Environmental Impact

- **Vector Dispersal**: Wind can help transport **mosquitoes** or **ticks**, spreading diseases like malaria or dengue.
- **Smoke Dispersion**: Wildfires produce toxic smoke; wind can carry this over hundreds of kilometers, affecting air quality and public health (e.g., PM2.5-related cardiovascular and lung issues).
- **Aggravation of Skin Disorders**: Dry, dusty winds may worsen eczema, dermatitis, and other skin issues.

7.1.4 Impact on Health and affected population

People with asthma**,** COPD**, or** allergies are very much affected besides Children, old aged people and outdoor workers.[15-17]

8. Precipitation and Related Diseases

Precipitation refers to all forms of water—rain, snow, sleet, hail, and drizzle—that fall from the atmosphere to the Earth's surface. While precipitation is essential for ecosystems and water supply, it can also contribute to disease outbreaks**,** vector proliferation**, and** water contamination**.**

8.1 Types of Precipitation and Their Health Effects

S. No.	Type	Description	Potential Health Impacts
1	**Rain**	Most common form; can cause flooding and damp conditions	Waterborne diseases, skin infections
2	**Snow**	Frozen rain; accumulates in cold climates	Hypothermia, slip-and-fall injuries
3	**Sleet/Hail**	Ice particles from freezing rain	Traumatic injury, cold exposure

8.1.2 Diseases and Health Conditions Related to Precipitation

S. NO.	Disease/Condition	Description
1	**Waterborne Diseases**	Heavy rainfall often leads to contamination of drinking water with pathogens like *E. coli*, *Vibrio cholerae*, and *Giardia*. Outbreaks of **cholera**, **diarrhea**, **dysentery**, and **typhoid** are common.

S. NO.	Disease/Condition	Description
2	**Vector-Borne Diseases**	Stagnant water from rain is a breeding ground for mosquitoes, increasing the risk of **malaria**, **dengue**, **chikungunya**, and **Zika virus**.
3	**Leptospirosis**	A bacterial infection caused by contact with water contaminated by animal urine, often after flooding. Symptoms include fever, headache, and kidney or liver failure.
4	**Respiratory Infections**	Damp indoor environments caused by prolonged rain can promote mold growth, leading to asthma exacerbations, allergic reactions, and **fungal infections**.
5	**Skin Infections**	Constant wetness or contact with dirty water can lead to **fungal** or **bacterial skin diseases**, especially in tropical regions.
6	**Hypothermia**	Prolonged exposure to cold rain or wet clothing can cause dangerously low body temperatures, particularly in children and the elderly.

8.1.3 Affected Persons

People with chronic illnesses or poor immunity, Infants, elderly, and pregnant women are much affected.[18-20]

9. Solar and Ultraviolet (UV) Radiation and Related Diseases

Solar radiation is the total electromagnetic energy emitted by the sun, which includes visible light, infrared radiation, and **ultraviolet (UV) rays**. While moderate sun exposure is essential for vitamin D synthesis and circadian rhythm regulation, **excessive or prolonged exposure**, especially to **UV radiation**, can lead to serious **health consequences**.

9.1 Types of UV Radiation

S. NO.	Type	Wavelength (nm)	Effect on Health
1	**UVA**	315–400	Penetrates deep into skin; causes aging and DNA damage
2	**UVB**	280–315	Causes sunburn and most skin cancers
3	**UVC**	100–280	Absorbed by ozone layer; not a concern at Earth's surface

9.1.1 Diseases and Health Effects Related to UV Exposure

S. No.	Disease/Condition	Description
1	**Skin Cancer (Melanoma & Non-**	UVB rays cause DNA mutations that lead to skin cancers. Prolonged unprotected exposure increases risk of **basal cell carcinoma**, **squamous**

S. No.	Disease/Condition	Description
	Melanoma)	**cell carcinoma**, and **melanoma**.
2	**Sunburn (Erythema)**	Acute inflammation of skin due to excessive UVB exposure; increases long-term cancer risk.
3	**Photoaging**	Chronic UVA exposure breaks down collagen and elastin, causing wrinkles and leathery skin.
4	**Eye Disorders (Cataracts, Photokeratitis)**	UV radiation can damage the cornea and lens, leading to **temporary blindness (snow blindness)** or **cataracts**, a leading cause of blindness.
5	**Immune Suppression**	Excessive UV exposure can impair immune responses and increase susceptibility to infections and cancer.
6	**Vitamin D Deficiency (From Avoidance)**	Lack of UV exposure can result in low vitamin D levels, increasing risk of **rickets**, **osteoporosis**, and **autoimmune disorders**.

9.1.2 Affected Persons

Children and adolescents and old aged people, outdoor workers, people living high altitude areas are very much affected.[21-23]

10. Conclusion

Weather parameters including temperature, humidity, pressure, wind, precipitation, and solar radiation—have significant effects on human health. Extreme temperatures can cause heatstroke, hypothermia, or worsen heart and respiratory conditions. High humidity increases the risk of asthma, allergies, and skin infections. Fluctuations in atmospheric pressure may trigger migraines and joint pain, while strong winds can spread allergens and pollutants, leading to respiratory issues. Heavy rainfall and flooding contribute to the spread of waterborne and vector-borne diseases like cholera and dengue. Prolonged exposure to solar and ultraviolet (UV) radiation can cause sunburn, eye damage, and increase the risk of skin cancers, despite its role in vitamin D synthesis. As climate patterns become more unpredictable, understanding these health impacts becomes essential. Effective monitoring, public awareness, and preventive strategies are critical to minimizing weather-related health risks and building climate-resilient populations

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