CLIMATE

FOCUS ON THE INDIAN SUB-CONTINENT

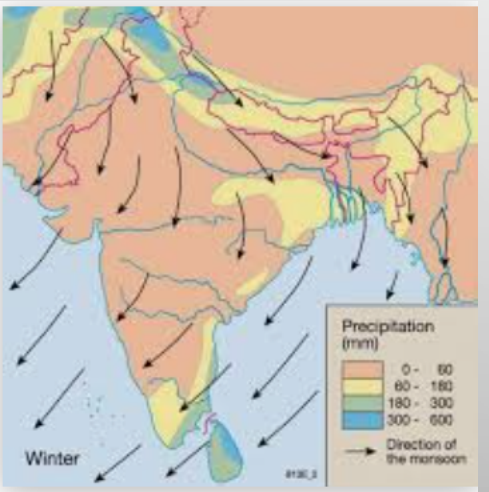
CLIMATE

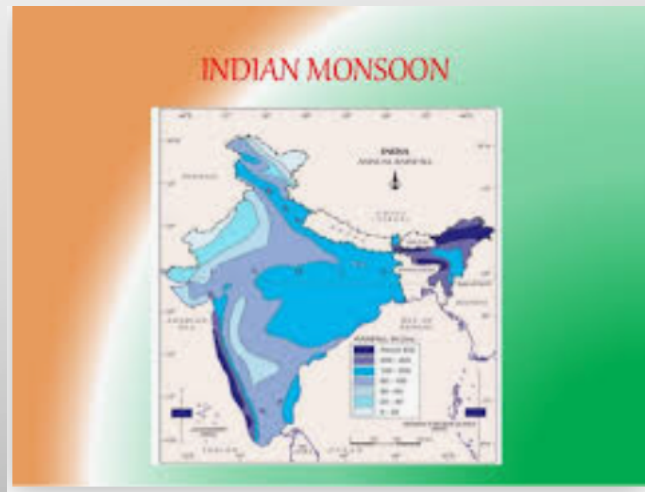
MODULE 1

- THE TERM **"CLIMATE"** IS THE SUM TOTAL OF THE WEATHER CONDITIONS (INCLUDING VARIATIONS) OVER A LARGE AREA, FOR A LONG PERIOD OF TIME (MORE THAN THIRTY YEARS).
- THE TERM "*WEATHER*" REFERS TO THE STATE OF THE ATMOSPHERE AT A PLACE AND TIME. THE WEATHER CONDITIONS IN AN AREA CAN FLUCTUATE VERY OFTEN WITHIN A DAY.
- BOTH CLIMATE AND WEATHER ARE CONCERNED WITH THE FOLLOWING ELEMENTS:
- TEMPERATURE
- HUMIDITY
- AIR PRESSURE
- PRECIPITATION (RAINFALL OR SNOWFALL)
- WIND

INDIA'S CLIMATE

- BASED ON THE GENERALISED MONTHLY ATMOSPHERIC CONDITIONS, A YEAR IS DIVIDED INTO **SEASONS** SUCH AS WINTER, SUMMER AND RAINY SEASONS.
- THE WORLD IS DIVIDED INTO A NUMBER OF CLIMATIC REGIONS. IN ASIA, INDIA AND OTHER SOUTH AND SOUTH-EASTERN COUNTRIES HAVE A ***MONSOON TYPE OF CLIMATE***. THE WORD MONSOON IS DERIVED FROM THE ARABIC WORD 'MAUSIM' WHICH LITERALLY MEANS SEASON. 'MONSOON' REFERS TO THE SEASONAL REVERSAL IN THE WIND DIRECTION DURING





REGIONAL CLIMATIC VARIATION IN INDIA

- ALTHOUGH THERE IS AN OVERALL UNITY IN THE GENERAL CLIMATIC PATTERN IN INDIA, THERE ARE SOME PERCEPTIBLE REGIONAL VARIATIONS.
- **TEMPERATURE**
  THE TEMPERATURE IN THE WINTER IN NORTH-WESTERN MOUNTAINOUS REGIONS CAN GO DOWN TO – 45° C (AT DRASS IN JAMMU AND KASHMIR), WHILE IT IS 22°C IN THIRUVANANTHAPURAM IN KERALA. SIMILARLY, IT CAN GO UP TO 50°C IN SUMMER IN SOME PARTS OF WESTERN RAJASTHAN WHILE IT IS A CHILLY 20°C IN SHILLONG.
- IN MANY AREAS, THERE IS A WIDE VARIATION BETWEEN DAY AND NIGHT TEMPERATURES. IN THE THAR DESERT, THE DAY TEMPERATURE MAY RISE UP TO 50°C AND DROP DOWN TO NEAR 15°C THE SAME NIGHT. ON THE OTHER HAND, THERE IS HARDLY ANY DIFFERENCE IN DAY AND NIGHT TEMPERATURES IN THE ANDAMAN AND NICOBAR ISLANDS OR IN KERALA.
- **PRECIPITATION**
  THERE IS A WIDE VARIATION OBSERVED IN THE AMOUNT AND SEASONAL DISTRIBUTION OF PRECIPITATION.

REGIONAL CLIMATIC VARIATION IN INDIA (2)

- **PRECIPITATION IN THE FORM OF SNOWFALL** OCCURS ONLY IN THE UPPER PARTS OF HIMALAYAS, WHEREAS THE REST OF THE COUNTRY RECEIVES RAINFALL.
- **PRECIPITATION IN THE FORM OF RAINFALL** VARIES FROM OVER 400 CM IN MEGHALAYA TO LESS THAN 10 CM IN LADAKH AND WESTERN RAJASTHAN. SIMILARLY, MOST PARTS OF THE COUNTRY RECEIVE RAINFALL FROM JUNE TO SEPTEMBER, HOWEVER THE TAMIL NADU COAST GETS MOST OF ITS RAIN DURING OCTOBER AND NOVEMBER.
- **COASTAL REGIONS** EXPERIENCE DIFFERENT WEATHER CONDITIONS FROM THE INTERIOR REGIONS. FOR EXAMPLE, TEMPERATURE AND SEASONAL CONTRAST ARE RELATIVELY MILD. THE RAINFALL ALSO DECREASES FROM EAST TO WEST. SUCH DIFFERENCES TEND TO CREATE A WIDE VARIETY OF CUSTOMS AMONG PEOPLE OF DIFFERENT REGIONS, IN TERMS OF THE FOOD THEY EAT, THE CLOTHES THEY WEAR, THE KIND OF HOUSES THEY REQUIRE AND SO ON.

CLIMATIC CONTROLS

- PERMANENT FACTORS WHICH GOVERN THE GENERAL NATURE OF THE CLIMATE OF ANY LOCATION ON THE EARTH ARE CALLED **FACTORS OF CLIMATIC CONTROL.**
- **THE FACTORS OF CLIMATIC CONTROL** ARE: LATITUDE, ALTITUDE, DISTANCE FROM THE SEA (CONTINENTALITY), PRESSURE AND WIND SYSTEMS, OCEAN CURRENTS AND RELIEF FEATURES.
- **LATITUDE** IS THE ANGULAR DISTANCE OF A LOCATION FROM THE EQUATOR IN NORTH-SOUTH DIRECTION. DUE TO THE CURVATURE OF THE EARTH, LATITUDE CHANGES THE AMOUNT OF SOLAR ENERGY RECEIVED. AS A RESULT, AIR TEMPERATURE DECREASES FROM THE EQUATOR TOWARDS THE POLES.
- **ALTITUDE** REFERS TO THE HEIGHT ABOVE MEAN SEA LEVEL. AS DISTANCE FROM THE EARTH'S SURFACE INCREASES IN HEIGHT, THE TEMPERATURE DECREASES AND THE AIR BECOMES LESS DENSE. THIS IS ONE OF THE REASONS WHY HILL STATIONS OR MOUNTAINOUS REGIONS ARE COOLER IN SUMMER.
- LATITUDE AND ALTITUDE AFFECT ATMOSPHERIC PRESSURE AND THE WIND SYSTEMS, WHICH IN TURN INFLUENCE THE TEMPERATURE AND RAINFALL PATTERN OF AN AREA.
- **CONTINENTALITY** OR DISTANCE FROM THE SEA AFFECTS CLIMATE. THE SEA EXERTS A MODERATING INFLUENCE ON THE CLIMATE OF A REGION. AS THE DISTANCE FROM THE SEA INCREASES, THE WEATHER CONDITIONS BECOME MORE EXTREME SUCH AS HIGH TEMPERATURES AND CHANGES IN RAINFALL VARIATION BETWEEN SEASONS.
- **OCEAN CURRENTS** ALONG WITH ONSHORE WINDS, (WARM OR COLD) AFFECT THE CLIMATE OF COASTAL AREAS. FOR EXAMPLE, COLD ONSHORE CURRENTS BRING COOLNESS TO COASTAL AREAS.
- **RELIEF FEATURES** LIKE HIGH MOUNTAINS (WESTERN GHATS) STOP COLD OR HOT WINDS FROM REACHING A LOCATION. THEY CAN ALSO CAUSE RAIN OR SNOW IF THE REGION IS ON THE WINDWARD SIDE OF THE MOUNTAINS.

FACTORS AFFECTING INDIA'S CLIMATE

- **LATITUDE**
  THE TROPIC OF CANCER (23°3 CV N) DIVIDES THE COUNTRY INTO THE TROPICAL ZONE (SOUTH OF THIS LINE) AND THE SUB-TROPICAL ZONE (NORTH OF THIS LINE). THE LINE RUNS FROM THE RANN OF KUCHCHH (WEST) TO MIZORAM (EAST). ALL THE REMAINING AREA, NORTH OF THE TROPIC, LIES IN THE SUB-TROPICS. INDIA'S CLIMATE, THEREFORE, HAS CHARACTERISTICS OF BOTH TROPICAL AS WELL AS SUB-TROPICAL ZONES.
- **ALTITUDE**
  MOUNTAINS IN THE NORTH OF INDIA HAVE AN AVERAGE ELEVATION OF ABOUT 6000 M, WHEREAS IN THE COASTAL AREAS AS WELL AS ON THE ISLANDS, THE MAXIMUM ELEVATION IS ABOUT 30 M.
- THE INDIAN SUB-CONTINENT EXPERIENCES MILDER WINTERS AS COMPARED TO CENTRAL ASIA BECAUSE OF THE HIMALAYAS WHICH PREVENT THE COLD WINDS FROM ENTERING THE SUB-CONTINENT.
- **PRESSURE AND WINDS**
  THE FOLLOWING ATMOSPHERIC CONDITIONS GOVERN THE CLIMATE AND ASSOCIATED WEATHER CONDITIONS IN INDIA
- PRESSURE AND SURFACE WINDS
- UPPER AIR CIRCULATION
- WESTERN CYCLONIC DISTURBANCES AND TROPICAL CYCLONES
- WINDS FROM HIGH PRESSURE AREAS OF THE SOUTHERN INDIAN OCEAN CROSS THE EQUATOR AND TURN RIGHT TOWARDS LOW PRESSURE AREAS OF THE INDIAN SUB-CONTINENT. THEY GATHER LARGE AMOUNTS OF MOISTURE WHILE MOVING OVER THE WARM OCEAN AND BRING WIDESPREAD RAINFALL OVER THE MAINLAND OF INDIA. THESE WINDS ARE KNOWN AS THE SOUTH-WEST MONSOON WINDS.

FACTORS AFFECTING INDIA'S CLIMATE (2)

- **UPPER AIR CIRCULATION AND WESTERN CYCLONIC DISTURBANCES**
  THE UPPER AIR CIRCULATION OF THE INDIAN SUBCONTINENT IS DOMINATED BY A WESTERLY FLOW, WHICH IS GOVERNED BY THE JET STREAMS. DUE TO THEIR LOCATION, (OVER 27°-30° N LATITUDE), THESE JET STREAMS ARE KNOWN AS SUB-TROPICAL WESTERLY JET STREAMS. THEY BLOW SOUTH OF THE HIMALAYAS THROUGHOUT THE YEAR, EXCEPT IN THE SUMMER.
- **WESTERN CYCLONIC DISTURBANCES AND TROPICAL CYCLONES**
  THE WESTERN CYCLONIC DISTURBANCES ARE WEATHER PHENOMENA OF THE WINTER MONTHS BROUGHT ON BY THE WESTERLY FLOW FROM THE MEDITERRANEAN REGION. THEY USUALLY INFLUENCE THE WEATHER OF THE NORTH AND NORTH-WESTERN REGIONS OF INDIA. TROPICAL CYCLONES OCCUR DURING THE MONSOON AS WELL AS IN OCTOBER-NOVEMBER AND ARE PART OF THE EASTERLY FLOW. THESE DISTURBANCES AFFECT THE COASTAL REGIONS OF THE COUNTRY.
- THE WESTERLY FLOW BRINGS THE WESTERN CYCLONIC DISTURBANCES IN THE NORTH AND NORTH-WESTERN INDIA. IN SUMMER, THE SUB-TROPICAL WESTERLY JET STREAM MOVES NORTH OF THE HIMALAYAS DUE TO APPARENT SHIFTING OF THE SUN. DURING THE SUMMER MONTHS, AN EASTERLY JET STREAM, CALLED SUB-TROPICAL EASTERLY JET STREAM, BLOWS OVER PENINSULAR INDIA (APPROXIMATELY OVER 14° N).

FACTORS AFFECTING INDIA'S CLIMATE (3)

- **THE CORIOLIS FORCE** IS AN APPARENT FORCE THAT OCCURS AS A RESULT OF THE EARTH'S ROTATION. IT DEFLECTS MOVING OBJECTS, LIKE AIR CURRENTS, TO THE RIGHT IN THE NORTHERN HEMISPHERE AND TO THE LEFT IN THE SOUTHERN HEMISPHERE. THIS IS KNOWN AS FERREL'S LAW. THIS LAW STATES THAT A WIND IN ANY DIRECTION TENDS TO DEFLECT TOWARDS THE RIGHT (WEST TO EAST) IN THE NORTHERN HEMISPHERE AND TO THE LEFT IN THE SOUTHERN HEMISPHERE, WITH A FORCE THAT IS DIRECTLY PROPORTIONAL TO THE MASS OF THE WIND IN QUESTION; ITS VELOCITY WOULD BE THE SINE OF THE LATITUDE AND THE ANGULAR VELOCITY OF THE EARTH'S ROTATION.
- **JET STREAMS** ARE A NARROW BELT OF HIGH ALTITUDE (ABOVE 12,000 M) WESTERLY WINDS IN THE TROPOSPHERE. THEIR SPEED VARIES FROM ABOUT 110 KM/H IN SUMMER TO ABOUT 184 KM/H IN WINTER. A NUMBER OF SEPARATE JET STREAMS HAVE BEEN IDENTIFIED. THE MOST CONSTANT ARE THE MID-LATITUDE AND THE SUBTROPICAL JET STREAM.

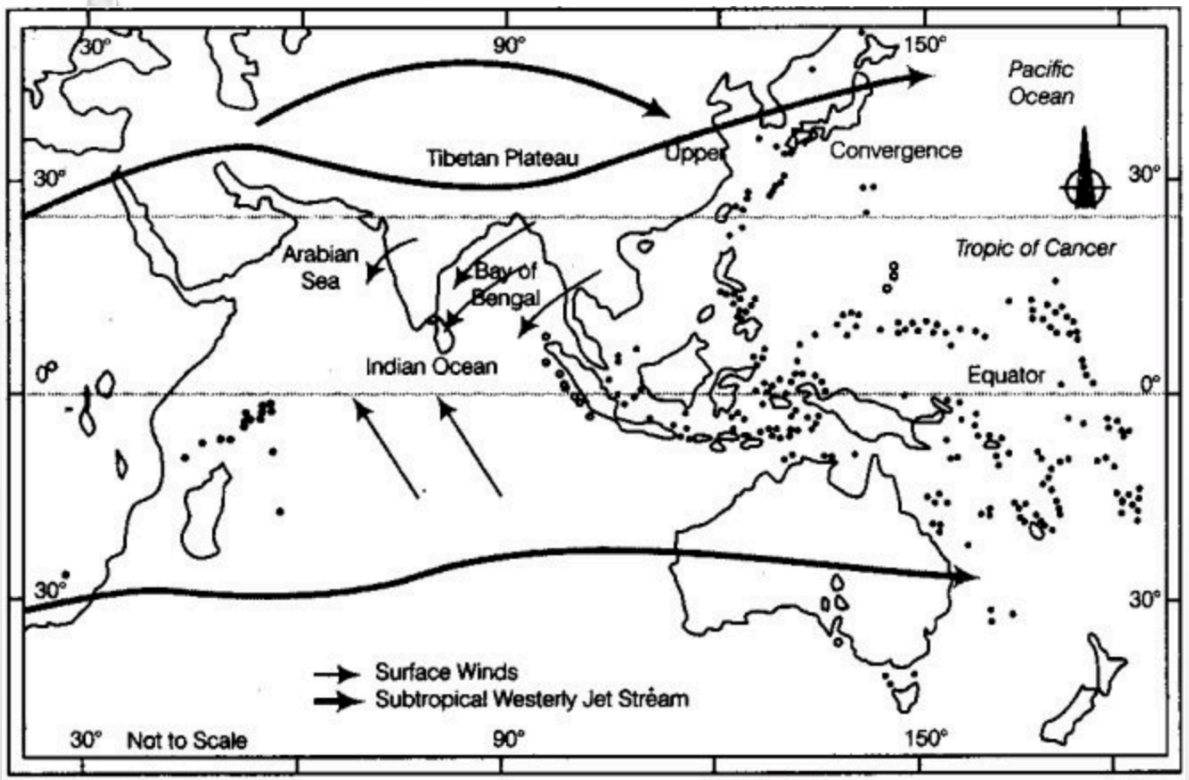
THE INDIAN MONSOON

- **THE INDIAN MONSOON**
  MONSOON WINDS STRONGLY INFLUENCE THE CLIMATE OF INDIA. THE MONSOON WINDS THAT ARE EXPERIENCED IN THE TROPICAL AREA FALL ROUGHLY BETWEEN 20° N AND 20° S.
- **MECHANISM OF MONSOON**
  THE FOLLOWING FACTS ARE IMPORTANT TO UNDERSTAND THE MECHANISM OF THE MONSOONS:
- THE DIFFERENTIAL HEATING AND COOLING OF LAND AND WATER CREATES LOW PRESSURE ON THE LANDMASS OF INDIA WHILE THE SEAS AROUND EXPERIENCE COMPARATIVELY HIGHER PRESSURE.
- THE INTER-TROPICAL CONVERGENCE ZONE (ITCZ) IN SUMMER SEASON SHIFTS ITS POSITION OVER THE GANGA PLAIN. THIS IS THE EQUATORIAL TROUGH NORMALLY POSITIONED ABOUT 5°N OF THE EQUATOR. IT IS ALSO KNOWN AS THE 'MONSOON TROUGH' DURING THE MONSOON SEASON.
- THE PRESENCE OF THE HIGH-PRESSURE AREA, EAST OF MADAGASCAR (APPROXIMATELY 20°S OVER THE INDIAN OCEAN). THE INTENSITY AND POSITION OF THIS HIGH-PRESSURE AREA AFFECT THE INDIAN MONSOON.
- THE TIBETAN PLATEAU GETS INTENSELY HEATED DURING SUMMER, WHICH RESULTS IN STRONG VERTICAL AIR CURRENTS AND THE FORMATION OF LOW PRESSURE OVER THE PLATEAU AT ABOUT 9 KM ABOVE SEA LEVEL.
- THE MOVEMENT OF THE WESTERLY JET STREAM TO THE NORTH OF THE HIMALAYAS AND THE PRESENCE OF THE TROPICAL EASTERLY JET STREAM OVER THE INDIAN PENINSULA DURING SUMMER.
- APART FROM THE GIVEN FACTS, IT HAS BEEN NOTICED THAT CHANGES IN THE PRESSURE CONDITIONS OVER THE SOUTHERN OCEANS ALSO AFFECT THE MONSOONS. NORMALLY, WHEN THE TROPICAL EASTERN SOUTH PACIFIC OCEAN EXPERIENCES HIGH PRESSURE, THE TROPICAL EASTERN INDIAN OCEAN EXPERIENCES LOW PRESSURE.
- BUT IN THE PAST A FEW YEARS, THERE HAS BEEN A REVERSAL IN THE PRESSURE CONDITIONS AND THE EASTERN PACIFIC HAS LOWER PRESSURE IN COMPARISON TO THE EASTERN INDIAN OCEAN. THIS PERIODIC CHANGE IN PRESSURE CONDITIONS IS KNOWN AS THE SOUTHERN OSCILLATION (SO).

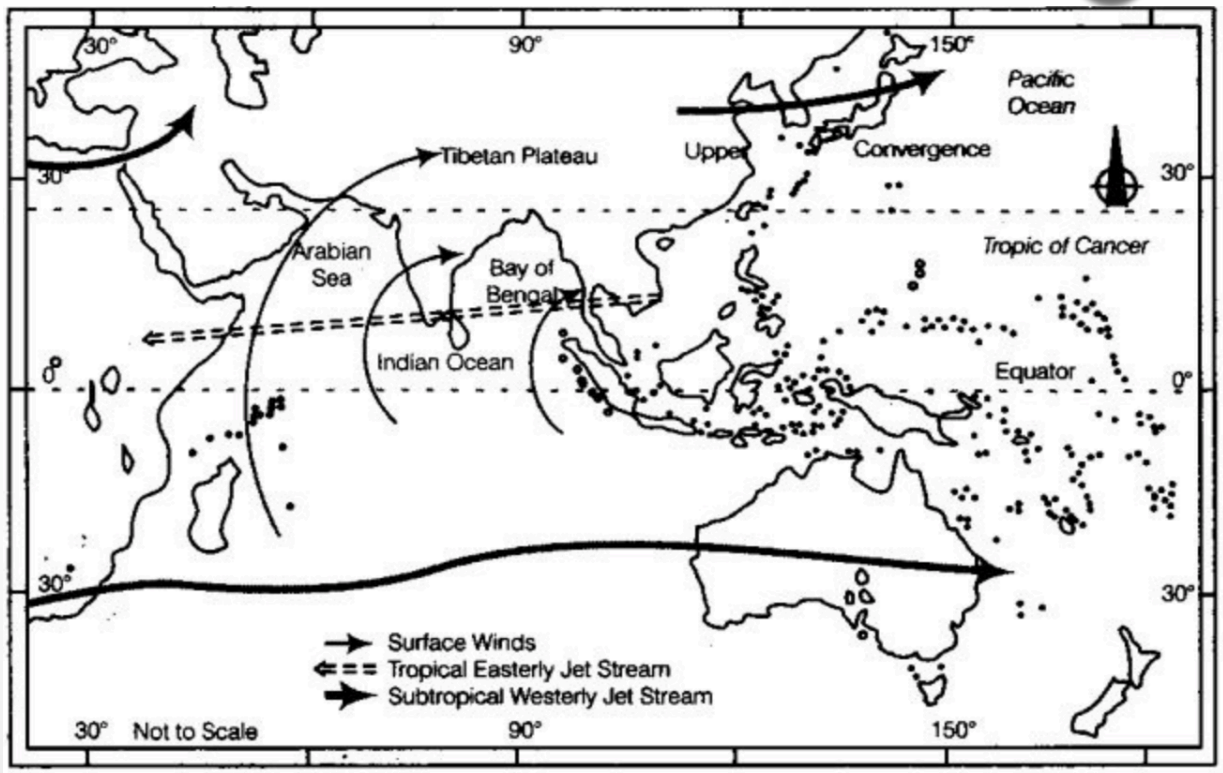
THE INDIAN MONSOON (2)

- **EL NINO SOUTHERN OSCILLATIONS (ENSO)**
  THE DIFFERENCE IN PRESSURE OVER TAHITI (PACIFIC OCEAN, 18°S/149°W) AND DARWIN IN NORTHERN AUSTRALIA (INDIAN OCEAN, 12°30'S/131°E) IS COMPUTED TO PREDICT THE INTENSITY OF THE MONSOONS.
- IF THE PRESSURE DIFFERENCES WERE NEGATIVE, IT WOULD MEAN BELOW AVERAGE AND LATE MONSOONS.
- THE EL NINO PHENOMENON IS A FEATURE CONNECTED WITH THE SOUTHERN OSCILLATION. IN THIS, A WARM OCEAN CURRENT FLOWS PAST THE PERUVIAN COAST, IN PLACE OF THE COLD PERUVIAN CURRENT. IT OCCURS AT AN INTERVAL OF 2 TO 5 YEARS.
- THE CHANGES IN PRESSURE CONDITIONS ARE CONNECTED TO THE EL NINO. HENCE, THE PHENOMENON IS REFERRED TO AS ENSO (EL NINO SOUTHERN OSCILLATIONS).

ATMOSPHERIC CONDITIONS



Atmospheric conditions over the Indian Sub-continent in the month of January



Atmospheric conditions over the Indian Sub-continent in the month of June

HANDOUT FOR CLIMATE MODULE 1
(P1/2)

- CLIMATE IS THE SUM TOTAL OF THE WEATHER CONDITIONS AND VARIATIONS OVER A LARGE AREA OVER A LONG PERIOD OF TIME, GENERALLY MORE THAN 30 YEARS.
- WEATHER IS THE STATE OF THE ATMOSPHERE OVER AN AREA AT ANY POINT OF TIME.
- VARIOUS ELEMENTS OF WEATHER AND CLIMATE ARE: TEMPERATURE, ATMOSPHERIC PRESSURE, WIND, HUMIDITY AND PRECIPITATION.
- INDIA ALONG WITH SOUTH AND SOUTH-EAST ASIA HAS A ***MONSOON*** TYPE OF CLIMATE.
- THE WORD "***MONSOON***" IS DERIVED FROM ARABIC WORD '*MAUSIM*.' IT REFERS TO THE SEASONAL REVERSAL IN THE WIND DIRECTION DURING A YEAR.
- THE ***CLIMATE*** OF ANY REGION ***IS CONTROLLED BY***: LATITUDE, ALTITUDE, PRESSURE AND WIND SYSTEM, DISTANCE FROM THE SEA, OCEAN CURRENTS AND RELIEF FEATURES.
- ***RELIEF FEATURES*** LIKE ***HIGH MOUNTAINS*** CAN BLOCK RAIN-BEARING WINDS, AND HELP IN CAUSING RAINFALL OVER REGIONS ON THE WINDWARD SIDE OF THE MOUNTAINS.
- INDIA'S CLIMATE HAS CHARACTERISTICS OF BOTH TROPICAL AS WELL AS SUB-TROPICAL ZONES, WITH MILDER WINTERS DUE TO THE HIMALAYAS.
- THE ***ATMOSPHERIC CONDITIONS*** WHICH GOVERN THE CLIMATE AND WEATHER CONDITION OF INDIA ARE: PRESSURE AND SURFACE WINDS, UPPER AIR CIRCULATION, WESTERN CYCLONIC DISTURBANCES AND TROPICAL CYCLONE.
- THE ***CORIOLIS FORCE,*** WHICH IS GENERATED BY THE ROTATION OF THE EARTH, IS RESPONSIBLE FOR DEFLECTING WINDS TOWARDS THE RIGHT IN NORTHERN HEMISPHERE, AND TOWARDS THE LEFT IN SOUTHERN HEMISPHERE.
- THE ***SOUTH-WEST MONSOON WINDS*** ARE SOUTH-EAST TRADE WINDS OF THE SOUTHERN HEMISPHERE, WHICH AFTER CROSSING THE EQUATOR, BECOME SOUTH-WESTERN TRADE WINDS (DUE TO RIGHTWARD DEFLECTION BY CORIOLIS FORCE). AS THEY BLOW OVER A WARM OCEAN, THEY CAUSE RAINFALL IN THE INDIAN SUB-CONTINENT.
- ***JET STREAMS*** ARE FAST BLOWING WINDS MOVING IN THE UPPER ATMOSPHERE. THE SUB-TROPICAL WESTERLY JET STREAMS OVER THE INDIAN SUB-CONTINENT ARE LOCATED AT ABOUT 27°-30° NORTH LATITUDE.

HANDOUT FOR CLIMATE MODULE 1
(P2/2)

- SHALLOW CYCLONIC DEPRESSIONS ORIGINATING OVER THE MEDITERRANEAN SEA ARE KNOWN AS ***WESTERN DISTURBANCES***. THEY CAUSE WINTER RAINFALL IN THE NORTH WESTERN PARTS OF INDIA.
- ***THE INTER TROPICAL CONVERGENCE ZONE (ITCZ),*** IS A BROAD TROUGH OF LOW PRESSURE IN THE EQUATORIAL LATITUDE. THIS IS KNOWN AS THE MONSOON TROUGH DURING THE MONSOON SEASON. IN THE ITCZ, THERE IS A CONVERGENCE OF NORTH-EAST AND SOUTH-EAST TRADE WINDS.
- ***SOUTHERN OSCILLATION (SO)*** IS THE PERIODIC CHANGE IN PRESSURE CONDITIONS OVER THE SOUTHERN PACIFIC OCEAN AND THE EASTERN INDIAN OCEAN. NORMALLY, WHEN ONE IS LOW, THE OTHER IS HIGH, AND SOMETIMES THIS CONDITION REVERSES.
- ***EL NINO*** IS A WARM OCEAN CURRENT THAT DEVELOPS ALONG THE PERUVIAN COAST, REPLACING THE COLD PERUVIAN CURRENT AND LEADING TO AN INCREASE IN SURFACE TEMPERATURES AND THE WEAKENING OF TRADE-WINDS IN THE REGION EVERY 2 TO 5 YEARS.
- ***ENSO*** IS THE COMBINATION OF EL NINO AND SOUTHERN OSCILLATION.
- *THE DIFFERENCES IN PRESSURE ARE COMPUTED TO PREDICT THE INTENSITY OF THE MONSOONS AND THEIR ARRIVAL OVER THE INDIAN SUB-CONTINENT.* THE CHANGES IN PRESSURE CONDITIONS ARE CONNECTED TO THE EL NINO, HENCE, THE PHENOMENON IS REFERRED TO AS ENSO

CLIMATE MODULE 1
WORKSHEET 1

1. DESCRIBE HOW LOCATION AND RELIEF AFFECT INDIA'S CLIMATE
2. STATE THE SIX FACTORS OF CLIMATIC CONTROL
3. WHAT ARE THE CHIEF ELEMENTS OF WEATHER AND CLIMATE?
4. WHAT DOES THE TERM 'MONSOON' REFER TO?
5. IN WHICH MONTH DOES THE MONSOON APPROXIMATELY ARRIVE IN INDIA?
6. WHAT IS CLIMATE?
7. WHAT IS WEATHER?
8. WHAT ARE JET STREAMS?
9. WHAT IS "ITCZ"?