GEOGRAPHY

Discovery and exploration

For many thousands of years, humanity, with a few exceptions, did not recognize or understand the concept of the Solar System. Most people up to the Late Middle Ages–Renaissance believed Earth to be stationary at the centre of the universe and categorically different from the divine or ethereal objects that moved through the sky. Although the Greek philosopher Aristarchus of Samos had speculated on a heliocentric reordering of the cosmos, Nicolaus Copernicus was the first to develop a mathematically predictive heliocentric system. In the 17th century, Galileo Galilei, Johannes Kepler, and Isaac Newton developed an understanding of physics that led to the gradual acceptance of the idea that Earth moves around the Sun and that the planets are governed by the same physical laws that governed Earth. The invention of the telescope led to the discovery of further planets and moons. Improvements in the telescope and the use of unmanned spacecraft have enabled the investigation of geological phenomena, such as mountains, craters, seasonal meteorological phenomena, such as clouds, dust storms and ice caps on the other planets.

Structure and composition

The principal component of the Solar System is the Sun, a G2 main-sequence star that contains 99.86% of the system's known mass and dominates it gravitationally. The Sun's four largest orbiting bodies, the giant planets, account for 99% of the remaining mass, with Jupiter and Saturn together comprising more than 90%. The remaining objects of the Solar System (including the four terrestrial planets, the dwarf planets, moons, asteroids, and comets) together comprise less than 0.002% of the Solar System's total mass.

Most large objects in orbit around the Sun lie near the plane of Earth's orbit, known as the ecliptic. The planets are very close to the ecliptic, whereas comets and Kuiper belt objects are frequently at significantly greater angles to it. All the planets and most other objects orbit the Sun in the same direction that the Sun is rotating (counter-clockwise, as viewed from above Earth's north pole). There are exceptions, such as Halley's Comet.

The overall structure of the charted regions of the Solar System consists of the Sun, four relatively small inner planets surrounded by a belt of mostly rocky asteroids, and four giant planets surrounded by the Kuiper belt of mostly icy objects. Astronomers sometimes informally divide this structure into separate regions. The inner Solar System includes the four terrestrial planets and the asteroid belt. The outer Solar System is beyond the asteroids, including the four giant planets. Since the discovery of the Kuiper belt, the outermost parts of the Solar System are considered a distinct region consisting of the objects beyond Neptune.

Most of the planets in the Solar System possess secondary systems of their own, being orbited by planetary objects called natural satellites, or moons (two of which are larger than the planet Mercury), and, in the case of the four giant planets, by planetary rings, thin bands of tiny particles that orbit them in unison. Most of the largest natural satellites are in synchronous rotation, with one face permanently turned toward their parent.

Kepler's laws of planetary motion describe the orbits of objects about the Sun. Following Kepler's laws, each object travels along an ellipse with the Sun at one focus. Objects closer to the Sun (with smaller semi-major axes) travel more quickly because they are more affected by the Sun's gravity. On an elliptical orbit, a body's distance from the Sun varies over the course of its year. A body's closest approach to the Sun is called its perihelion, whereas its most distant point from the Sun is called its aphelion. The orbits of the planets are nearly circular, but many comets, asteroids, and Kuiper belt objects follow highly elliptical orbits. The positions of the bodies in the Solar System can be predicted using numerical models.

Although the Sun dominates the system by mass, it accounts for only about 2% of the angular momentum. The planets, dominated by Jupiter, account for most of the rest of the angular momentum due to the combination of their mass, orbit, and distance from the Sun, with a possibly significant contribution from comets.

The Sun, which comprises nearly all the matter in the Solar System, is composed of roughly 98% hydrogen and helium. Jupiter and Saturn, which comprise nearly all the remaining matter, possess atmospheres composed of roughly 99% of these elements. A composition gradient exists in the Solar System, created by heat and light pressure from the Sun; those objects closer to the Sun, which are more affected by heat and light pressure, are composed of elements with high melting points. Objects farther from the Sun are composed largely of materials with lower melting points. The boundary in the Solar System beyond which those volatile substances could condense is known as the frost line, and it lies at roughly 5 AU from the Sun.

The objects of the inner Solar System are composed mostly of rock, the collective name for compounds with high melting points, such as silicates, iron or nickel, that remained solid under almost all conditions in the protoplanetary nebula. Jupiter and Saturn are composed mainly of gases, the astronomical term for materials with extremely low melting points and high vapour pressure, such as hydrogen, helium, and neon, which were always in the gaseous phase in the nebula. Ices, like water, methane, ammonia, hydrogen sulfide and carbon dioxide, have melting points up to a few hundred kelvins. They can be found as ices, liquids, or gases in various places in the Solar System, whereas in the nebula they were either in the solid or gaseous phase. Icy substances comprise the majority of the satellites of the giant planets, as well as most of Uranus and Neptune (the so-called "ice giants") and the numerous small objects that lie beyond Neptune's orbit. Together, gases and ices are referred to as volatiles.

Distances and scales

The distance from Earth to the Sun is 1 astronomical unit (150,000,000 km), or AU. For comparison, the radius of the Sun is 0.0047 AU (700,000 km). Thus, the Sun occupies 0.00001% (10−5 %) of the volume of a sphere with a radius the size of Earth's orbit, whereas Earth's volume is roughly one millionth (10−6) that of the Sun. Jupiter, the largest planet, is 5.2 astronomical units (780,000,000 km) from the Sun and has a radius of 71,000 km (0.00047 AU), whereas the most distant planet, Neptune, is 30 AU (4.5×109 km) from the Sun.

With a few exceptions, the farther a planet or belt is from the Sun, the larger the distance between its orbit and the orbit of the next nearer object to the Sun. For example, Venus is approximately 0.33 AU farther out from the Sun than Mercury, whereas Saturn is 4.3 AU out from Jupiter, and Neptune lies 10.5 AU out from Uranus. Attempts have been made to determine a relationship between these orbital distances (for example, the Titius–Bode law), but no such theory has been accepted. The images at the beginning of this section show the orbits of the various constituents of the Solar System on different scales.

Some Solar System models attempt to convey the relative scales involved in the Solar System on human terms. Some are small in scale (and may be mechanical—called orreries)—whereas others extend across cities or regional areas. The largest such scale model, the Sweden Solar System, uses the 110-metre (361-ft) Ericsson Globe in Stockholm as its substitute Sun, and, following the scale, Jupiter is a 7.5-metre (25-foot) sphere at Arlanda International Airport, 40 km (25 mi) away, whereas the farthest current object, Sedna, is a 10-cm (4-in) sphere in Luleå, 912 km (567 mi) away.

If the Sun–Neptune distance is scaled to 100 metres, then the Sun would be about 3 cm in diameter (roughly two-thirds the diameter of a golf ball), the giant planets would be all smaller than about 3 mm, and Earth's diameter along with the that of the other terrestrial planets would be smaller than a flea (0.3 mm) at this scale.

Formation and evolution

The Solar System formed 4.568 billion years ago from the gravitational collapse of a region within a large molecular cloud. This initial cloud was likely several light-years across and probably birthed several stars. As is typical of molecular clouds, this one consisted mostly of hydrogen, with some helium, and small amounts of heavier elements fused by previous generations of stars. As the region that would become the Solar System, known as the pre-solar nebula, collapsed, conservation of angular momentum caused it to rotate faster. The centre, where most of the mass collected, became increasingly hotter than the surrounding disc. As the contracting nebula rotated faster, it began to flatten into a protoplanetary disc with a diameter of roughly 200 AU and a hot, dense protostar at the centre. The planets formed by accretion from this disc, in which dust and gas gravitationally attracted each other, coalescing to form ever larger bodies. Hundreds of protoplanets may have existed in the early Solar System, but they either merged or were destroyed, leaving the planets, dwarf planets, and leftover minor bodies.

Due to their higher boiling points, only metals and silicates could exist in solid form in the warm inner Solar System close to the Sun, and these would eventually form the rocky planets of Mercury, Venus, Earth, and Mars. Because metallic elements only comprised a very small fraction of the solar nebula, the terrestrial planets could not grow very large. The giant planets (Jupiter, Saturn, Uranus, and Neptune) formed further out, beyond the frost line, the point between the orbits of Mars and Jupiter where material is cool enough for volatile icy compounds to remain solid. The ices that formed these planets were more plentiful than the metals and silicates that formed the terrestrial inner planets, allowing them to grow massive enough to capture large atmospheres of hydrogen and helium, the lightest and most abundant elements. Leftover debris that never became planets congregated in regions such as the asteroid belt, Kuiper belt, and Oort cloud. The Nice model is an explanation for the creation of these regions and how the outer planets could have formed in different positions and migrated to their current orbits through various gravitational interactions.

Within 50 million years, the pressure and density of hydrogen in the centre of the protostar became great enough for it to begin thermonuclear fusion. The temperature, reaction rate, pressure, and density increased until hydrostatic equilibrium was achieved: the thermal pressure equalled the force of gravity. At this point, the Sun became a main-sequence star. The main-sequence phase, from beginning to end, will last about 10 billion years for the Sun compared to around two billion years for all other phases of the Sun's pre-remnant life combined. Solar wind from the Sun created the heliosphere and swept away the remaining gas and dust from the protoplanetary disc into interstellar space, ending the planetary formation process. The Sun is growing brighter; early in its main-sequence life its brightness was 70% that of what it is today.

The Solar System will remain roughly as we know it today until the hydrogen in the core of the Sun has been entirely converted to helium, which will occur roughly 5 billion years from now. This will mark the end of the Sun's main-sequence life. At this time, the core of the Sun will collapse, and the energy output will be much greater than at present. The outer layers of the Sun will expand to roughly 260 times its current diameter, and the Sun will become a red giant. Because of its vastly increased surface area, the surface of the Sun will be considerably cooler (2,600 K at its coolest) than it is on the main sequence. The expanding Sun is expected to vaporize Mercury and Venus and render Earth uninhabitable as the habitable zone moves out to the orbit of Mars. Eventually, the core will be hot enough for helium fusion; the Sun will burn helium for a fraction of the time it burned hydrogen in the core. The Sun is not massive enough to commence the fusion of heavier elements, and nuclear reactions in the core will dwindle. Its outer layers will move away into space, leaving a white dwarf, an extraordinarily dense object, half the original mass of the Sun but only the size of Earth. The ejected outer layers will form what is known as a planetary nebula, returning some of the material that formed the Sun—but now enriched with heavier elements like carbon—to the interstellar medium.

Sun

The Sun is the Solar System's star and by far its most massive component. Its large mass (332,900 Earth masses) produces temperatures and densities in its core high enough to sustain nuclear fusion of hydrogen into helium, making it a main-sequence star. This releases an enormous amount of energy, mostly radiated into space as electromagnetic radiation peaking in visible light.

The Sun is a G2-type main-sequence star. Hotter main-sequence stars are more luminous. The Sun's temperature is intermediate between that of the hottest stars and that of the coolest stars. Stars brighter and hotter than the Sun are rare, whereas substantially dimmer and cooler stars, known as red dwarfs, make up 85% of the stars in the Milky Way.

The Sun is a population I star; it has a higher abundance of elements heavier than hydrogen and helium ("metals" in astronomical parlance) than the older population II stars. Elements heavier than hydrogen and helium were formed in the cores of ancient and exploding stars, so the first generation of stars had to die before the Universe could be enriched with these atoms. The oldest stars contain few metals, whereas stars born later have more. This high metallicity is thought to have been crucial to the Sun's development of a planetary system because the planets form from the accretion of "metals".

Interplanetary medium

The vast majority of the Solar System consists of a near-vacuum known as the interplanetary medium. Along with light, the Sun radiates a continuous stream of charged particles (a plasma) known as the solar wind. This stream of particles spreads outwards at roughly 1.5 million kilometres per hour, creating a tenuous atmosphere that permeates the interplanetary medium out to at least 100 AU (see § Heliosphere). Activity on the Sun's surface, such as solar flares and coronal mass ejections, disturb the heliosphere, creating space weather and causing geomagnetic storms. The largest structure within the heliosphere is the heliospheric current sheet, a spiral form created by the actions of the Sun's rotating magnetic field on the interplanetary medium.

Earth's magnetic field stops its atmosphere from being stripped away by the solar wind. Venus and Mars do not have magnetic fields, and as a result the solar wind is causing their atmospheres to gradually bleed away into space. Coronal mass ejections and similar events blow a magnetic field and huge quantities of material from the surface of the Sun. The interaction of this magnetic field and material with Earth's magnetic field funnels charged particles into Earth's upper atmosphere, where its interactions create aurorae seen near the magnetic poles.

The heliosphere and planetary magnetic fields (for those planets that have them) partially shield the Solar System from high-energy interstellar particles called cosmic rays. The density of cosmic rays in the interstellar medium and the strength of the Sun's magnetic field change on very long timescales, so the level of cosmic-ray penetration in the Solar System varies, though by how much is unknown.

The interplanetary medium is home to at least two disc-like regions of cosmic dust. The first, the zodiacal dust cloud, lies in the inner Solar System and causes the zodiacal light. It was likely formed by collisions within the asteroid belt brought on by gravitational interactions with the planets. The second dust cloud extends from about 10 AU to about 40 AU, and was probably created by similar collisions within the Kuiper belt.

Inner Solar System

The inner Solar System is the region comprising the terrestrial planets and the asteroid belt. Composed mainly of silicates and metals, the objects of the inner Solar System are relatively close to the Sun; the radius of this entire region is less than the distance between the orbits of Jupiter and Saturn. This region is also within the frost line, which is a little less than 5 AU (about 700 million km) from the Sun.

Inner planets

The four terrestrial or inner planets have dense, rocky compositions, few or no moons, and no ring systems. They are composed largely of refractory minerals, such as the silicates, which form their crusts and mantles, and metals, such as iron and nickel, which form their cores. Three of the four inner planets (Venus, Earth and Mars) have atmospheres substantial enough to generate weather; all have impact craters and tectonic surface features, such as rift valleys and volcanoes. The term inner planet should not be confused with inferior planet, which designates those planets that are closer to the Sun than Earth is (i.e. Mercury and Venus).

Mercury

Mercury (0.4 AU from the Sun) is the closest planet to the Sun and the smallest planet in the Solar System (0.055 Earth masses). Mercury has no natural satellites; besides impact craters, its only known geological features are lobed ridges or rupes that were probably produced by a period of contraction early in its history. Mercury's very tenuous atmosphere consists of atoms blasted off its surface by the solar wind. Its relatively large iron core and thin mantle have not yet been adequately explained. Hypotheses include that its outer layers were stripped off by a giant impact; or, that it was prevented from fully accreting by the young Sun's energy.

Venus

Venus (0.7 AU from the Sun) is close in size to Earth (0.815 Earth masses) and, like Earth, has a thick silicate mantle around an iron core, a substantial atmosphere, and evidence of internal geological activity. It is much drier than Earth, and its atmosphere is ninety times as dense. Venus has no natural satellites. It is the hottest planet, with surface temperatures over 400 °C (752°F), most likely due to the amount of greenhouse gases in the atmosphere. No definitive evidence of current geological activity has been detected on Venus, but it has no magnetic field that would prevent depletion of its substantial atmosphere, which suggests that its atmosphere is being replenished by volcanic eruptions.

Earth

Earth (1 AU from the Sun) is the largest and densest of the inner planets, the only one known to have current geological activity, and the only place where life is known to exist. Its liquid hydrosphere is unique among the terrestrial planets, and it is the only planet where plate tectonics has been observed. Earth's atmosphere is radically different from those of the other planets, having been altered by the presence of life to contain 21% free oxygen. It has one natural satellite, the Moon, the only large satellite of a terrestrial planet in the Solar System.

Chronology

Formation

The earliest material found in the Solar System is dated to 7000456720000000000004.5672±0.0006 billion years ago (Gya). By 7000454000000000000004.54±0.04 Gya the primordial Earth had formed. The formation and evolution of the Solar System bodies occurred along with those of the Sun. In theory, a solar nebula partitions a volume out of a molecular cloud by gravitational collapse, which begins to spin and flatten into a circumstellar disk, and then the planets grow out of that along with the Sun. A nebula contains gas, ice grains, and dust (including primordial nuclides). In nebular theory, planetesimals form by accretion. The assembly of the primordial Earth proceeded for 10–70146311520000000000020 Ma.

The process that led to the formation of the Moon approximately 4.53 billion years ago is the subject of ongoing research. The working hypothesis is that it formed by accretion from material loosed from Earth after a Mars-sized object, named Theia, impacted with Earth. In this scenario, the mass of Theia was 10% of that of Earth, it impacted Earth with a glancing blow, and some of its mass merged with Earth. Between approximately 4.1 and 7000380000000000000003.8 Gya, numerous asteroid impacts during the Late Heavy Bombardment caused significant changes to the greater surface environment of the Moon, and by inference, to Earth.

Geological history

Earth's atmosphere and oceans formed by volcanic activity and outgassing that included water vapor. The origin of the world's oceans was condensation augmented by water and ice delivered by asteroids, protoplanets, and comets. In this model, atmospheric "greenhouse gases" kept the oceans from freezing when the newly forming

Sun had only 70% of its current luminosity. By 7000350000000000003.5 Gya, Earth's magnetic field was established, which helped prevent the atmosphere from being stripped away by the solar wind. A crust formed when the molten outer layer of Earth cooled to form a solid as the accumulated water vapor began to act in the atmosphere. The two models that explain land mass propose either a steady growth to the present-day forms or, more likely, a rapid growth early in Earth history followed by a long-term steady continental area. Continents formed by plate tectonics, a process ultimately driven by the continuous loss of heat from Earth's interior. On time scales lasting hundreds of millions of years, the supercontinents have formed and broken up three times. Roughly 7016236682000000000750 mya (million years ago), one of the earliest known supercontinents, Rodinia, began to break apart. The continents later recombined to form Pannotia, 600–7016170411040000000540 mya, then finally Pangaea, which also broke apart 7015568036800000000180 mya.

The present pattern of ice ages began about 701512623040000000040 mya and then intensified during the Pleistocene about 70139467280000000003 mya. High-latitude regions have since undergone repeated cycles of glaciation and thaw, repeating every 40–7012315576000000000100000 years. The last continental glaciation ended 10,000 years ago.

Evolution of life

Highly energetic chemical reactions are thought to have produced self–replicating molecules around four billion years ago. This was followed a half billion years later by the last common ancestor of all life. The development of photosynthesis allowed the Sun's energy to be harvested directly by life forms; the resultant molecular oxygen (O2) accumulated in the atmosphere and due to interaction with ultraviolet solar radiation, formed a protective ozone layer (O3) in the upper atmosphere. The incorporation of smaller cells within larger ones resulted in the development of complex cells called eukaryotes. True multicellular organisms formed as cells within colonies became increasingly specialized. Aided by the absorption of harmful ultraviolet radiation by the ozone layer, life colonized Earth's surface. The earliest fossil evidence for life is microbial mat fossils found in 3.48 billion-year-old sandstone in Western Australia, biogenic graphite found in 3.7 billion-year-old metasedimentary rocks in Western Greenland, as well as, remains of biotic material found in 4.1 billion-year-old rocks in Western Australia.

Since the 1960s, it has been hypothesized that severe glacial action between 750 and 7016183034080000000580 mya, during the Neoproterozoic, covered much of Earth in ice. This hypothesis has been termed "Snowball Earth", and it is of particular interest because it preceded the Cambrian explosion, when multicellular life forms began to proliferate. Following the Cambrian explosion, about 7016168833160000000535 mya, there have been five major mass extinctions. The most recent such event was 701520828016000000066 mya, when an asteroid impact triggered the extinction of the non-avian dinosaurs and other large reptiles, but spared some small animals such as mammals, which then resembled shrews. Over the past

7015208280160000000066 Ma, mammalian life has diversified, and several million years ago an African ape-like animal such as Orrorin tugenensis gained the ability to stand upright. This facilitated tool use and encouraged communication that provided the nutrition and stimulation needed for a larger brain, which allowed the evolution of the human race. The development of agriculture, and then civilization, led to humans having an influence on Earth and the nature and quantity of other life forms as no other species ever has.

Predicted future

Estimates on how much longer Earth will be able to continue to support life range from 500 million years (Myr), to as long as 2.3 billion years (Ga). Earth's long-term future is closely tied to that of the Sun. As a result of the steady accumulation of helium at the Sun's core, the Sun's total luminosity will slowly increase. The luminosity of the Sun will grow by 10% over the next 7016347133600000001.1 Ga and by 40% over the next 7017110451600000003.5 Ga. Climate models indicate that the rise in radiation reaching Earth is likely to have dire consequences, including the loss of the oceans.

Earth's increasing surface temperature will accelerate the inorganic CO_2 cycle, reducing its concentration to levels lethally low for plants (6995099999999999910 ppm for C4 photosynthesis) in approximately 500–7016284018400000000900 Ma. The lack of vegetation will result in the loss of oxygen in the atmosphere, so animal life will become extinct within several million more years. After another billion years all surface water will have disappeared and the mean global temperature will reach 7002343150000000000070 °C (7002343150000000000158 °F). Earth is expected to be effectively habitable for about another 7016157788000000000500 Ma from that point, although this may be extended up to 7016725824800000002.3 Ga if the nitrogen is removed from the atmosphere. Even if the Sun were eternal and stable, 27% of the water in the modern oceans will descend to the mantle in one billion years, due to reduced steam venting from mid-ocean ridges.

The Sun will evolve to become a red giant in about 7017157788000000005 Ga. Models predict that the Sun will expand to roughly 1 AU (150,000,000 km), which is about 250 times its present radius. Earth's fate is less clear. As a red giant, the Sun will lose roughly 30% of its mass, so, without tidal effects, Earth will move to an orbit 1.7 AU (250,000,000 km) from the Sun when it reaches its maximum radius. Earth was, therefore, once expected to escape envelopment by the expanded Sun's outer atmosphere, though most, if not all, remaining life would have been destroyed by the Sun's increased luminosity (peaking at about 5,000 times its present level). A 2008 simulation indicates that Earth's orbit will decay due to tidal effects and drag, causing it to enter the red giant Sun's atmosphere and be vaporized.

Name and etymology

The modern English word Earth developed from a wide variety of Middle English forms, which derived from an Old English noun most often spelled eorðe. It has cognates in every Germanic language, and their proto-Germanic root has been reconstructed as *erþō. In its earliest appearances, eorðe was already being used to translate the many senses of Latin terra and Greek γῆ (gē): the ground, its soil, dry land, the human world, the surface of the world (including the sea), and the globe itself. As with Terra and Gaia, Earth was a personified goddess in Germanic paganism: the Angles were listed by Tacitus as among the devotees of Nerthus, and later Norse mythology included Jörð, a giantess often given as the mother of Thor.

Originally, earth was written in lowercase, and from early Middle English, its definite sense as "the globe" was expressed as the earth. By early Modern English, many nouns were capitalized, and the earth became (and often remained) the Earth, particularly when referenced along with other heavenly bodies. More recently, the name is sometimes simply given as Earth, by analogy with the names of the other planets. House styles now vary: Oxford spelling recognizes the lowercase form as the most common, with the capitalized form an acceptable variant. Another convention capitalizes "Earth" when appearing as a name (e.g. "Earth's atmosphere") but writes it in lowercase when preceded by the (e.g. "the atmosphere of the earth"). It almost always appears in lowercase in colloquial expressions such as "what on earth are you doing?"

Composition and structure

Shape

The shape of Earth approximates an oblate spheroid, a sphere flattened along the axis from pole to pole such that there is a bulge around the equator. This bulge results from the rotation of Earth, and causes the diameter at the equator to be 43 kilometres (27 mi) larger than the pole-to-pole diameter. Thus the point on the surface farthest from Earth's center of mass is the summit of the equatorial Chimborazo volcano in Ecuador. The average diameter of the reference spheroid is about 12,742 kilometres (7,918 mi), which is approximately (40,000 km)/π, because the meter was originally defined as 1/10,000,000 of the distance from the equator to the North Pole through Paris, France.

Local topography deviates from this idealized spheroid, although on a global scale these deviations are small compared to Earth's radius: The maximum deviation of only 0.17% is at the Mariana Trench (10,911 metres (35,797 ft) below local sea level), whereas Mount Everest (8,848 metres (29,029 ft) above local sea level) represents a deviation of 0.14%. If Earth were shrunk to the size of a billiard ball, some areas of Earth such as large mountain ranges and oceanic trenches would feel like tiny imperfections, whereas much of the planet, including the Great Plains and the abyssal plains, would feel smoother.

Chemical composition

Earth's mass is approximately 70245970000000000005.97×1024 kg (5,970 Yg). It is composed mostly of iron (32.1%), oxygen (30.1%), silicon (15.1%), magnesium (13.9%), sulfur (2.9%), nickel (1.8%), calcium (1.5%), and aluminium (1.4%), with the remaining 1.2% consisting of trace amounts of other elements. Due to mass segregation, the core region is estimated to be primarily composed of iron (88.8%), with smaller amounts of nickel (5.8%), sulfur (4.5%), and less than 1% trace elements.

The geochemist F. W. Clarke calculated that a little more than 47% of Earth's crust consists of oxygen. The more common rock constituents of the crust are nearly all oxides: chlorine, sulfur and fluorine are the important exceptions to this and their total amount in any rock is usually much less than 1%. The principal oxides are silica, alumina, iron oxides, lime, magnesia, potash and soda. The silica functions principally as an acid, forming silicates, and all the most common minerals of igneous rocks are of this nature. From a computation based on 1,672 analyses of all kinds of rocks, Clarke deduced that 99.22% was composed of 11 oxides (see the table at right), with the other constituents occurring in minute quantities.

Internal structure

Earth's interior, like that of the other terrestrial planets, is divided into layers by their chemical or physical (rheological) properties, but unlike the other terrestrial planets, it has a distinct outer and inner core. The outer layer is a chemically distinct silicate solid crust, which is underlain by a highly viscous solid mantle. The crust is separated from the mantle by the Mohorovičić discontinuity, and the thickness of the crust varies: averaging 70036000000000000006 km (kilometers) under the oceans and 30–50 km on the continents. The crust and the cold, rigid, top of the upper mantle are collectively known as the lithosphere, and it is of the lithosphere that the tectonic plates are composed. Beneath the lithosphere is the asthenosphere, a relatively low-viscosity layer on which the lithosphere rides. Important changes in crystal structure within the mantle occur at 410 and 700566000000000000660 km below the surface, spanning a transition zone that separates the upper and lower mantle. Beneath the mantle, an extremely low viscosity liquid outer core lies above a solid inner core. The inner core may rotate at a slightly higher angular velocity than the remainder of the planet, advancing by 0.1–0.5° per year. The radius of the inner core is about one fifth of Earth's.

Heat

Earth's internal heat comes from a combination of residual heat from planetary accretion (about 20%) and heat produced through radioactive decay (80%). The major heat-producing isotopes within Earth are potassium-40, uranium-238, uranium-235, and thorium-232. At the center, the temperature may be up to 6,000 °C (10,830 °F), and the pressure could reach 360 GPa. Because much of the heat is provided by radioactive decay, scientists postulate that early in Earth's history, before isotopes with short half-lives had been depleted, Earth's heat production would have been much higher. This extra heat production, twice present-day at approximately 7016946728000000003 Ga, would have increased temperature gradients with radius, increasing the rates of mantle convection and plate tectonics, and allowing the production of uncommon igneous rocks such as komatiites that are rarely formed today.

The mean heat loss from Earth is 87 mW m−2, for a global heat loss of 4.42 × 1013 W. A portion of the core's thermal energy is transported toward the crust by mantle plumes; a form of convection consisting of upwellings of higher-temperature rock. These plumes can produce hotspots and flood basalts. More of the heat in Earth is lost through plate tectonics, by mantle upwelling associated with mid-ocean ridges. The final major mode of heat loss is through conduction through the lithosphere, the majority of which occurs under the oceans because the crust there is much thinner than that of the continents.

Tectonic plates

The mechanically rigid outer layer of Earth, the lithosphere, is broken into pieces called tectonic plates. These plates are rigid segments that move in relation to one another at one of three types of plate boundaries: convergent boundaries, at which two plates come together, divergent boundaries, at which two plates are pulled apart, and transform boundaries, in which two plates slide past one another laterally. Earthquakes, volcanic activity, mountain-building, and oceanic trench formation can occur along these plate boundaries. The tectonic plates ride on top of the asthenosphere, the solid but less-viscous part of the upper mantle that can flow and move along with the plates.

As the tectonic plates migrate, the ocean floor is subducted under the leading edges of the plates at convergent boundaries. At the same time, the upwelling of mantle material at divergent boundaries creates mid-ocean ridges. The combination of these processes continually recycles the oceanic crust back into the mantle. Due to this recycling, most of the ocean floor is less than 7015315576000000000100 Ma old in age. The oldest oceanic crust is located in the Western Pacific, and has an estimated age of about 7015631152000000000200 Ma. By comparison, the oldest dated continental crust is 70171271771280000004030 Ma.

The seven major plates are the Pacific, North American, Eurasian, African, Antarctic, Indo-Australian, and South American. Other notable plates include the Arabian Plate, the Caribbean Plate, the Nazca Plate off the west coast of South America and the Scotia Plate in the southern Atlantic Ocean. The Australian Plate fused with the Indian Plate between 50 and 7015173566800000000055 mya. The fastest-moving plates are the oceanic plates, with the Cocos Plate advancing at a rate of 75 mm/year and the Pacific Plate moving 52–69 mm/year. At the other extreme, the slowest-moving plate is the Eurasian Plate, progressing at a typical rate of about 21 mm/year.

Surface

Earth's terrain varies greatly from place to place. About 70.8% of the surface is covered by water, with much of the continental shelf below sea level. This equates to 7008361132000000000361.132 million km2 (139.43 million sq mi). The submerged surface has mountainous features, including a globe-spanning mid-ocean ridge system, as well as undersea volcanoes, oceanic trenches, submarine canyons, oceanic plateaus and abyssal plains. The remaining 29.2% (7008148940000000000148.94 million km2, or 57.51 million sq mi) not covered by water consists of mountains, deserts, plains, plateaus, and other landforms.

The Earth's surface undergoes reshaping over geological time periods due to tectonics and erosion. The surface features built up or deformed through plate tectonics are subject to steady weathering and erosion from precipitation, thermal cycles, and chemical effects. Glaciation, coastal erosion, the build-up of coral reefs, and large meteorite impacts also act to reshape the landscape.

The continental crust consists of lower density material such as the igneous rocks granite and andesite. Less common is basalt, a denser volcanic rock that is the primary constituent of the ocean floors. Sedimentary rock is formed from the accumulation of sediment that becomes buried and compacted together. Nearly 75% of the continental surfaces are covered by sedimentary rocks, although they form about 5% of the crust. The third form of rock material found on Earth is metamorphic rock, which is created from the transformation of pre-existing rock types through high pressures, high temperatures, or both. The most abundant silicate minerals on Earth's surface include quartz, feldspars, amphibole, mica, pyroxene and olivine. Common carbonate minerals include calcite (found in limestone) and dolomite.

The pedosphere is the outermost layer of Earth's continental surface and is composed of soil and subject to soil formation processes. The total arable land is 10.9% of the land surface, with 1.3% being permanent cropland. Close to 40% of Earth's land surface is used for cropland and pasture, or an estimated 1.3×107 km2 of cropland and 3.4×107 km2 of pastureland.

The elevation of the land surface varies from the low point of −418 m at the Dead Sea, to a 2005-estimated maximum altitude of 8,848 m at the top of Mount Everest. The mean height of land above sea level is 840 m.

Besides being described in terms of Northern and Southern hemispheres centered on the poles, Earth is also often described in terms of Eastern and Western hemispheres. Earth's surface is traditionally divided into seven continents and various seas.

Hydrosphere

The abundance of water on Earth's surface is a unique feature that distinguishes the "Blue Planet" from other planets in the Solar System. Earth's hydrosphere consists chiefly of the oceans, but technically includes all water surfaces in the world, including inland seas, lakes, rivers, and underground waters down to a depth of 2,000 m. The deepest underwater location is Challenger Deep of the Mariana Trench in the Pacific Ocean with a depth of 10,911.4 m.

The mass of the oceans is approximately 1.35×1018 metric tons, or about 1/4400 of Earth's total mass. The oceans cover an area of 7014361800000000000003.618×108 km2 with a mean depth of 7003368200000000000003682 m, resulting in an estimated volume of 7018133200000000000001.332×109 km3. If all of Earth's crustal surface was at the same elevation as a smooth sphere, the depth of the resulting world ocean would be 2.7 to 2.8 km.

About 97.5% of the water is saline; the remaining 2.5% is fresh water. Most fresh water, about 68.7%, is present as ice in ice caps and glaciers.

The average salinity of Earth's oceans is about 35 grams of salt per kilogram of sea water (3.5% salt). Most of this salt was released from volcanic activity or extracted from cool igneous rocks. The oceans are also a reservoir of dissolved atmospheric gases, which are essential for the survival of many aquatic life forms. Sea water has an important influence on the world's climate, with the oceans acting as a large heat reservoir. Shifts in the oceanic temperature distribution can cause significant weather shifts, such as the El Niño-Southern Oscillation.

Atmosphere

The atmospheric pressure on Earth's surface averages 101.325 kPa, with a scale height of about 8.5 km. It has a composition of 78% nitrogen and 21% oxygen, with trace amounts of water vapor, carbon dioxide and other gaseous molecules. The height of the troposphere varies with latitude, ranging between 8 km at the poles to 17 km at the equator, with some variation resulting from weather and seasonal factors.

Earth's biosphere has significantly altered its atmosphere. Oxygenic photosynthesis evolved 7000270000000000000002.7 Gya, forming the primarily nitrogen–oxygen atmosphere of today. This change enabled the proliferation of aerobic organisms and, indirectly, the formation of the ozone layer due to the subsequent conversion of atmospheric O2 into O3. The ozone layer blocks ultraviolet solar radiation, permitting life on land. Other atmospheric functions important to life include transporting water vapor, providing useful gases, causing small meteors to burn up before they strike the surface, and moderating temperature. This last phenomenon is known as the greenhouse effect: trace molecules within the atmosphere serve to capture thermal energy emitted from the ground, thereby raising the average temperature. Water vapor, carbon dioxide, methane and ozone are the primary greenhouse gases in the atmosphere. Without this heat-retention effect, the average surface temperature would be −18 °C, in contrast to the current +15 °C, and life would likely not exist.

Weather and climate

Earth's atmosphere has no definite boundary, slowly becoming thinner and fading into outer space. Three-quarters of the atmosphere's mass is contained within the first 11 km of the surface. This lowest layer is called the troposphere. Energy from the Sun heats this layer, and the surface below, causing expansion of the air. This lower-density air then rises, and is replaced by cooler, higher-density air. The result is atmospheric circulation that drives the weather and climate through redistribution of thermal energy.

The primary atmospheric circulation bands consist of the trade winds in the equatorial region below 30° latitude and the westerlies in the mid-latitudes between 30° and 60°. Ocean currents are also important factors in determining climate, particularly the thermohaline circulation that distributes thermal energy from the equatorial oceans to the polar regions.

Water vapor generated through surface evaporation is transported by circulatory patterns in the atmosphere. When atmospheric conditions permit an uplift of warm, humid air, this water condenses and falls to the surface as precipitation. Most of the water is then transported to lower elevations by river systems and usually returned to the oceans or deposited into lakes. This water cycle is a vital mechanism for supporting life on land, and is a primary factor in the erosion of surface features over geological periods. Precipitation patterns vary widely, ranging from several meters of water per year to less than a millimeter. Atmospheric circulation, topographic features and temperature differences determine the average precipitation that falls in each region.

The amount of solar energy reaching Earth's surface decreases with increasing latitude. At higher latitudes the sunlight reaches the surface at lower angles and it must pass through thicker columns of the atmosphere. As a result, the mean annual air temperature at sea level decreases by about 0.4 °C (0.7 °F) per degree of latitude from the equator. Earth's surface can be subdivided into specific latitudinal belts of approximately homogeneous climate. Ranging from the equator to the polar regions, these are the tropical (or equatorial), subtropical, temperate and polar climates. Climate can also be classified based on the temperature and precipitation, with the climate regions characterized by fairly uniform air masses. The commonly used Köppen climate classification system (as modified by Wladimir Köppen's student Rudolph Geiger) has five broad groups (humid tropics, arid, humid middle latitudes, continental and cold polar), which are further divided into more specific subtypes.

Climate on Earth has latitudinal anomalies, namely the habitability of the Scandinavian peninsula very far north in sharp contrast to the polar climates of northern

Canada as well as the cool summers expected at low latitudes in the Southern Hemisphere (for example on the west coast of South America). Another anomaly is the impact of landmass on temperature, manifested by the fact that Earth is much warmer at aphelion, where the planet is at a more distant position from the Sun. When the Northern hemisphere is turned towards the sunlight even the increased distance to it does not hinder temperatures to be 2.3 °C (4 °F) warmer than at perihelion—when the marine southern hemisphere is turned towards the Sun.

At high latitudes, the western sides of continents tend to be milder than the eastern sides—for example seen in North America and Western Europe where rough continental climates appear on the east coast on parallels with mild climates on the other side of the ocean.

The highest air temperature ever measured on Earth was 56.7 °C (134.1 °F) in Furnace Creek, California, in Death Valley, in 1913. The lowest air temperature ever directly measured on Earth was −89.2 °C (−128.6 °F) at Vostok Station in 1983, but satellites have used remote sensing to measure temperatures as low as −94.7 °C (−138.5 °F) in East Antarctica. These temperature records are only measurements made with modern instruments from the 20th century onwards and likely do not reflect the full range of temperature on Earth.

Upper atmosphere

Above the troposphere, the atmosphere is usually divided into the stratosphere, mesosphere, and thermosphere. Each layer has a different lapse rate, defining the rate of change in temperature with height. Beyond these, the exosphere thins out into the magnetosphere, where the geomagnetic fields interact with the solar wind. Within the stratosphere is the ozone layer, a component that partially shields the surface from ultraviolet light and thus is important for life on Earth. The Kármán line, defined as 100 km above Earth's surface, is a working definition for the boundary between the atmosphere and outer space.

Thermal energy causes some of the molecules at the outer edge of the atmosphere to increase their velocity to the point where they can escape from Earth's gravity. This causes a slow but steady leakage of the atmosphere into space. Because unfixed hydrogen has a low molecular mass, it can achieve escape velocity more readily and it leaks into outer space at a greater rate than other gases. The leakage of hydrogen into space contributes to the shifting of Earth's atmosphere and surface from an initially reducing state to its current oxidizing one. Photosynthesis provided a source of free oxygen, but the loss of reducing agents such as hydrogen is thought to have been a necessary precondition for the widespread accumulation of oxygen in the atmosphere. Hence the ability of hydrogen to escape from the atmosphere may have influenced the nature of life that developed on Earth. In the current, oxygen-rich atmosphere most hydrogen is converted into water before it has an opportunity to escape. Instead, most of the hydrogen loss comes from the destruction of methane in the upper atmosphere.

Magnetic field

The main part of Earth's magnetic field is generated in the core, the site of a dynamo process that converts kinetic energy of fluid convective motion into electrical and magnetic field energy. The field extends outwards from the core, through the mantle, and up to Earth's surface, where it is, to rough approximation, a dipole. The poles of the dipole are located close to Earth's geographic poles. At the equator of the magnetic field, the magnetic-field strength at the surface is 3.05 × 10−5 T, with global magnetic dipole moment of 7.91 × 1015 T m3. The convection movements in the core are chaotic; the magnetic poles drift and periodically change alignment. This causes field reversals at irregular intervals averaging a few times every million years. The most recent reversal occurred approximately 700,000 years ago.

Magnetosphere

The extent of Earth's magnetic field in space defines the magnetosphere. Ions and electrons of the solar wind are deflected by the magnetosphere; solar wind pressure compresses the dayside of the magnetosphere, to about 10 Earth radii, and extends the nightside magnetosphere into a long tail. Because the velocity of the solar wind is greater than the speed at which wave propagate through the solar wind, a supersonic bowshock precedes the dayside magnetosphere within the solar wind. Charged particles are contained within the magnetosphere; the plasmasphere is defined by low-energy particles that essentially follow magnetic field lines as Earth rotates; the ring current is defined by medium-energy particles that drift relative to the geomagnetic field, but with paths that are still dominated by the magnetic field, and the Van Allen radiation belt are formed by high-energy particles whose motion is essentially random, but otherwise contained by the magnetosphere.

During a magnetic storm, charged particles can be deflected from the outer magnetosphere, directed along field lines into Earth's ionosphere, where atmospheric atoms can be excited and ionized, causing the aurora.

Orbit and rotation

Rotation

Earth's rotation period relative to the Sun—its mean solar day—is 86,400 seconds of mean solar time (86,400.0025 SI seconds). Because Earth's solar day is now slightly longer than it was during the 19th century due to tidal deceleration, each day varies between 0 and 2 SI ms longer.

Earth's rotation period relative to the fixed stars, called its stellar day by the International Earth Rotation and Reference Systems Service (IERS), is 86,164.098903691 seconds of mean solar time (UT1), or 23h 56m 4.098903691s. Earth's rotation period relative to the precessing or moving mean vernal equinox, misnamed its sidereal day, is 86,164.09053083288 seconds of mean solar time (UT1)

(23h 56m 4.09053083288s) as of 1982. Thus the sidereal day is shorter than the stellar day by about 8.4 ms. The length of the mean solar day in SI seconds is available from the IERS for the periods 1623–2005 and 1962–2005.

Apart from meteors within the atmosphere and low-orbiting satellites, the main apparent motion of celestial bodies in Earth's sky is to the west at a rate of 15°/h = 15'/min. For bodies near the celestial equator, this is equivalent to an apparent diameter of the Sun or the Moon every two minutes; from Earth's surface, the apparent sizes of the Sun and the Moon are approximately the same.

Orbit

Earth orbits the Sun at an average distance of about 150 million kilometres (93,000,000 mi) every 365.2564 mean solar days, or one sidereal year. This gives an apparent movement of the Sun eastward with respect to the stars at a rate of about 1°/day, which is one apparent Sun or Moon diameter every 12 hours. Due to this motion, on average it takes 24 hours—a solar day—for Earth to complete a full rotation about its axis so that the Sun returns to the meridian. The orbital speed of Earth averages about 29.8 km/s (107,000 km/h), which is fast enough to travel a distance equal to Earth's diameter, about 12,742 km (7,918 mi), in seven minutes, and the distance to the Moon, 384,000 km (239,000 mi), in about 3.5 hours.

The Moon and Earth orbit a common barycenter every 27.32 days relative to the background stars. When combined with the Earth–Moon system's common orbit around the Sun, the period of the synodic month, from new moon to new moon, is 29.53 days. Viewed from the celestial north pole, the motion of Earth, the Moon, and their axial rotations are all counterclockwise. Viewed from a vantage point above the north poles of both the Sun and Earth, Earth orbits in a counterclockwise direction about the Sun. The orbital and axial planes are not precisely aligned: Earth's axis is tilted some 23.4 degrees from the perpendicular to the Earth–Sun plane (the ecliptic), and the Earth–Moon plane is tilted up to ±5.1 degrees against the Earth–Sun plane. Without this tilt, there would be an eclipse every two weeks, alternating between lunar eclipses and solar eclipses.

The Hill sphere, or gravitational sphere of influence, of Earth is about 1.5 million kilometres (930,000 mi) in radius. This is the maximum distance at which the Earth's gravitational influence is stronger than the more distant Sun and planets. Objects must orbit Earth within this radius, or they can become unbound by the gravitational perturbation of the Sun.

Earth, along with the Solar System, is situated in the Milky Way and orbits about 28,000 light-years from its center. It is about 20 light-years above the galactic plane in the Orion Arm.

Axial tilt and seasons

The axial tilt of the Earth is approximately 23.439281°. Due to Earth's axial tilt, the amount of sunlight reaching any given point on the surface varies over the course of the year. This causes seasonal change in climate, with summer in the northern hemisphere occurring when the North Pole is pointing toward the Sun, and winter taking place when the pole is pointed away. During the summer, the day lasts longer and the Sun climbs higher in the sky. In winter, the climate becomes generally cooler and the days shorter. In northern temperate latitudes, the Sun rises north of true east during the summer solstice, and sets north of true west, reversing in the winter. The Sun rises south of true east in the summer for the southern temperate zone, and sets south of true west.

Above the Arctic Circle, an extreme case is reached where there is no daylight at all for part of the year, up to six months at the North Pole itself, a polar night. In the southern hemisphere the situation is exactly reversed, with the South Pole oriented opposite the direction of the North Pole. Six months later, this pole will experience a midnight sun, a day of 24 hours, again reversing with the South Pole.

By astronomical convention, the four seasons can be determined by the solstices — the points in the orbit of maximum axial tilt toward or away from the Sun — and the equinoxes, when the direction of the tilt and the direction to the Sun are perpendicular. In the northern hemisphere, winter solstice currently occurs around 21 December, summer solstice is near 21 June, spring equinox is around 20 March and autumnal equinox is about 22 or 23 September. In the southern hemisphere, the situation is reversed, with the summer and winter solstices exchanged and the spring and autumnal equinox dates swapped.

The angle of Earth's axial tilt is relatively stable over long periods of time. Its axial tilt does undergo nutation; a slight, irregular motion with a main period of 18.6 years. The orientation (rather than the angle) of Earth's axis also changes over time, precessing around in a complete circle over each 25,800 year cycle; this precession is the reason for the difference between a sidereal year and a tropical year. Both of these motions are caused by the varying attraction of the Sun and the Moon on Earth's equatorial bulge. The poles also migrate a few meters across Earth's surface. This polar motion has multiple, cyclical components, which collectively are termed quasiperiodic motion. In addition to an annual component to this motion, there is a 14-month cycle called the Chandler wobble. Earth's rotational velocity also varies in a phenomenon known as length-of-day variation.

In modern times, Earth's perihelion occurs around 3 January, and its aphelion around 4 July. These dates change over time due to precession and other orbital factors, which follow cyclical patterns known as Milankovitch cycles. The changing Earth–Sun distance causes an increase of about 6.9% in solar energy reaching Earth at perihelion relative to aphelion. Because the southern hemisphere is tilted toward the Sun at about the same time that Earth reaches the closest approach to the Sun, the southern hemisphere receives slightly more energy from the Sun than does the northern over the course of a year. This effect is much less significant than the total energy change due to the axial tilt, and most of the excess energy is absorbed by the higher proportion of water in the southern hemisphere.

Habitability

A planet that can sustain life is termed habitable, even if life did not originate there. Earth provides liquid water—an environment where complex organic molecules can assemble and interact, and sufficient energy to sustain metabolism. The distance of Earth from the Sun, as well as its orbital eccentricity, rate of rotation, axial tilt, geological history, sustaining atmosphere and protective magnetic field all contribute to the current climatic conditions at the surface.

Biosphere

A planet's life forms inhabit ecosystems, whose total is sometimes said to form a "biosphere". Earth's biosphere is thought to have begun evolving about 7000350000000000003.5 Gya. The biosphere is divided into a number of biomes, inhabited by broadly similar plants and animals. On land, biomes are separated primarily by differences in latitude, height above sea level and humidity. Terrestrial biomes lying within the Arctic or Antarctic Circles, at high altitudes or in extremely arid areas are relatively barren of plant and animal life; species diversity reaches a peak in humid lowlands at equatorial latitudes.

Natural resources and land use

Earth has resources that have been exploited by humans. Those termed non-renewable resources, such as fossil fuels, only renew over geological timescales.

Large deposits of fossil fuels are obtained from Earth's crust, consisting of coal, petroleum, and natural gas. These deposits are used by humans both for energy production and as feedstock for chemical production. Mineral ore bodies have also been formed within the crust through a process of ore genesis, resulting from actions of magmatism, erosion and plate tectonics. These bodies form concentrated sources for many metals and other useful elements.

Earth's biosphere produces many useful biological products for humans, including food, wood, pharmaceuticals, oxygen, and the recycling of many organic wastes. The land-based ecosystem depends upon topsoil and fresh water, and the oceanic ecosystem depends upon dissolved nutrients washed down from the land. In 1980, 5,053 Mha (50.53 million km2) of Earth's land surface consisted of forest and woodlands, 6,788 Mha (67.88 million km2) was grasslands and pasture, and 1,501 Mha (15.01 million km2) was cultivated as croplands. The estimated amount of irrigated land in 1993 was 2,481,250 square kilometres (958,020 sq mi). Humans also live on the land by using building materials to construct shelters.

Natural and environmental hazards

Large areas of Earth's surface are subject to extreme weather such as tropical cyclones, hurricanes, or typhoons that dominate life in those areas. From 1980 to 2000, these events caused an average of 11,800 human deaths per year. Many places are subject to earthquakes, landslides, tsunamis, volcanic eruptions, tornadoes, sinkholes, blizzards, floods, droughts, wildfires, and other calamities and disasters.

Many localized areas are subject to human-made pollution of the air and water, acid rain and toxic substances, loss of vegetation (overgrazing, deforestation, desertification), loss of wildlife, species extinction, soil degradation, soil depletion and erosion.

According to the United Nations, a scientific consensus exists linking human activities to global warming due to industrial carbon dioxide emissions. This is predicted to produce changes such as the melting of glaciers and ice sheets, more extreme temperature ranges, significant changes in weather and a global rise in average sea levels.

Human geography

The seven continents of Earth

Cartography, the study and practice of map-making, and geography, the study of the lands, features, inhabitants and phenomena on Earth, have historically been the disciplines devoted to depicting Earth. Surveying, the determination of locations and distances, and to a lesser extent navigation, the determination of position and direction, have developed alongside cartography and geography, providing and suitably quantifying the requisite information.

Earth's human population reached approximately seven billion on 31 October 2011. Projections indicate that the world's human population will reach 9.2 billion in 2050. Most of the growth is expected to take place in developing nations. Human population density varies widely around the world, but a majority live in Asia. By 2020, 60% of the world's population is expected to be living in urban, rather than rural, areas.

It is estimated that one-eighth of Earth's surface is suitable for humans to live on – three-quarters of Earth's surface is covered by oceans, leaving one quarter as land. Half of that land area is desert (14%), high mountains (27%), or other unsuitable terrain. The northernmost permanent settlement in the world is Alert, on Ellesmere Island in Nunavut, Canada. (82°28′N) The southernmost is the Amundsen–Scott South Pole Station, in Antarctica, almost exactly at the South Pole. (90°S)

Independent sovereign nations claim the planet's entire land surface, except for some parts of Antarctica, a few land parcels along the Danube river's western bank, and the odd unclaimed area of Bir Tawil between Egypt and Sudan. As of 2015, there are

193 sovereign states that are member states of the United Nations, plus two observer states and 72 dependent territories and states with limited recognition. Historically, Earth has never had a sovereign government with authority over the entire globe although a number of nation-states have striven for world domination and failed.

The United Nations is a worldwide intergovernmental organization that was created with the goal of intervening in the disputes between nations, thereby avoiding armed conflict. The U.N. serves primarily as a forum for international diplomacy and international law. When the consensus of the membership permits, it provides a mechanism for armed intervention.

The first human to orbit Earth was Yuri Gagarin on 12 April 1961. In total, about 487 people have visited outer space and reached orbit as of 30 July 2010, and, of these, twelve have walked on the Moon. Normally, the only humans in space are those on the International Space Station. The station's crew, made up of six people, is usually replaced every six months. The farthest that humans have travelled from Earth is 400,171 km, achieved during the Apollo 13 mission in 1970.

Moon

The Moon is a relatively large, terrestrial, planet-like natural satellite, with a diameter about one-quarter of Earth's. It is the largest moon in the Solar System relative to the size of its planet, although Charon is larger relative to the dwarf planet Pluto. The natural satellites of other planets are also referred to as "moons", after Earth's.

The gravitational attraction between Earth and the Moon causes tides on Earth. The same effect on the Moon has led to its tidal locking: its rotation period is the same as the time it takes to orbit Earth. As a result, it always presents the same face to the planet. As the Moon orbits Earth, different parts of its face are illuminated by the Sun, leading to the lunar phases; the dark part of the face is separated from the light part by the solar terminator.

Due to their tidal interaction, the Moon recedes from Earth at the rate of approximately 38 mm/yr. Over millions of years, these tiny modifications—and the lengthening of Earth's day by about 23 µs/yr—add up to significant changes. During the Devonian period, for example, (approximately 7016129386160000000410 mya) there were 400 days in a year, with each day lasting 21.8 hours.

The Moon may have dramatically affected the development of life by moderating the planet's climate. Paleontological evidence and computer simulations show that Earth's axial tilt is stabilized by tidal interactions with the Moon. Some theorists think that without this stabilization against the torques applied by the Sun and planets to Earth's equatorial bulge, the rotational axis might be chaotically unstable, exhibiting chaotic changes over millions of years, as appears to be the case for Mars.

Viewed from Earth, the Moon is just far enough away to have almost the same apparent-sized disk as the Sun. The angular size (or solid angle) of these two bodies match because, although the Sun's diameter is about 400 times as large as the Moon's, it is also 400 times more distant. This allows total and annular solar eclipses to occur on Earth.

The most widely accepted theory of the Moon's origin, the giant impact theory, states that it formed from the collision of a Mars-size protoplanet called Theia with the early Earth. This hypothesis explains (among other things) the Moon's relative lack of iron and volatile elements, and the fact that its composition is nearly identical to that of Earth's crust.

Asteroids and artificial satellites

Earth has at least five co-orbital asteroids, including 3753 Cruithne and 2002 AA29. A trojan asteroid companion, 2010 TK7, is librating around the leading Lagrange triangular point, L4, in the Earth's orbit around the Sun.

The tiny near-Earth asteroid 2006 RH120 makes close approaches to the Earth–Moon system roughly every twenty years. During these approaches, it can orbit Earth for brief periods of time.

As of September 2015, there were 1,305 operational, human-made satellites orbiting Earth. There are also inoperative satellites, including Vanguard 1 the oldest satellite currently in orbit, and over 300,000 pieces of space debris. Earth's largest artificial satellite is the International Space Station.

Cultural and historical viewpoint

The standard astronomical symbol of Earth consists of a cross circumscribed by a circle, , representing the four quadrants of the world.

Human cultures have developed many views of the planet. Earth is sometimes personified as a deity. In many cultures it is a mother goddess that is also the primary fertility deity, and by the mid-20th century the Gaia Principle compared Earth's environments and life as a single self-regulating organism leading to broad stabilization of the conditions of habitability. Creation myths in many religions involve the creation of Earth by a supernatural deity or deities.

Scientific investigation has resulted in several culturally transformative shifts in our view of the planet. In the West, belief in a flat Earth was displaced by the idea of spherical Earth, credited to Pythagoras in the 6th century BC. Earth was further believed to be the center of the universe until the 16th century, when scientists first theorized that it was a moving object, comparable to the other planets in the Solar System. Due to the efforts of influential Christian scholars and clerics such as James Ussher, who sought to determine the age of Earth through analysis of genealogies in

Scripture, Westerners prior to the 19th century generally believed Earth to be a few thousand years old at most. It was only during the 19th century that geologists realized Earth's age was at least many millions of years. Lord Kelvin used thermodynamics to estimate the age of Earth to be between 20 million and 400 million years in 1864, sparking a vigorous debate on the subject; it was only when radioactivity and radioactive dating were discovered in the late 19th and early 20th centuries that a reliable mechanism for determining Earth's age was established, proving the planet to be billions of years old. The perception of Earth shifted again in the 20th century when humans first viewed it from orbit, and especially with photographs of Earth returned by the Apollo program.

Mars

Mars (1.5 AU from the Sun) is smaller than Earth and Venus (0.107 Earth masses). It possesses an atmosphere of mostly carbon dioxide with a surface pressure of 6.1 millibars (roughly 0.6% of that of Earth). Its surface, peppered with vast volcanoes, such as Olympus Mons, and rift valleys, such as Valles Marineris, shows geological activity that may have persisted until as recently as 2 million years ago. Its red colour comes from iron oxide (rust) in its soil. Mars has two tiny natural satellites (Deimos and Phobos) thought to be captured asteroids.

Asteroid belt

Asteroids except for the largest, Ceres, are classified as small Solar System bodies and are composed mainly of refractory rocky and metallic minerals, with some ice. They range from a few metres to hundreds of kilometres in size. Asteroids smaller than one meter are usually called meteoroids and micrometeoroids (grain-sized), depending on different, somewhat arbitrary definitions.

The asteroid belt occupies the orbit between Mars and Jupiter, between 2.3 and 3.3 AU from the Sun. It is thought to be remnants from the Solar System's formation that failed to coalesce because of the gravitational interference of Jupiter. The asteroid belt contains tens of thousands, possibly millions, of objects over one kilometre in diameter. Despite this, the total mass of the asteroid belt is unlikely to be more than a thousandth of that of Earth. The asteroid belt is very sparsely populated; spacecraft routinely pass through without incident.

Ceres

Ceres (2.77 AU) is the largest asteroid, a protoplanet, and a dwarf planet. It has a diameter of slightly under 1,000 km, and a mass large enough for its own gravity to pull it into a spherical shape. Ceres was considered a planet when it was discovered in 1801, and was reclassified to asteroid in the 1850s as further observations revealed additional asteroids. It was classified as a dwarf planet in 2006 when the definition of a planet was created.

Asteroid groups

Asteroids in the asteroid belt are divided into asteroid groups and families based on their orbital characteristics. Asteroid moons are asteroids that orbit larger asteroids. They are not as clearly distinguished as planetary moons, sometimes being almost as large as their partners. The asteroid belt also contains main-belt comets, which may have been the source of Earth's water.

Jupiter trojans are located in either of Jupiter's L4 or L5 points (gravitationally stable regions leading and trailing a planet in its orbit); the term "trojan" is also used for small bodies in any other planetary or satellite Lagrange point. Hilda asteroids are in a 2:3 resonance with Jupiter; that is, they go around the Sun three times for every two Jupiter orbits.

The inner Solar System also contains near-Earth asteroids, many of which cross the orbits of the inner planets. Some of them are potentially hazardous objects.

Outer Solar System

The outer region of the Solar System is home to the giant planets and their large moons. The centaurs and many short-period comets also orbit in this region. Due to their greater distance from the Sun, the solid objects in the outer Solar System contain a higher proportion of volatiles, such as water, ammonia, and methane than those of the inner Solar System because the lower temperatures allow these compounds to remain solid.

Outer planets

The four outer planets, or giant planets (sometimes called Jovian planets), collectively make up 99% of the mass known to orbit the Sun. Jupiter and Saturn are together over 400 times the mass of Earth and consist overwhelmingly of hydrogen and helium; Uranus and Neptune are far less massive (<20 Earth masses each) and possess more ices in their makeup. For these reasons, some astronomers suggest they belong in their own category, "ice giants". All four giant planets have rings, although only Saturn's ring system is easily observed from Earth. The term superior planet designates planets outside Earth's orbit and thus includes both the outer planets and Mars.

Jupiter

Jupiter (5.2 AU), at 318 Earth masses, is 2.5 times the mass of all the other planets put together. It is composed largely of hydrogen and helium. Jupiter's strong internal heat creates semi-permanent features in its atmosphere, such as cloud bands and the Great Red Spot. Jupiter has 67 known satellites. The four largest, Ganymede, Callisto, Io, and Europa, show similarities to the terrestrial planets, such as volcanism and internal heating. Ganymede, the largest satellite in the Solar System, is larger than Mercury.

Saturn

Saturn (9.5 AU), distinguished by its extensive ring system, has several similarities to Jupiter, such as its atmospheric composition and magnetosphere. Although Saturn has 60% of Jupiter's volume, it is less than a third as massive, at 95 Earth masses, making it the least dense planet in the Solar System. The rings of Saturn are made up of small ice and rock particles. Saturn has 62 confirmed satellites composed largely of ice. Two of these, Titan and Enceladus, show signs of geological activity. Titan, the second-largest moon in the Solar System, is larger than Mercury and the only satellite in the Solar System with a substantial atmosphere.

Uranus

Uranus (19.2 AU), at 14 Earth masses, is the lightest of the outer planets. Uniquely among the planets, it orbits the Sun on its side; its axial tilt is over ninety degrees to the ecliptic. It has a much colder core than the other giant planets and radiates very little heat into space. Uranus has 27 known satellites, the largest ones being Titania, Oberon, Umbriel, Ariel, and Miranda.

Neptune

Neptune (30.1 AU), though slightly smaller than Uranus, is more massive (equivalent to 17 Earths) and hence more dense. It radiates more internal heat, but not as much as Jupiter or Saturn. Neptune has 14 known satellites. The largest, Triton, is geologically active, with geysers of liquid nitrogen. Triton is the only large satellite with a retrograde orbit. Neptune is accompanied in its orbit by several minor planets, termed Neptune trojans, that are in 1:1 resonance with it.

Centaurs

The centaurs are icy comet-like bodies whose orbits have semi-major axes greater than Jupiter's (5.5 AU) and less than Neptune's (30 AU). The largest known centaur, 10199 Chariklo, has a diameter of about 250 km. The first centaur discovered, 2060 Chiron, has also been classified as comet (95P) because it develops a coma just as comets do when they approach the Sun.

Comets

Comets are small Solar System bodies, typically only a few kilometres across, composed largely of volatile ices. They have highly eccentric orbits, generally a perihelion within the orbits of the inner planets and an aphelion far beyond Pluto. When a comet enters the inner Solar System, its proximity to the Sun causes its icy surface to sublimate and ionise, creating a coma: a long tail of gas and dust often visible to the naked eye.

Short-period comets have orbits lasting less than two hundred years. Long-period comets have orbits lasting thousands of years. Short-period comets are thought to originate in the Kuiper belt, whereas long-period comets, such as Hale–Bopp, are thought to originate in the Oort cloud. Many comet groups, such as the Kreutz Sungrazers, formed from the breakup of a single parent. Some comets with hyperbolic orbits may originate outside the Solar System, but determining their precise orbits is difficult. Old comets that have had most of their volatiles driven out by solar warming are often categorised as asteroids.

Trans-Neptunian region

Beyond the orbit of Neptune lies the area of the "trans-Neptunian region", with the doughnut-shaped Kuiper belt, home of Pluto and several other dwarf planets, and an overlapping disc of scattered objects, which is tilted toward the plane of the Solar System and reaches much further out than the Kuiper belt. The entire region is still largely unexplored. It appears to consist overwhelmingly of many thousands of small worlds—the largest having a diameter only a fifth that of Earth and a mass far smaller than that of the Moon—composed mainly of rock and ice. This region is sometimes described as the "third zone of the Solar System", enclosing the inner and the outer Solar System.

Kuiper belt

The Kuiper belt is a great ring of debris similar to the asteroid belt, but consisting mainly of objects composed primarily of ice. It extends between 30 and 50 AU from the Sun. Though it is estimated to contain anything from dozens to thousands of dwarf planets, it is composed mainly of small Solar System bodies. Many of the larger Kuiper belt objects, such as Quaoar, Varuna, and Orcus, may prove to be dwarf planets with further data. There are estimated to be over 100,000 Kuiper belt objects with a diameter greater than 50 km, but the total mass of the Kuiper belt is thought to be only a tenth or even a hundredth the mass of Earth. Many Kuiper belt objects have multiple satellites, and most have orbits that take them outside the plane of the ecliptic.

The Kuiper belt can be roughly divided into the "classical" belt and the resonances. Resonances are orbits linked to that of Neptune (e.g. twice for every three Neptune orbits, or once for every two). The first resonance begins within the orbit of Neptune itself. The classical belt consists of objects having no resonance with Neptune, and extends from roughly 39.4 AU to 47.7 AU. Members of the classical Kuiper belt are classified as cubewanos, after the first of their kind to be discovered, (15760) 1992 QB1, and are still in near primordial, low-eccentricity orbits.

Pluto and Charon

The dwarf planet Pluto (39 AU average) is the largest known object in the Kuiper belt. When discovered in 1930, it was considered to be the ninth planet; this changed in 2006 with the adoption of a formal definition of planet. Pluto has a relatively eccentric orbit inclined 17 degrees to the ecliptic plane and ranging from 29.7 AU from the Sun at perihelion (within the orbit of Neptune) to 49.5 AU at aphelion. Pluto has a 3:2

resonance with Neptune, meaning that Pluto orbits twice round the Sun for every three Neptunian orbits. Kuiper belt objects whose orbits share this resonance are called plutinos.

Charon, the largest of Pluto's moons, is sometimes described as part of a binary system with Pluto, as the two bodies orbit a barycentre of gravity above their surfaces (i.e. they appear to "orbit each other"). Beyond Charon, four much smaller moons, Styx, Nix, Kerberos, and Hydra, orbit within the system.

Makemake and Haumea

Makemake (45.79 AU average), although smaller than Pluto, is the largest known object in the classical Kuiper belt (that is, a Kuiper belt object not in a confirmed resonance with Neptune). Makemake is the brightest object in the Kuiper belt after Pluto. It was named and designated a dwarf planet in 2008. Its orbit is far more inclined than Pluto's, at 29°.

Haumea (43.13 AU average) is in an orbit similar to Makemake except that it is in a 7:12 orbital resonance with Neptune. It is about the same size as Makemake and has two natural satellites. A rapid, 3.9-hour rotation gives it a flattened and elongated shape. It was named and designated a dwarf planet in 2008.

Scattered disc

The scattered disc, which overlaps the Kuiper belt but extends much further outwards, is thought to be the source of short-period comets. Scattered-disc objects are thought to have been ejected into erratic orbits by the gravitational influence of Neptune's early outward migration. Most scattered disc objects (SDOs) have perihelia within the Kuiper belt but aphelia far beyond it (some more than 150 AU from the Sun). SDOs' orbits are also highly inclined to the ecliptic plane and are often almost perpendicular to it. Some astronomers consider the scattered disc to be merely another region of the Kuiper belt and describe scattered disc objects as "scattered Kuiper belt objects". Some astronomers also classify centaurs as inward-scattered Kuiper belt objects along with the outward-scattered residents of the scattered disc.

Eris

Eris (68 AU average) is the largest known scattered disc object, and caused a debate about what constitutes a planet, because it is 25% more massive than Pluto and about the same diameter. It is the most massive of the known dwarf planets. It has one known moon, Dysnomia. Like Pluto, its orbit is highly eccentric, with a perihelion of 38.2 AU (roughly Pluto's distance from the Sun) and an aphelion of 97.6 AU, and steeply inclined to the ecliptic plane.

Farthest regions

The point at which the Solar System ends and interstellar space begins is not precisely defined because its outer boundaries are shaped by two separate forces: the solar wind and the Sun's gravity. The limit of the solar wind's influence is roughly four times Pluto's distance from the Sun; this heliopause, the outer boundary of the heliosphere, is considered the beginning of the interstellar medium. The Sun's Hill sphere, the effective range of its gravitational dominance, is thought to extend up to a thousand times farther and encompasses the theorized Oort cloud.

Heliosphere

The heliosphere is a stellar-wind bubble, a region of space dominated by the Sun, which radiates at roughly 400 km/s its solar wind, a stream of charged particles, until it collides with the wind of the interstellar medium.

The collision occurs at the termination shock, which is roughly 80–100 AU from the Sun upwind of the interstellar medium and roughly 200 AU from the Sun downwind. Here the wind slows dramatically, condenses and becomes more turbulent, forming a great oval structure known as the heliosheath. This structure is thought to look and behave very much like a comet's tail, extending outward for a further 40 AU on the upwind side but tailing many times that distance downwind; evidence from Cassini and Interstellar Boundary Explorer spacecraft has suggested that it is forced into a bubble shape by the constraining action of the interstellar magnetic field.

The outer boundary of the heliosphere, the heliopause, is the point at which the solar wind finally terminates and is the beginning of interstellar space. Voyager 1 and Voyager 2 are reported to have passed the termination shock and entered the heliosheath, at 94 and 84 AU from the Sun, respectively. Voyager 1 is reported to have crossed the heliopause in August 2012.

The shape and form of the outer edge of the heliosphere is likely affected by the fluid dynamics of interactions with the interstellar medium as well as solar magnetic fields prevailing to the south, e.g. it is bluntly shaped with the northern hemisphere extending 9 AU farther than the southern hemisphere. Beyond the heliopause, at around 230 AU, lies the bow shock, a plasma "wake" left by the Sun as it travels through the Milky Way.

- inner Solar System and Jupiter
- outer Solar System and Pluto
- orbit of Sedna (detached object)
- inner part of the Oort Cloud

Due to a lack of data, conditions in local interstellar space are not known for certain. It is expected that NASA's Voyager spacecraft, as they pass the heliopause, will transmit valuable data on radiation levels and solar wind to Earth. How well the heliosphere shields the Solar System from cosmic rays is poorly understood. A NASA-funded team has developed a concept of a "Vision Mission" dedicated to sending a probe to the heliosphere.

Detached objects

90377 Sedna (520 AU average) is a large, reddish object with a gigantic, highly elliptical orbit that takes it from about 76 AU at perihelion to 940 AU at aphelion and takes 11,400 years to complete. Mike Brown, who discovered the object in 2003, asserts that it cannot be part of the scattered disc or the Kuiper belt because its perihelion is too distant to have been affected by Neptune's migration. He and other astronomers consider it to be the first in an entirely new population, sometimes termed "distant detached objects" (DDOs), which also may include the object 2000 CR105, which has a perihelion of 45 AU, an aphelion of 415 AU, and an orbital period of 3,420 years. Brown terms this population the "inner Oort cloud" because it may have formed through a similar process, although it is far closer to the Sun. Sedna is very likely a dwarf planet, though its shape has yet to be determined. The second unequivocally detached object, with a perihelion farther than Sedna's at roughly 81 AU, is 2012 VP113, discovered in 2012. Its aphelion is only half that of Sedna's, at 400–500 AU.

Oort cloud

The Oort cloud is a hypothetical spherical cloud of up to a trillion icy objects that is thought to be the source for all long-period comets and to surround the Solar System at roughly 50,000 AU (around 1 light-year (ly)), and possibly to as far as 100,000 AU (1.87 ly). It is thought to be composed of comets that were ejected from the inner Solar System by gravitational interactions with the outer planets. Oort cloud objects move very slowly, and can be perturbed by infrequent events, such as collisions, the gravitational effects of a passing star, or the galactic tide, the tidal force exerted by the Milky Way.

Boundaries

Much of the Solar System is still unknown. The Sun's gravitational field is estimated to dominate the gravitational forces of surrounding stars out to about two light years (125,000 AU). Lower estimates for the radius of the Oort cloud, by contrast, do not place it farther than 50,000 AU. Despite discoveries such as Sedna, the region between the Kuiper belt and the Oort cloud, an area tens of thousands of AU in radius, is still virtually unmapped. There are also ongoing studies of the region between Mercury and the Sun. Objects may yet be discovered in the Solar System's uncharted regions.

Currently, the furthest known objects, such as Comet West have aphelion around 70,000 AU from the Sun, but as the Oort cloud becomes better known, this may change.

Galactic context

The Solar System is located in the Milky Way, a barred spiral galaxy with a diameter of about 100,000 light-years containing about 200 billion stars. The Sun resides in one of the Milky Way's outer spiral arms, known as the Orion–Cygnus Arm or Local Spur. The Sun lies between 25,000 and 28,000 light-years from the Galactic Centre, and its speed within the Milky Way is about 220 km/s, so that it completes one revolution every 225–250 million years. This revolution is known as the Solar System's galactic year. The solar apex, the direction of the Sun's path through interstellar space, is near the constellation Hercules in the direction of the current location of the bright star Vega. The plane of the ecliptic lies at an angle of about 60° to the galactic plane.

The Solar System's location in the Milky Way is a factor in the evolutionary history of life on Earth. Its orbit is close to circular, and orbits near the Sun are at roughly the same speed as that of the spiral arms. Therefore, the Sun passes through arms only rarely. Because spiral arms are home to a far larger concentration of supernovae, gravitational instabilities, and radiation that could disrupt the Solar System, this has given Earth long periods of stability for life to evolve. The Solar System also lies well outside the star-crowded environs of the galactic centre. Near the centre, gravitational tugs from nearby stars could perturb bodies in the Oort cloud and send many comets into the inner Solar System, producing collisions with potentially catastrophic implications for life on Earth. The intense radiation of the galactic centre could also interfere with the development of complex life. Even at the Solar System's current location, some scientists have speculated that recent supernovae may have adversely affected life in the last 35,000 years, by flinging pieces of expelled stellar core towards the Sun, as radioactive dust grains and larger, comet-like bodies.

Neighbourhood

The Solar System is in the Local Interstellar Cloud or Local Fluff. It is thought to be near the neighbouring G-Cloud but it is not known if the Solar System is embedded in the Local Interstellar Cloud, or if it is in the region where the Local Interstellar Cloud and G-Cloud are interacting. The Local Interstellar Cloud is an area of denser cloud in an otherwise sparse region known as the Local Bubble, an hourglass-shaped cavity in the interstellar medium roughly 300 light-years (ly) across. The bubble is suffused with high-temperature plasma, that suggests it is the product of several recent supernovae.

There are relatively few stars within ten light-years of the Sun. The closest is the triple star system Alpha Centauri, which is about 4.4 light-years away. Alpha Centauri A and B are a closely tied pair of Sun-like stars, whereas the small red dwarf, Proxima Centauri, orbits the pair at a distance of 0.2 light-year. The stars next closest to the Sun are the red dwarfs Barnard's Star (at 5.9 ly), Wolf 359 (7.8 ly), and Lalande 21185 (8.3 ly).

The largest nearby star is Sirius, a bright main-sequence star roughly 8.6 light-years away and roughly twice the Sun's mass and that is orbited by a white dwarf, Sirius

B. The nearest brown dwarfs are the binary Luhman 16 system at 6.6 light-years. Other systems within ten light-years are the binary red-dwarf system Luyten 726-8 (8.7 ly) and the solitary red dwarf Ross 154 (9.7 ly). The closest solitary Sun-like star to the Solar System is Tau Ceti at 11.9 light-years. It has roughly 80% of the Sun's mass but only 60% of its luminosity. The closest confirmed exoplanet to the Sun orbits the red dwarf Gliese 674, 15 light years away. It has a mass similar to that of Uranus and an orbital period of just five days. The closest known free-floating planetary-mass object to the Sun is WISE 0855−0714, an object with a mass less than 10 Jupiter masses roughly 7 light-years away.

Comparison with other planetary systems

Compared to other planetary systems the Solar System stands out in lacking planets interior to the orbit of Mercury. It also lacks super-Earths. Uncommonly, it has only small rocky planets and large gas giants; elsewhere intermediate-size planets are typical—both rocky and gas—so there is no "gap" as seen between the size of Earth and of Neptune (with a radius 3.8 times as large). Also, these super-Earths have closer orbits than Mercury. This led to hypothesis that all planetary systems start with many close-in planets, and that typically a sequence of their collisions causes consolidation of mass into few larger planets, but in case of the Solar System the collisions caused their destruction and ejection.

The orbits of Solar System planets are nearly circular. Compared to other systems, they have smaller orbital eccentricity. Although there are attempts to explain it partly with a bias in the radial-velocity detection method and partly with long interactions of a quite high number of planets, the exact causes remain undetermined.

Chronology

Formation

The earliest material found in the Solar System is dated to 70004567200000000004.5672±0.0006 billion years ago (Gya). By 70004540000000000004.54±0.04 Gya the primordial Earth had formed. The formation and evolution of the Solar System bodies occurred along with those of the Sun. In theory, a solar nebula partitions a volume out of a molecular cloud by gravitational collapse, which begins to spin and flatten into a circumstellar disk, and then the planets grow out of that along with the Sun. A nebula contains gas, ice grains, and dust (including primordial nuclides). In nebular theory, planetesimals form by accretion. The assembly of the primordial Earth proceeded for 10–7014631152000000000020 Ma.

The process that led to the formation of the Moon approximately 4.53 billion years ago is the subject of ongoing research. The working hypothesis is that it formed by accretion from material loosed from Earth after a Mars-sized object, named Theia, impacted with Earth. In this scenario, the mass of Theia was 10% of that of Earth, it impacted Earth with a glancing blow, and some of its mass merged with Earth. Between approximately 4.1 and 70003800000000000003.8 Gya, numerous asteroid impacts during the Late Heavy Bombardment caused significant changes to the greater surface environment of the Moon, and by inference, to Earth.

Geological history

Earth's atmosphere and oceans formed by volcanic activity and outgassing that included water vapor. The origin of the world's oceans was condensation augmented by water and ice delivered by asteroids, protoplanets, and comets. In this model, atmospheric "greenhouse gases" kept the oceans from freezing when the newly forming Sun had only 70% of its current luminosity. By 70003500000000000003.5 Gya, Earth's magnetic field was established, which helped prevent the atmosphere from being stripped away by the solar wind. A crust formed when the molten outer layer of Earth cooled to form a solid as the accumulated water vapor began to act in the atmosphere. The two models that explain land mass propose either a steady growth to the present-day forms or, more likely, a rapid growth early in Earth history followed by a long-term steady continental area. Continents formed by plate tectonics, a process ultimately driven by the continuous loss of heat from Earth's interior. On time scales lasting hundreds of millions of years, the supercontinents have formed and broken up three times. Roughly 7016236682000000000750 mya (million years ago), one of the earliest known supercontinents, Rodinia, began to break apart. The continents later recombined to form Pannotia, 600–7016170411040000000540 mya, then finally Pangaea, which also broke apart 7015568036800000000180 mya.

The present pattern of ice ages began about 7015126230400000000040 mya and then intensified during the Pleistocene about 7013946728000000000003 mya. High-latitude regions have since undergone repeated cycles of glaciation and thaw, repeating every 40–7012315576000000000100000 years. The last continental glaciation ended 10,000 years ago.

Evolution of life

Highly energetic chemical reactions are thought to have produced self–replicating molecules around four billion years ago. This was followed a half billion years later by the last common ancestor of all life. The development of photosynthesis allowed the Sun's energy to be harvested directly by life forms; the resultant molecular oxygen (O_2) accumulated in the atmosphere and due to interaction with ultraviolet solar radiation, formed a protective ozone layer (O_3) in the upper atmosphere. The incorporation of smaller cells within larger ones resulted in the development of complex cells called eukaryotes. True multicellular organisms formed as cells within colonies became increasingly specialized. Aided by the absorption of harmful ultraviolet radiation by the ozone layer, life colonized Earth's surface. The earliest fossil evidence for life is microbial mat fossils found in 3.48 billion-year-old sandstone in Western Australia, biogenic graphite found in 3.7 billion-year-old metasedimentary rocks in Western Greenland, as well as, remains of biotic material found in 4.1 billion-year-old rocks in Western Australia.

Since the 1960s, it has been hypothesized that severe glacial action between 750 and 7016183034080000000580 mya, during the Neoproterozoic, covered much of Earth in ice. This hypothesis has been termed "Snowball Earth", and it is of particular interest because it preceded the Cambrian explosion, when multicellular life forms began to proliferate. Following the Cambrian explosion, about 7016168833160000000535 mya, there have been five major mass extinctions. The most recent such event was 7015208280160000000066 mya, when an asteroid impact triggered the extinction of the non-avian dinosaurs and other large reptiles, but spared some small animals such as mammals, which then resembled shrews. Over the past 7015208280160000000066 Ma, mammalian life has diversified, and several million years ago an African ape-like animal such as Orrorin tugenensis gained the ability to stand upright. This facilitated tool use and encouraged communication that provided the nutrition and stimulation needed for a larger brain, which allowed the evolution of the human race. The development of agriculture, and then civilization, led to humans having an influence on Earth and the nature and quantity of other life forms as no other species ever has.

Predicted future

Estimates on how much longer Earth will be able to continue to support life range from 500 million years (Myr), to as long as 2.3 billion years (Ga). Earth's long-term future is closely tied to that of the Sun. As a result of the steady accumulation of helium at the Sun's core, the Sun's total luminosity will slowly increase. The luminosity of the Sun will grow by 10% over the next 7016347133600000000001.1 Ga and by 40% over the next 7017110451600000000003.5 Ga. Climate models indicate that the rise in radiation reaching Earth is likely to have dire consequences, including the loss of the oceans.

Earth's increasing surface temperature will accelerate the inorganic $CO2$ cycle, reducing its concentration to levels lethally low for plants (6995099999999999999910 ppm for C4 photosynthesis) in approximately 500–7016284018400000000900 Ma. The lack of vegetation will result in the loss of oxygen in the atmosphere, so animal life will become extinct within several million more years. After another billion years all surface water will have disappeared and the mean global temperature will reach 7002343150000000000070 °C (7002343150000000000158 °F). Earth is expected to be effectively habitable for about another 7016157788000000000500 Ma from that point, although this may be extended up to 7016725824800000000002.3 Ga if the nitrogen is removed from the atmosphere. Even if the Sun were eternal and stable, 27% of the water in the modern oceans will descend to the mantle in one billion years, due to reduced steam venting from mid-ocean ridges.

The Sun will evolve to become a red giant in about 7017157788000000000005 Ga. Models predict that the Sun will expand to roughly 1 AU (150,000,000 km), which is about 250 times its present radius. Earth's fate is less clear. As a red giant, the Sun will lose roughly 30% of its mass, so, without tidal effects, Earth will move to an orbit 1.7 AU (250,000,000 km) from the Sun when it reaches its maximum radius. Earth was, therefore, once expected to escape envelopment by the expanded Sun's outer atmosphere, though most, if not all, remaining life would have been destroyed by the Sun's increased luminosity (peaking at about 5,000 times its present level). A 2008 simulation indicates that Earth's orbit will decay due to tidal effects and drag, causing it to enter the red giant Sun's atmosphere and be vaporized.

Name and etymology

The modern English word Earth developed from a wide variety of Middle English forms, which derived from an Old English noun most often spelled eorðe. It has cognates in every Germanic language, and their proto-Germanic root has been reconstructed as *erþō. In its earliest appearances, eorðe was already being used to translate the many senses of Latin terra and Greek γῆ (gē): the ground, its soil, dry land, the human world, the surface of the world (including the sea), and the globe itself. As with Terra and Gaia, Earth was a personified goddess in Germanic paganism: the Angles were listed by Tacitus as among the devotees of Nerthus, and later Norse mythology included Jörð, a giantess often given as the mother of Thor.

Originally, earth was written in lowercase, and from early Middle English, its definite sense as "the globe" was expressed as the earth. By early Modern English, many nouns were capitalized, and the earth became (and often remained) the Earth, particularly when referenced along with other heavenly bodies. More recently, the name is sometimes simply given as Earth, by analogy with the names of the other planets. House styles now vary: Oxford spelling recognizes the lowercase form as the most common, with the capitalized form an acceptable variant. Another convention capitalizes "Earth" when appearing as a name (e.g. "Earth's atmosphere") but writes it in lowercase when preceded by the (e.g. "the atmosphere of the earth"). It almost always appears in lowercase in colloquial expressions such as "what on earth are you doing?"

Composition and structure

Shape

The shape of Earth approximates an oblate spheroid, a sphere flattened along the axis from pole to pole such that there is a bulge around the equator. This bulge results from the rotation of Earth, and causes the diameter at the equator to be 43 kilometres (27 mi) larger than the pole-to-pole diameter. Thus the point on the surface farthest from Earth's center of mass is the summit of the equatorial Chimborazo volcano in Ecuador. The average diameter of the reference spheroid is about 12,742 kilometres (7,918 mi), which is approximately (40,000 km)/π, because the meter was originally defined as 1/10,000,000 of the distance from the equator to the North Pole through Paris, France.

Local topography deviates from this idealized spheroid, although on a global scale these deviations are small compared to Earth's radius: The maximum deviation of only 0.17% is at the Mariana Trench (10,911 metres (35,797 ft) below local sea level), whereas Mount Everest (8,848 metres (29,029 ft) above local sea level) represents a deviation of 0.14%. If Earth were shrunk to the size of a billiard ball, some areas of Earth such as large mountain ranges and oceanic trenches would feel like tiny imperfections, whereas much of the planet, including the Great Plains and the abyssal plains, would feel smoother.

Chemical composition

Earth's mass is approximately 70245970000000000005.97×1024 kg (5,970 Yg). It is composed mostly of iron (32.1%), oxygen (30.1%), silicon (15.1%), magnesium (13.9%), sulfur (2.9%), nickel (1.8%), calcium (1.5%), and aluminium (1.4%), with the remaining 1.2% consisting of trace amounts of other elements. Due to mass segregation, the core region is estimated to be primarily composed of iron (88.8%), with smaller amounts of nickel (5.8%), sulfur (4.5%), and less than 1% trace elements.

The geochemist F. W. Clarke calculated that a little more than 47% of Earth's crust consists of oxygen. The more common rock constituents of the crust are nearly all oxides: chlorine, sulfur and fluorine are the important exceptions to this and their total amount in any rock is usually much less than 1%. The principal oxides are silica, alumina, iron oxides, lime, magnesia, potash and soda. The silica functions principally as an acid, forming silicates, and all the most common minerals of igneous rocks are of this nature. From a computation based on 1,672 analyses of all kinds of rocks, Clarke deduced that 99.22% was composed of 11 oxides (see the table at right), with the other constituents occurring in minute quantities.

Internal structure

Earth's interior, like that of the other terrestrial planets, is divided into layers by their chemical or physical (rheological) properties, but unlike the other terrestrial planets, it has a distinct outer and inner core. The outer layer is a chemically distinct silicate solid crust, which is underlain by a highly viscous solid mantle. The crust is separated from the mantle by the Mohorovičić discontinuity, and the thickness of the crust varies: averaging 70036000000000000006 km (kilometers) under the oceans and 30–50 km on the continents. The crust and the cold, rigid, top of the upper mantle are collectively known as the lithosphere, and it is of the lithosphere that the tectonic plates are composed. Beneath the lithosphere is the asthenosphere, a relatively low-viscosity layer on which the lithosphere rides. Important changes in crystal structure within the mantle occur at 410 and 70056600000000000660 km below the surface, spanning a transition zone that separates the upper and lower mantle. Beneath the mantle, an extremely low viscosity liquid outer core lies above a solid inner core. The inner core may rotate at a slightly higher angular velocity than the remainder of the planet, advancing by 0.1–0.5° per year. The radius of the inner core is about one fifth of Earth's.

Heat

Earth's internal heat comes from a combination of residual heat from planetary accretion (about 20%) and heat produced through radioactive decay (80%). The major heat-producing isotopes within Earth are potassium-40, uranium-238, uranium-235, and thorium-232. At the center, the temperature may be up to 6,000 °C (10,830 °F), and the pressure could reach 360 GPa. Because much of the heat is provided by radioactive decay, scientists postulate that early in Earth's history, before isotopes with short half-lives had been depleted, Earth's heat production would have been much higher. This extra heat production, twice present-day at approximately 7016946728000000003 Ga, would have increased temperature gradients with radius, increasing the rates of mantle convection and plate tectonics, and allowing the production of uncommon igneous rocks such as komatiites that are rarely formed today.

The mean heat loss from Earth is 87 mW m−2, for a global heat loss of 4.42 × 1013 W. A portion of the core's thermal energy is transported toward the crust by mantle plumes; a form of convection consisting of upwellings of higher-temperature rock. These plumes can produce hotspots and flood basalts. More of the heat in Earth is lost through plate tectonics, by mantle upwelling associated with mid-ocean ridges. The final major mode of heat loss is through conduction through the lithosphere, the majority of which occurs under the oceans because the crust there is much thinner than that of the continents.

Tectonic plates

The mechanically rigid outer layer of Earth, the lithosphere, is broken into pieces called tectonic plates. These plates are rigid segments that move in relation to one another at one of three types of plate boundaries: convergent boundaries, at which two plates come together, divergent boundaries, at which two plates are pulled apart, and transform boundaries, in which two plates slide past one another laterally. Earthquakes, volcanic activity, mountain-building, and oceanic trench formation can occur along these plate boundaries. The tectonic plates ride on top of the asthenosphere, the solid but less-viscous part of the upper mantle that can flow and move along with the plates.

As the tectonic plates migrate, the ocean floor is subducted under the leading edges of the plates at convergent boundaries. At the same time, the upwelling of mantle material at divergent boundaries creates mid-ocean ridges. The combination of these processes continually recycles the oceanic crust back into the mantle. Due to this recycling, most of the ocean floor is less than 7015315576000000000100 Ma old in age. The oldest oceanic crust is located in the Western Pacific, and has an estimated age of about 7015631152000000000200 Ma. By comparison, the oldest dated continental crust is 7017127177128000004030 Ma.

The seven major plates are the Pacific, North American, Eurasian, African, Antarctic, Indo-Australian, and South American. Other notable plates include the Arabian Plate, the Caribbean Plate, the Nazca Plate off the west coast of South America and the Scotia Plate in the southern Atlantic Ocean. The Australian Plate fused with the Indian Plate between 50 and 7015173566800000000055 mya. The fastest-moving plates are the oceanic plates, with the Cocos Plate advancing at a rate of 75 mm/year and the Pacific Plate moving 52–69 mm/year. At the other extreme, the slowest-moving plate is the Eurasian Plate, progressing at a typical rate of about 21 mm/year.

Surface

Earth's terrain varies greatly from place to place. About 70.8% of the surface is covered by water, with much of the continental shelf below sea level. This equates to 7008361132000000000361.132 million km2 (139.43 million sq mi). The submerged surface has mountainous features, including a globe-spanning mid-ocean ridge system, as well as undersea volcanoes, oceanic trenches, submarine canyons, oceanic plateaus and abyssal plains. The remaining 29.2% (7008148940000000000148.94 million km2, or 57.51 million sq mi) not covered by water consists of mountains, deserts, plains, plateaus, and other landforms.

The Earth's surface undergoes reshaping over geological time periods due to tectonics and erosion. The surface features built up or deformed through plate tectonics are subject to steady weathering and erosion from precipitation, thermal cycles, and chemical effects. Glaciation, coastal erosion, the build-up of coral reefs, and large meteorite impacts also act to reshape the landscape.

The continental crust consists of lower density material such as the igneous rocks granite and andesite. Less common is basalt, a denser volcanic rock that is the primary constituent of the ocean floors. Sedimentary rock is formed from the accumulation of sediment that becomes buried and compacted together. Nearly 75% of the continental surfaces are covered by sedimentary rocks, although they form about 5% of the crust. The third form of rock material found on Earth is metamorphic rock, which is created from the transformation of pre-existing rock types through high pressures, high temperatures, or both. The most abundant silicate minerals on Earth's surface include quartz, feldspars, amphibole, mica, pyroxene and olivine. Common carbonate minerals include calcite (found in limestone) and dolomite.

The pedosphere is the outermost layer of Earth's continental surface and is composed of soil and subject to soil formation processes. The total arable land is 10.9% of the land surface, with 1.3% being permanent cropland. Close to 40% of Earth's land surface is used for cropland and pasture, or an estimated 1.3×107 km2 of cropland and 3.4×107 km2 of pastureland.

The elevation of the land surface varies from the low point of −418 m at the Dead Sea, to a 2005-estimated maximum altitude of 8,848 m at the top of Mount Everest. The mean height of land above sea level is 840 m.

Besides being described in terms of Northern and Southern hemispheres centered on the poles, Earth is also often described in terms of Eastern and Western hemispheres. Earth's surface is traditionally divided into seven continents and various seas.

Hydrosphere

The abundance of water on Earth's surface is a unique feature that distinguishes the "Blue Planet" from other planets in the Solar System. Earth's hydrosphere consists chiefly of the oceans, but technically includes all water surfaces in the world, including inland seas, lakes, rivers, and underground waters down to a depth of 2,000 m. The deepest underwater location is Challenger Deep of the Mariana Trench in the Pacific Ocean with a depth of 10,911.4 m.

The mass of the oceans is approximately 1.35×1018 metric tons, or about 1/4400 of Earth's total mass. The oceans cover an area of 7014361800000000000003.618×108 km2 with a mean depth of 7003368200000000000003682 m, resulting in an estimated volume of 7018133200000000000001.332×109 km3. If all of Earth's crustal surface was at the same elevation as a smooth sphere, the depth of the resulting world ocean would be 2.7 to 2.8 km.

About 97.5% of the water is saline; the remaining 2.5% is fresh water. Most fresh water, about 68.7%, is present as ice in ice caps and glaciers.

The average salinity of Earth's oceans is about 35 grams of salt per kilogram of sea water (3.5% salt). Most of this salt was released from volcanic activity or extracted from cool igneous rocks. The oceans are also a reservoir of dissolved atmospheric gases, which are essential for the survival of many aquatic life forms. Sea water has an important influence on the world's climate, with the oceans acting as a large heat reservoir. Shifts in the oceanic temperature distribution can cause significant weather shifts, such as the El Niño-Southern Oscillation.

Atmosphere

The atmospheric pressure on Earth's surface averages 101.325 kPa, with a scale height of about 8.5 km. It has a composition of 78% nitrogen and 21% oxygen, with trace amounts of water vapor, carbon dioxide and other gaseous molecules. The height of the troposphere varies with latitude, ranging between 8 km at the poles to 17 km at the equator, with some variation resulting from weather and seasonal factors.

Earth's biosphere has significantly altered its atmosphere. Oxygenic photosynthesis evolved 7000270000000000000002.7 Gya, forming the primarily nitrogen–oxygen atmosphere of today. This change enabled the proliferation of aerobic organisms and, indirectly, the formation of the ozone layer due to the subsequent conversion of atmospheric O2 into O3. The ozone layer blocks ultraviolet solar radiation, permitting life on land. Other atmospheric functions important to life include transporting water vapor, providing useful gases, causing small meteors to burn up before they strike the surface, and moderating temperature. This last phenomenon is known as the greenhouse effect: trace molecules within the atmosphere serve to capture thermal energy emitted from the ground, thereby raising the average temperature. Water vapor, carbon dioxide, methane and ozone are the primary greenhouse gases in the atmosphere. Without this heat-retention effect, the average surface temperature would be −18 °C, in contrast to the current +15 °C, and life would likely not exist.

Weather and climate

Earth's atmosphere has no definite boundary, slowly becoming thinner and fading into outer space. Three-quarters of the atmosphere's mass is contained within the first 11 km of the surface. This lowest layer is called the troposphere. Energy from the Sun heats this layer, and the surface below, causing expansion of the air. This lower-density air then rises, and is replaced by cooler, higher-density air. The result is atmospheric circulation that drives the weather and climate through redistribution of thermal energy.

The primary atmospheric circulation bands consist of the trade winds in the equatorial region below 30° latitude and the westerlies in the mid-latitudes between 30° and 60°. Ocean currents are also important factors in determining climate, particularly the thermohaline circulation that distributes thermal energy from the equatorial oceans to the polar regions.

Water vapor generated through surface evaporation is transported by circulatory patterns in the atmosphere. When atmospheric conditions permit an uplift of warm, humid air, this water condenses and falls to the surface as precipitation. Most of the water is then transported to lower elevations by river systems and usually returned to the oceans or deposited into lakes. This water cycle is a vital mechanism for supporting life on land, and is a primary factor in the erosion of surface features over geological periods. Precipitation patterns vary widely, ranging from several meters of water per year to less than a millimeter. Atmospheric circulation, topographic features and temperature differences determine the average precipitation that falls in each region.

The amount of solar energy reaching Earth's surface decreases with increasing latitude. At higher latitudes the sunlight reaches the surface at lower angles and it must pass through thicker columns of the atmosphere. As a result, the mean annual air temperature at sea level decreases by about 0.4 °C (0.7 °F) per degree of latitude from the equator. Earth's surface can be subdivided into specific latitudinal belts of approximately homogeneous climate. Ranging from the equator to the polar regions, these are the tropical (or equatorial), subtropical, temperate and polar climates. Climate can also be classified based on the temperature and precipitation, with the climate regions characterized by fairly uniform air masses. The commonly used Köppen climate classification system (as modified by Wladimir Köppen's student Rudolph Geiger) has five broad groups (humid tropics, arid, humid middle latitudes, continental and cold polar), which are further divided into more specific subtypes.

Climate on Earth has latitudinal anomalies, namely the habitability of the Scandinavian peninsula very far north in sharp contrast to the polar climates of northern Canada as well as the cool summers expected at low latitudes in the Southern Hemisphere (for example on the west coast of South America). Another anomaly is the impact of landmass on temperature, manifested by the fact that Earth is much warmer at aphelion, where the planet is at a more distant position from the Sun. When the Northern hemisphere is turned towards the sunlight even the increased distance to it does not hinder temperatures to be 2.3 °C (4 °F) warmer than at perihelion—when the marine southern hemisphere is turned towards the Sun.

At high latitudes, the western sides of continents tend to be milder than the eastern sides—for example seen in North America and Western Europe where rough continental climates appear on the east coast on parallels with mild climates on the other side of the ocean.

The highest air temperature ever measured on Earth was 56.7 °C (134.1 °F) in Furnace Creek, California, in Death Valley, in 1913. The lowest air temperature ever directly measured on Earth was −89.2 °C (−128.6 °F) at Vostok Station in 1983, but satellites have used remote sensing to measure temperatures as low as −94.7 °C (−138.5 °F) in East Antarctica. These temperature records are only measurements made with modern instruments from the 20th century onwards and likely do not reflect the full range of temperature on Earth.

Upper atmosphere

Above the troposphere, the atmosphere is usually divided into the stratosphere, mesosphere, and thermosphere. Each layer has a different lapse rate, defining the rate of change in temperature with height. Beyond these, the exosphere thins out into the magnetosphere, where the geomagnetic fields interact with the solar wind. Within the stratosphere is the ozone layer, a component that partially shields the surface from ultraviolet light and thus is important for life on Earth. The Kármán line, defined as 100 km above Earth's surface, is a working definition for the boundary between the atmosphere and outer space.

Thermal energy causes some of the molecules at the outer edge of the atmosphere to increase their velocity to the point where they can escape from Earth's gravity. This causes a slow but steady leakage of the atmosphere into space. Because unfixed hydrogen has a low molecular mass, it can achieve escape velocity more readily and it leaks into outer space at a greater rate than other gases. The leakage of hydrogen into space contributes to the shifting of Earth's atmosphere and surface from an initially reducing state to its current oxidizing one. Photosynthesis provided a source of free oxygen, but the loss of reducing agents such as hydrogen is thought to have been a necessary precondition for the widespread accumulation of oxygen in the atmosphere. Hence the ability of hydrogen to escape from the atmosphere may have influenced the nature of life that developed on Earth. In the current, oxygen-rich atmosphere most hydrogen is converted into water before it has an opportunity to escape. Instead, most of the hydrogen loss comes from the destruction of methane in the upper atmosphere.

Magnetic field

The main part of Earth's magnetic field is generated in the core, the site of a dynamo process that converts kinetic energy of fluid convective motion into electrical and magnetic field energy. The field extends outwards from the core, through the mantle, and up to Earth's surface, where it is, to rough approximation, a dipole. The poles of the dipole are located close to Earth's geographic poles. At the equator of the magnetic field, the magnetic-field strength at the surface is 3.05 × 10−5 T, with global magnetic dipole moment of 7.91 × 1015 T m3. The convection movements in the core are chaotic; the magnetic poles drift and periodically change alignment. This causes field reversals at irregular intervals averaging a few times every million years. The most recent reversal occurred approximately 700,000 years ago.

Magnetosphere

The extent of Earth's magnetic field in space defines the magnetosphere. Ions and electrons of the solar wind are deflected by the magnetosphere; solar wind pressure compresses the dayside of the magnetosphere, to about 10 Earth radii, and extends the nightside magnetosphere into a long tail. Because the velocity of the solar wind is greater than the speed at which wave propagate through the solar wind, a supersonic bowshock precedes the dayside magnetosphere within the solar wind. Charged particles are contained within the magnetosphere; the plasmasphere is defined by low-energy particles that essentially follow magnetic field lines as Earth rotates; the ring current is defined by medium-energy particles that drift relative to the geomagnetic field, but with paths that are still dominated by the magnetic field, and the Van Allen radiation belt are formed by high-energy particles whose motion is essentially random, but otherwise contained by the magnetosphere.

During a magnetic storm, charged particles can be deflected from the outer magnetosphere, directed along field lines into Earth's ionosphere, where atmospheric atoms can be excited and ionized, causing the aurora.

Orbit and rotation

Rotation

Earth's rotation period relative to the Sun—its mean solar day—is 86,400 seconds of mean solar time (86,400.0025 SI seconds). Because Earth's solar day is now slightly longer than it was during the 19th century due to tidal deceleration, each day varies between 0 and 2 SI ms longer.

Earth's rotation period relative to the fixed stars, called its stellar day by the International Earth Rotation and Reference Systems Service (IERS), is

86,164.098903691 seconds of mean solar time (UT1), or 23h 56m 4.098903691s. Earth's rotation period relative to the precessing or moving mean vernal equinox, misnamed its sidereal day, is 86,164.09053083288 seconds of mean solar time (UT1) (23h 56m 4.09053083288s) as of 1982. Thus the sidereal day is shorter than the stellar day by about 8.4 ms. The length of the mean solar day in SI seconds is available from the IERS for the periods 1623–2005 and 1962–2005.

Apart from meteors within the atmosphere and low-orbiting satellites, the main apparent motion of celestial bodies in Earth's sky is to the west at a rate of 15°/h = 15'/min. For bodies near the celestial equator, this is equivalent to an apparent diameter of the Sun or the Moon every two minutes; from Earth's surface, the apparent sizes of the Sun and the Moon are approximately the same.

Orbit

Earth orbits the Sun at an average distance of about 150 million kilometres (93,000,000 mi) every 365.2564 mean solar days, or one sidereal year. This gives an apparent movement of the Sun eastward with respect to the stars at a rate of about 1°/day, which is one apparent Sun or Moon diameter every 12 hours. Due to this motion, on average it takes 24 hours—a solar day—for Earth to complete a full rotation about its axis so that the Sun returns to the meridian. The orbital speed of Earth averages about 29.8 km/s (107,000 km/h), which is fast enough to travel a distance equal to Earth's diameter, about 12,742 km (7,918 mi), in seven minutes, and the distance to the Moon, 384,000 km (239,000 mi), in about 3.5 hours.

The Moon and Earth orbit a common barycenter every 27.32 days relative to the background stars. When combined with the Earth–Moon system's common orbit around the Sun, the period of the synodic month, from new moon to new moon, is 29.53 days. Viewed from the celestial north pole, the motion of Earth, the Moon, and their axial rotations are all counterclockwise. Viewed from a vantage point above the north poles of both the Sun and Earth, Earth orbits in a counterclockwise direction about the Sun. The orbital and axial planes are not precisely aligned: Earth's axis is tilted some 23.4 degrees from the perpendicular to the Earth–Sun plane (the ecliptic), and the Earth–Moon plane is tilted up to ±5.1 degrees against the Earth–Sun plane. Without this tilt, there would be an eclipse every two weeks, alternating between lunar eclipses and solar eclipses.

The Hill sphere, or gravitational sphere of influence, of Earth is about 1.5 million kilometres (930,000 mi) in radius. This is the maximum distance at which the Earth's gravitational influence is stronger than the more distant Sun and planets. Objects must orbit Earth within this radius, or they can become unbound by the gravitational perturbation of the Sun.

Earth, along with the Solar System, is situated in the Milky Way and orbits about 28,000 light-years from its center. It is about 20 light-years above the galactic plane in the Orion Arm.

Axial tilt and seasons

The axial tilt of the Earth is approximately 23.439281°. Due to Earth's axial tilt, the amount of sunlight reaching any given point on the surface varies over the course of the year. This causes seasonal change in climate, with summer in the northern hemisphere occurring when the North Pole is pointing toward the Sun, and winter taking place when the pole is pointed away. During the summer, the day lasts longer and the Sun climbs higher in the sky. In winter, the climate becomes generally cooler and the days shorter. In northern temperate latitudes, the Sun rises north of true east during the summer solstice, and sets north of true west, reversing in the winter. The Sun rises south of true east in the summer for the southern temperate zone, and sets south of true west.

Above the Arctic Circle, an extreme case is reached where there is no daylight at all for part of the year, up to six months at the North Pole itself, a polar night. In the southern hemisphere the situation is exactly reversed, with the South Pole oriented opposite the direction of the North Pole. Six months later, this pole will experience a midnight sun, a day of 24 hours, again reversing with the South Pole.

By astronomical convention, the four seasons can be determined by the solstices — the points in the orbit of maximum axial tilt toward or away from the Sun — and the equinoxes, when the direction of the tilt and the direction to the Sun are perpendicular. In the northern hemisphere, winter solstice currently occurs around 21 December, summer solstice is near 21 June, spring equinox is around 20 March and autumnal equinox is about 22 or 23 September. In the southern hemisphere, the situation is reversed, with the summer and winter solstices exchanged and the spring and autumnal equinox dates swapped.

The angle of Earth's axial tilt is relatively stable over long periods of time. Its axial tilt does undergo nutation; a slight, irregular motion with a main period of 18.6 years. The orientation (rather than the angle) of Earth's axis also changes over time, precessing around in a complete circle over each 25,800 year cycle; this precession is the reason for the difference between a sidereal year and a tropical year. Both of these motions are caused by the varying attraction of the Sun and the Moon on Earth's equatorial bulge. The poles also migrate a few meters across Earth's surface. This polar motion has multiple, cyclical components, which collectively are termed quasiperiodic motion. In addition to an annual component to this motion, there is a 14-month cycle called the Chandler wobble. Earth's rotational velocity also varies in a phenomenon known as length-of-day variation.

In modern times, Earth's perihelion occurs around 3 January, and its aphelion around 4 July. These dates change over time due to precession and other orbital factors, which follow cyclical patterns known as Milankovitch cycles. The changing Earth–Sun distance causes an increase of about 6.9% in solar energy reaching Earth at perihelion relative to aphelion. Because the southern hemisphere is tilted toward the Sun at about the same time that Earth reaches the closest approach to the Sun, the southern hemisphere receives slightly more energy from the Sun than does the northern over the course of a year. This effect is much less significant than the total energy change due to the axial tilt, and most of the excess energy is absorbed by the higher proportion of water in the southern hemisphere.

Habitability

A planet that can sustain life is termed habitable, even if life did not originate there. Earth provides liquid water—an environment where complex organic molecules can assemble and interact, and sufficient energy to sustain metabolism. The distance of Earth from the Sun, as well as its orbital eccentricity, rate of rotation, axial tilt, geological history, sustaining atmosphere and protective magnetic field all contribute to the current climatic conditions at the surface.

Biosphere

A planet's life forms inhabit ecosystems, whose total is sometimes said to form a "biosphere". Earth's biosphere is thought to have begun evolving about 7000350000000000000003.5 Gya. The biosphere is divided into a number of biomes, inhabited by broadly similar plants and animals. On land, biomes are separated primarily by differences in latitude, height above sea level and humidity. Terrestrial biomes lying within the Arctic or Antarctic Circles, at high altitudes or in extremely arid areas are relatively barren of plant and animal life; species diversity reaches a peak in humid lowlands at equatorial latitudes.

Natural resources and land use

Earth has resources that have been exploited by humans. Those termed non-renewable resources, such as fossil fuels, only renew over geological timescales.

Large deposits of fossil fuels are obtained from Earth's crust, consisting of coal, petroleum, and natural gas. These deposits are used by humans both for energy production and as feedstock for chemical production. Mineral ore bodies have also been formed within the crust through a process of ore genesis, resulting from actions of magmatism, erosion and plate tectonics. These bodies form concentrated sources for many metals and other useful elements.

Earth's biosphere produces many useful biological products for humans, including food, wood, pharmaceuticals, oxygen, and the recycling of many organic wastes. The land-based ecosystem depends upon topsoil and fresh water, and the oceanic ecosystem depends upon dissolved nutrients washed down from the land. In 1980, 5,053 Mha (50.53 million km2) of Earth's land surface consisted of forest and woodlands, 6,788 Mha (67.88 million km2) was grasslands and pasture, and 1,501 Mha (15.01 million km2) was cultivated as croplands. The estimated amount of irrigated land in 1993 was 2,481,250 square kilometres (958,020 sq mi). Humans also live on the land by using building materials to construct shelters.

Natural and environmental hazards

Large areas of Earth's surface are subject to extreme weather such as tropical cyclones, hurricanes, or typhoons that dominate life in those areas. From 1980 to 2000, these events caused an average of 11,800 human deaths per year. Many places are subject to earthquakes, landslides, tsunamis, volcanic eruptions, tornadoes, sinkholes, blizzards, floods, droughts, wildfires, and other calamities and disasters.

Many localized areas are subject to human-made pollution of the air and water, acid rain and toxic substances, loss of vegetation (overgrazing, deforestation, desertification), loss of wildlife, species extinction, soil degradation, soil depletion and erosion.

According to the United Nations, a scientific consensus exists linking human activities to global warming due to industrial carbon dioxide emissions. This is predicted to produce changes such as the melting of glaciers and ice sheets, more extreme temperature ranges, significant changes in weather and a global rise in average sea levels.

Human geography

The seven continents of Earth

Cartography, the study and practice of map-making, and geography, the study of the lands, features, inhabitants and phenomena on Earth, have historically been the disciplines devoted to depicting Earth. Surveying, the determination of locations and distances, and to a lesser extent navigation, the determination of position and direction, have developed alongside cartography and geography, providing and suitably quantifying the requisite information.

Earth's human population reached approximately seven billion on 31 October 2011. Projections indicate that the world's human population will reach 9.2 billion in 2050. Most of the growth is expected to take place in developing nations. Human population density varies widely around the world, but a majority live in Asia. By 2020, 60% of the world's population is expected to be living in urban, rather than rural, areas.

It is estimated that one-eighth of Earth's surface is suitable for humans to live on – three-quarters of Earth's surface is covered by oceans, leaving one quarter as land. Half of that land area is desert (14%), high mountains (27%), or other unsuitable terrain. The northernmost permanent settlement in the world is Alert, on Ellesmere Island in Nunavut, Canada. (82°28′N) The southernmost is the Amundsen–Scott South Pole Station, in Antarctica, almost exactly at the South Pole. (90°S)

Independent sovereign nations claim the planet's entire land surface, except for some parts of Antarctica, a few land parcels along the Danube river's western bank, and the odd unclaimed area of Bir Tawil between Egypt and Sudan. As of 2015, there are

193 sovereign states that are member states of the United Nations, plus two observer states and 72 dependent territories and states with limited recognition. Historically, Earth has never had a sovereign government with authority over the entire globe although a number of nation-states have striven for world domination and failed.

The United Nations is a worldwide intergovernmental organization that was created with the goal of intervening in the disputes between nations, thereby avoiding armed conflict. The U.N. serves primarily as a forum for international diplomacy and international law. When the consensus of the membership permits, it provides a mechanism for armed intervention.

The first human to orbit Earth was Yuri Gagarin on 12 April 1961. In total, about 487 people have visited outer space and reached orbit as of 30 July 2010, and, of these, twelve have walked on the Moon. Normally, the only humans in space are those on the International Space Station. The station's crew, made up of six people, is usually replaced every six months. The farthest that humans have travelled from Earth is 400,171 km, achieved during the Apollo 13 mission in 1970.

Rivers of the world

	River	Length (km)	Length (miles)	Drainage area (km^2)	Average discharge (m^3/s)	Outflow	Countries in the drainage basin
1.	Nile – Kagera	6,853 (6,650)	4,258 (4,132)	3,254,555	5,100	Mediterranean	Ethiopia, Eritrea, Sudan, Uganda, Tanzania, Kenya, Rwanda, Burundi, Egypt, Democratic Republic of the Congo, South Sudan
2.	Amazon – Ucayali – Apurímac	6,992 (6,400)	4,345 (3,976)	7,050,000	219,000	Atlantic Ocean	Brazil, Peru, Bolivia, Colombia, Ecuador,

							Venezuela, Guyana
3.	Yangtze (Chang Jiang; Long River)	6,300 (6,418)	3,917 (3,988)	1,800,000	31,900	East China Sea	China
4.	Mississippi–Missouri–Jefferson	6,275	3,902	2,980,000	16,200	Gulf of Mexico	United States (98.5%), Canada (1.5%)
5.	Yenisei–Angara–Selenge	5,539	3,445	2,580,000	19,600	Kara Sea	Russia (97%), Mongolia (2.9%)
6.	Yellow River (Huang He)	5,464	3,395	745,000	2,110	Bohai Sea	China
7.	Ob–Irtysh	5,410	3,364	2,990,000	12,800	Gulf of Ob	Russia, Kazakhstan, China, Mongolia
8.	Paraná – Río de la Plata	4,880	3,030	2,582,672	18,000	Río de la Plata	Brazil (46.7%), Argentina (27.7%), Paraguay (13.5%), Bolivia (8.3%), Uruguay (3.8%)
9.	Congo–Chambeshi (Zaïre)	4,700	2,922	3,680,000	41,800	Atlantic Ocean	Democratic Republic of the Congo, Central African Republic, Angola, Republic of the Congo, Tanzania, Cameroo

							n, Zambia, Burundi, Rwanda
10.	Amur–Argun (Heilong Jiang)	4,444	2,763	1,855,000	11,400	Sea of Okhotsk	Russia, China, Mongolia
11.	Lena	4,400	2,736	2,490,000	17,100	Laptev Sea	Russia
12.	Mekong (Lancang Jiang)	4,350	2,705	810,000	16,000	South China Sea	China, Myanmar, Laos, Thailand, Cambodi a, Vietnam
13.	Mackenzie–Slave–Peace–Finlay	4,241	2,637	1,790,000	10,300	Beaufort Sea	Canada
14.	Niger	4,200	2,611	2,090,000	9,570	Gulf of Guinea	Nigeria (26.6%), Mali (25.6%), Niger (23.6%), Algeria (7.6%), Guinea (4.5%), Cameroo n (4.2%), Burkina Faso (3.9%), Côte d'Ivoire, Benin, Chad
15.	Murray–Darling	3,672	2,282	1,061,000	767	Southern Ocean	Australia
16.	Tocantins–Araguaia	3,650	2,270	950,000	13,598	Atlantic Ocean, Amazon	Brazil
17.	Volga	3,645	2,266	1,380,000	8,080	Caspian Sea	Russia
18.	Shatt al-Arab – Euphrates	3,596	2,236	884,000	856	Persian Gulf	Iraq (60.5%), Turkey

							(24.8%), Syria (14.7%)
19.	Madeira–Mamoré–Grande–Caine–Rocha	3,380	2,100	1,485,200	31,200	Amazon	Brazil, Bolivia, Peru
20.	Purús	3,211	1,995	63,166	8,400	Amazon	Brazil, Peru
21.	Yukon	3,185	1,980	850,000	6,210	Bering Sea	United States (59.8%), Canada (40.2%)
22.	Indus	3,180	1,976	960,000	7,160	Arabian Sea	Pakistan (93%), India, China
23.	São Francisco	3,180* (2,900)	1,976* (1,802)	610,000	3,300	Atlantic Ocean	Brazil
24.	Syr Darya – Naryn	3,078	1,913	219,000	703	Aral Sea	Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan
25.	Salween (Nu Jiang)	3,060	1,901	324,000	3,153	Andaman Sea	China (52.4%), Myanmar (43.9%), Thailand (3.7%)
26.	Saint Lawrence – Great Lakes	3,058	1,900	1,030,000	10,100	Gulf of Saint Lawrence	Canada (52.1%), United States (47.9%)
27.	Rio Grande	3,057	1,900	570,000	82	Gulf of Mexico	United States (52.1%), Mexico (47.9%)
28.	Lower Tunguska	2,989	1,857	473,000	3,600	Yenisei	Russia
29.	Brahmaputra–	2,948*	1,832*	1,730,000	19,200	Ganges	India

	Tsangpo						(58.0%), China (19.7%), Nepal (9.0%), Bangladesh (6.6%), Disputed India/China (4.2%), Bhutan (2.4%)
30.	Danube–Breg (Duna)	2,888*	1,795*	817,000	7,130	Black Sea	Romania (28.9%), Hungary (11.7%), Austria (10.3%), Serbia (10.3%), Germany (7.5%), Slovakia (5.8%), Bulgaria (5.2%), Croatia (4.5%),
31.	Zambezi (Zambesi)	2,693*	1,673*	1,330,000	4,880	Mozambique Channel	Zambia (41.6%), Angola (18.4%), Zimbabwe (15.6%), Mozambique (11.8%), Malawi (8.0%), Tanzania (2.0%), Namibia, Botswana

32.	Vilyuy	2,650	1,647	454,000	1,480	Lena	Russia
33.	Araguaia	2,627	1,632	358,125	5,510	Tocantins	Brazil
34.	Ganges–Hooghly–Padma (Ganga)	2,620	1,628	907,000	12,037	Bay of Bengal	India, Bangladesh, Nepal, China
35.	Amu Darya -- Panj	2,620	1,628	534,739	1,400	Aral Sea	Uzbekistan, Turkmenistan, Tajikistan, Afghanistan
36.	Japurá (Rio Yapurá)	2,615*	1,625*	242,259	6,000	Amazon	Brazil, Colombia
37.	Nelson–Saskatchewan	2,570	1,597	1,093,000	2,575	Hudson Bay	Canada, United States
38.	Paraguay (Rio Paraguay)	2,549	1,584	900,000	4,300	Paraná	Brazil, Paraguay, Bolivia, Argentina
39.	Kolyma	2,513	1,562	644,000	3,800	East Siberian Sea	Russia
40.	Pilcomayo	2,500	1,553	270,000		Paraguay	Paraguay, Argentina, Bolivia
41.	Upper Ob -- Katun	2,490	1,547			Ob	Russia
42.	Ishim	2,450	1,522	177,000	56	Irtysh	Kazakhstan, Russia
43.	Juruá	2,410	1,498	200,000	6,000	Amazon	Peru, Brazil
44.	Ural	2,428	1,509	237,000	475	Caspian Sea	Russia, Kazakhstan
45.	Arkansas	2,348	1,459	505,000 (435,122)	1,066	Mississippi	United States
46.	Colorado (western U.S.)	2,333	1,450	390,000	1,200	Gulf of California	United States, Mexico
47.	Olenyok	2,292	1,424	219,000	1,210	Laptev Sea	Russia

48.	Dnieper	2,287	1,421	516,300	1,670	Black Sea	Russia, Belarus, Ukraine
49.	Aldan	2,273	1,412	729,000	5,060	Lena	Russia
50.	Ubangi–Uele	2,270	1,410	772,800	4,000	Congo	Democratic Republic of the Congo, Central African Republic, Republic of Congo
51.	Negro	2,250	1,398	720,114	26,700	Amazon	Brazil, Venezuela, Colombia
52.	Columbia	2,250 (1,953)	1,398 (1,214)	415,211	7,500	Pacific Ocean	United States, Canada
53.	Pearl – Zhu Jiang	2,200	1,376	437,000	13,600	South China Sea	China (98.5%), Vietnam (1.5%)
54.	Red (USA)	2,188	1,360	78,592	875	Mississippi	United States
55.	Ayeyarwady (Irrawaddy)	2,170	1,348	411,000	13,000	Andaman Sea	Myanmar
56.	Kasai	2,153	1,338	880,200	10,000	Congo	Angola, Democratic Republic of the Congo
57.	Ohio–Allegheny	2,102	1,306	490,603	7,957	Mississippi	United States
58.	Orinoco	2,101	1,306	1,380,000	33,000	Atlantic Ocean	Venezuela, Colombia, Guyana
59.	Tarim	2,100	1,305	557,000		Lop Nur	P. R. China
60.	Xingu	2,100	1,305			Amazon	Brazil
61.	Orange	2,092	1,300			Atlantic Ocean	South Africa,

							Namibia, Botswana, Lesotho
62.	Northern Salado	2,010	1,249			Paraná	Argentina
63.	Vitim	1,978	1,229			Lena	Russia
64.	Tigris	1,950	1,212			Shatt al-Arab	Turkey, Iraq, Syria
65.	Songhua	1,927	1,197			Amur	P. R. China
66.	Tapajós	1,900	1,181			Amazon	Brazil
67.	Don	1,870	1,162	425,600	935	Sea of Azov	Russia, Ukraine
68.	Stony Tunguska	1,865	1,159	240,000		Yenisei	Russia
69.	Pechora	1,809	1,124	322,000		Barents Sea	Russia
70.	Kama	1,805	1,122	507,000		Volga	Russia
71.	Limpopo	1,800	1,118	413,000		Indian Ocean	Mozambique, Zimbabwe, South Africa, Botswana
72.	Guaporé (Itenez)	1,749	1,087			Mamoré	Brazil, Bolivia
73.	Indigirka	1,726	1,072	360,400	1,810	East Siberian Sea	Russia
74.	Snake	1,670	1,038	279,719	1,611	Columbia	United States
75.	Senegal	1,641	1,020	419,659		Atlantic Ocean	Guinea, Senegal, Mali, Mauritania
76.	Uruguay	1,610	1,000	370,000		Atlantic Ocean	Uruguay, Argentina, Brazil
77.	Murrumbidgee River	1,600	994			Murray River	Australia
77.	Blue Nile	1,600	994	326,400		Nile	Ethiopia, Sudan
77.	Churchill	1,600	994			Hudson Bay	Canada
77.	Khatanga	1,600	994			Laptev Sea	Russia
77.	Okavango	1,600	994			Okavango Delta	Namibia, Angola,

							Botswana
77.	Volta	1,600	994			Gulf of Guinea	Ghana, Burkina Faso, Togo, Côte d'Ivoire, Benin
83.	Beni	1,599	994	283,350	8,900	Madeira	Bolivia
84.	Platte	1,594	990			Missouri	United States
85.	Tobol	1,591	989			Irtysh	Kazakhst an, Russia
86.	Jubba–Shebelle	1,580*	982*			Indian Ocean	Ethiopia, Somalia
87.	Içá (Putumayo)	1,575	979			Amazon	Brazil, Peru, Colombia , Ecuador
88.	Magdalena	1,550	963	263,858	9,000	Caribbean	Colombia
89.	Han	1,532	952			Yangstze	P. R. China
90.	Kura	1,515	941			Caspian Sea	Turkey, Georgia, Azerbaija n
91.	Oka	1,500	932			Volga	Russia
92.	Guaviare	1,497	930			Orinoco	Colombia
93.	Pecos	1,490	926			Rio Grande	United States
94.	Upper Yenisei -- Little Yenisei (Kaa-Hem)	1,480	920			Yenisei	Russia, Mongolia
95.	Godavari	1,465	910	312,812	3,061	Bay of Bengal	India
96.	Colorado (Texas)	1,438	894			Gulf of Mexico	United States
96.	Río Grande (Guapay)	1,438	894	102,600	264	Ichilo	Bolivia
98.	Oder-Warta	1,425				Baltic Sea	Poland, Germany
99.	Belaya	1,420	882			Kama	Russia
99.	Cooper–Barcoo	1,420	880			Lake Eyre	Australia
101.	Marañón	1,415	879			Amazon	Peru

102.	Dniester	1,411 (1,352)	877 (840)			Black Sea	Ukraine, Moldova
103.	Benue	1,400	870			Niger	Cameroon, Nigeria
103.	Ili (Yili)	1,400	870			Lake Balkhash	P. R. China, Kazakhstan
103.	Warburton–Georgina	1,400	870			Lake Eyre	Australia
106.	Sutlej	1,372	852			Chenab	China, India, Pakistan
107.	Yamuna	1,370	851	366,223	2,950	Ganges	India
107.	Vyatka	1,370	851			Kama	Russia
109.	Fraser	1,368	850	220,000	3,475	Pacific Ocean	Canada
110.	Mtkvari (Kura)	1,364	848			Caspian Sea	Azerbaijan, Georgia, Armenia, Turkey, Iran
111.	Grande	1,360	845			Paraná	Brazil
112.	Brazos	1,352	840			Gulf of Mexico	United States
113.	Cauca	1,350	839			Magdalena	Colombia
114.	Liao	1,345	836			Bohai Sea	P. R. China
115.	Yalong	1,323	822			Yangtze	P. R. China
116.	Iguaçu	1,320	820			Paraná	Brazil, Argentina
116.	Olyokma	1,320	820			Lena	Russia
118.	Northern Dvina – Sukhona	1,302	809	357,052	3,332	White Sea	Russia
119.	Krishna	1,300	808			Bay of Bengal	India
119.	Iriri	1,300	808			Xingu	Brazil
121.	Narmada	1,289	801			Arabian Sea	India
122.	Lomami	1,280	795			Congo	Democratic Republic of the Congo
123.	Ottawa	1,271	790	146,300	1,950	Saint Lawrence	Canada

124.	Lerma - Rio Grande de Santiago	1,270	789	119,543		Pacific	Mexico
125.	Elbe–Vltava	1,252	778	148,268	711	North Sea	Germany, Czech Republic
126.	Zeya	1,242	772			Amur	Russia
127.	Juruena	1,240	771			Tapajós	Brazil
128.	Upper Mississippi	1,236	768			Mississippi	United States
129.	Rhine	1,233	768	198,735	2,330	North Sea	Germany, France, Switzerland, Netherlands, Austria, Liechtenstein, Italy (minimal), Belgium, Luxembourg
130.	Athabasca	1,231	765	95,300		Mackenzie	Canada
131.	Canadian	1,223	760			Arkansas	United States
132.	North Saskatchewan	1,220	758			Saskatchewan	Canada
133.	Vaal	1,210	752			Orange	South Africa
134.	Shire	1,200	746			Zambezi	Mozambique, Malawi
135.	Nen (Nonni)	1,190	739			Songhua	P. R. China
136.	Kızıl River	1,182	734	115,000	400	Black Sea	Turkey
137.	Green	1,175	730			Colorado (western U.S.)	United States
138.	Milk	1,173	729			Missouri	United States, Canada
139.	Chindwin	1,158	720			Ayeyarwady	Myanmar
140.	Sankuru	1,150	715			Kasai	Democratic Republic of the

							Congo
140.	Wu	1,150	715	80,300	1,108	Yangtze River	China
141.	Red (Asia)	1,149	714	143,700	2,640	Gulf of Tonkin	China, Vietnam
142.	James (Dakotas)	1,143	710			Missouri	United States
142.	Kapuas	1,143	710			South China Sea	Indonesia
144.	Desna	1,130	702	88,900	360	Dnieper	Russia, Belarus, Ukraine
144.	Helmand	1,130	702			Hamun-i-Helmand	Afghanistan, Iran
144.	Madre de Dios	1,130	702	125,000	4,915	Beni	Peru, Bolivia
144.	Tietê	1,130	702			Paraná	Brazil
144.	Vychegda	1,130	702			Northern Dvina	Russia
149.	Sepik	1,126	700	77,700		Pacific Ocean	Papua New Guinea, Indonesia
150.	Cimarron	1,123	698			Arkansas	United States
151.	Anadyr	1,120	696			Gulf of Anadyr	Russia
151.	Paraíba do Sul	1,120	696			Atlantic Ocean	Brazil
153.	Jialing River	1,119	695			Yangtze	P. R. China
154.	Liard	1,115	693			Mackenzie	Canada
155.	Cumberland	1,105	687	46,830	862	Mississippi	United States
156.	White	1,102	685			Mississippi	United States
157.	Huallaga	1,100	684			Marañón	Peru
157.	Kwango	1,100	684	263,500	2,700	Kasai	Angola, Democratic Republic of the Congo
157.	Draa	1,100	684			Atlantic	Morocco
160.	Gambia	1,094	680			Atlantic	The Gambia, Senegal, Guinea

161.	Chenab	1,086	675			Indus	India, Pakistan
162.	Yellowstone	1,080	671	114,260		Missouri	United States
162.	Ghaghara	1,080	671	127,950	2,990	Ganges	India, Nepal, China
164.	Huai River	1,078	670	270,000	1,110	Yangtze River	China
165.	Aras	1,072	665	102,000	285	Kura	Turkey, Armenia, Azerbaija n, Iran
166.	Chu River	1,067	663	62,500		none	Kyrgyzsta n, Kazakhst an
167.	Seversky Donets	1,078 (1,053)	670 (654)			Don	Russia, Ukraine
168.	Bermejo	1,050	652			Paraguay	Argentina , Bolivia
168.	Fly	1,050	652			Gulf of Papua	Papua New Guinea, Indonesia
168.	Kuskokwim	1,050	652			Bering Sea	United States
171.	Tennessee	1,049	652			Ohio	United States
172.	Vistula	1,047	630	194,424	1,080	Baltic Sea	Poland
173.	Aruwimi	1,030	640			Congo River	Democrat ic Republic of the Congo
174.	Daugava	1,020	634	87,900	678	Gulf of Riga	Latvia, Belarus, Russia
175.	Gila	1,015	631			Colorado (western U.S.)	United States
176.	Loire	1,012	629	115,271	840	Atlantic Ocean	France
177.	Essequibo	1,010	628			Atlantic Ocean	Guyana
177.	Khoper	1,010	628			Don	Russia
179.	Tagus (Tajo/Tejo)	1,006	625	80,100		Atlantic Ocean	Spain, Portugal

Riverside cities in the world

City	River	Country
Alexandria	Nile	Egypt
Amsterdam	Amsel	Netherlands
Antwerp	Scheldt	Belgium
Ankara	Kizil	Turkey
Baghdad	Tigris	Iraq
Bangkok	Menam	Thailand
Belgrade	Danube	Yugoslavia
Berlin	Spree	Germany
Bonn	Rhine	Germany
Bristol	Avon	England
Budapest	Danube	Hungary
Cairo	Nile	Egypt
Canton	Canton	China
Chittagong	Karnaphuli	Bangladesh
Chungking	Yang-tse-kiang	China
Cologne	Rhine	Germany
Glasgow	Clyde	Scotland
Hull	Humber	England
Hamburg	Elbe	Germany
Karachi	Indus	Pakistan
Khartoum	Blue & White Nile	Sudan
Lahore	Ravi	Pakistan
Lisbon	Tagus	Portugal
Liverpool	Mersey	England
London	Thames	England
Montreal	Ottawa	Canada
Moscow	Moskva	Russia
Nanking	Yang-tse-kiang	China
New Orleans	Mississippi	USA
New York	Hudson	USA
Paris	Seine	France
Philadelphia	Delaware	USA
Quebec	St. Lawrence	Canada
Rangoon (Yangoon)	Irawadi	Burma
Rome	Tiber	Italy
Shanghai	Yang-tse-kiang	China
Tokyo	Sumida	Japan
Vienna	Danube	Austria
Warsaw	Vistula	Poland

Washington	Potamac	USA

Geological development

India is situated entirely on the Indian Plate, a major tectonic plate that was formed when it split off from the ancient continent Gondwanaland (ancient landmass, consisting of the southern part of the supercontinent of Pangea). The Indo-Australian is subdivided into the Indian and Australian plates. About 90 million years ago, during the late Cretaceous Period, the Indian Plate began moving north at about 15 cm/year (6 in/yr). About 50 to 55 million years ago, in the Eocene Epoch of the Cenozoic Era, the plate collided with Asia after covering a distance of 2,000 to 3,000 km (1,243 to 1,864 mi), having moved faster than any other known plate. In 2007, German geologists determined that the Indian Plate was able to move so quickly because it is only half as thick as the other plates which formerly constituted Gondwanaland. The collision with the Eurasian Plate along the modern border between India and Nepal formed the orogenic belt that created the Tibetan Plateau and the Himalayas. As of 2009, the Indian Plate is moving northeast at 5 cm/yr (2 in/yr), while the Eurasian Plate is moving north at only 2 cm/yr (0.8 in/yr). India is thus referred to as the "fastest continent". This is causing the Eurasian Plate to deform, and the Indian Plate to compress at a rate of 4 cm/yr (1.6 in/yr).

Plate tectonics

The Indian Craton was once part of the supercontinent of Pangaea. At that time, what is now India's southwest coast was attached to Madagascar and southern Africa, and what is now its east coast was attached to Australia. During the Jurassic Period about 160 Ma (ICS 2004), rifting caused Pangaea to break apart into two supercontinents, namely Gondwana (to the south) and Laurasia (to the north). The Indian Craton remained attached to Gondwana, until the supercontinent began to rift apart about in the early Cretaceous, about 125 million years ago (ICS 2004). The Indian Plate then drifted northward toward the Eurasian Plate, at a pace that is the fastest known movement of any plate. It is generally believed that the Indian Plate separated from Madagascar about 90 Million years ago (ICS 2004), however some biogeographical and geological evidence suggests that the connection between Madagascar and Africa was retained at the time when the Indian Plate collided with the Eurasian Plate about 50 Million years ago (ICS 2004). This orogeny, which is continuing today, is related to closure of the Tethys Ocean. The closure of this ocean which created the Alps in Europe, and the Caucasus range in western Asia, created the Himalaya Mountains and the Tibetan Plateau in South Asia. The current orogenic event is causing parts of the Asian continent to deform westward and eastward on either side of the orogen. Concurrently with this collision, the Indian Plate sutured on to the adjacent Australian Plate, forming a new larger plate, the Indo-Australian Plate.

Tectonic evolution

The earliest phase of tectonic evolution was marked by the cooling and solidification of the upper crust of the earth's surface in the Archaean Era (prior to 2.5 billion years) which is represented by the exposure of gneisses and granites especially on the Peninsula. These form the core of the Indian Craton. The Aravalli Range is the remnant of an early Proterozoic orogen called the Aravali-Delhi Orogen that joined the two older segments that make up the Indian Craton. It extends approximately 500 kilometres (311 mi) from its northern end to isolated hills and rocky ridges into Haryana, ending near Delhi.

Minor igneous intrusions, deformation (folding and faulting) and subsequent metamorphism of the Aravalli Mountains represent the main phase of orogenesis. The erosion of the mountains, and further deformation of the sediments of the Dharwarian group (Bijawars) marks the second phase. The volcanic activities and intrusions, associated with this second phase are recorded in the composition of these sediments.

Early to Late Proterozoic(2.5 to 0.54 billion years) calcareous and arenaceous deposits, which correspond to humid and semi-arid climatic regimes, were deposited the Cuddapah and Vindhyan basins. These basins which border or lie within the existing crystalline basement, were uplifted during the Cambrian (500 Ma (ICS 2004)). The sediments are generally undeformed and have in many places preserved their original horizontal stratification. The Vindhyans are believed to have been deposited between ~1700 and 650 Ma (ICS 2004).

Early Paleozoic rocks are found in the Himalayas and consist of southerly derived sediments eroded from the crystalline craton and deposited on the Indian platform.

In the Late Paleozoic, Permo-Carboniferous glaciations left extensive glacio-fluvial deposits across central India, in new basins created by sag/normal faulting. These tillites and glacially derived sediments are designated the Gondwanas series. The sediments are overlain by rocks resulting from a Permian marine transgression (270 Ma (ICS 2004)).

The late Paleozoic coincided with the deformation and drift of the Gondwana supercontinent. To this drift, the uplift of the Vindhyan sediments and the deposition of northern peripheral sediments in the Himalayan Sea, can be attributed.

During the Jurassic, as Pangea began to rift apart, large grabens formed in central India filling with Upper Jurassic and Lower Cretaceous sandstones and conglomerates.

By the Late Cretaceous India had separated from Australia and Africa and was moving northward towards Asia. At this time, prior to the Deccan eruptions, uplift in southern India resulted in sedimentation in the adjacent nascent Indian Ocean. Exposures of these rocks occur along the south Indian coast at Pondicherry and in Tamil Nadu.

At the close of the Mesozoic one of the greatest volcanic eruptions in earth's history occurred, the Deccan lava flows. Covering more than 500,000 square kilometres (193,051 sq mi) area, these mark the final break from Gondwana.

In the early Tertiary, the first phase of the Himalayan orogeny, the Karakoram phase occurred. The Himalayan orogeny has continued to the present day.

Major rock groups

Precambrian super-eon

A considerable area of peninsular India, the Indian Shield, consists of Archean gneisses and schists which are the oldest rocks found in India. The Precambrian rocks of India have been classified into two systems, namely the Dharwar system and the Archaean system.

The rocks of the Dharwar system are mainly sedimentary in origin, and occur in narrow elongated synclines resting on the gneisses found in Bellary district, Mysore and the Aravalis of Rajputana. These rocks are enriched in manganese and iron ore which represents a significant resource of these metals. They are also extensively mineralised with gold most notably the Kolar gold mines located in Kolar. In the north and west of India, the Vaikrita system, which occurs in Hundes, Kumaon and Spiti areas, the Dailing series in Sikkim and the Shillong series in Assam are believed to be of the same age as the Dharwar system.

The metamorphic basement consists of gneisses which are further classified into the Bengal gneiss, the Bundelkhand gneiss and the Nilgiri gneiss. The Nilgiri system comprises charnockites ranging from granites to gabbros.

Phanerozoic

Palaeozoic

Lower Paleozoic

Rocks of the earliest part of the Cambrian Period are found in the Salt range in Punjab and the Spiti are in central Himalayas and consist of a thick sequence of fossiliferous sediments. In the Salt range, the stratigraphy starts with the Salt Pseudomorph zone, which has a thickness of 450 feet (137 m) and consists of dolomites and sandstones. It is overlain by magnesian sandstones with a thickness of 250 feet (76 m), similar to the underlying dolomites. These sandstones have very few fossils. Overlying the sandstones is the Neobolus Shale, which is composed of dark shales with a thickness of 100 feet (30 m). Finally there is a zone consisting of red or purple sandstones having a thickness of 250 feet (76 m) to 400 feet (122 m) called the Purple Sandstone. These are unfossiliferous and show sun-cracks and worm burrows which are typical of subaerial weathering. The deposits in Spiti are known as the

Haimanta system and they consist of slates, micaceous quartzite and dolomitic limestones. The Ordovician rocks comprise flaggy shales, limestones, red quartzites, quartzites, sandstones and conglomerates. Siliceous limestones belonging to the Silurian overlie the Ordovician rocks. These limestones are in turn overlain by white quartzite and this is known as Muth quartzite. Silurian rocks which contain typical Silurian fauna are also found in the Vihi district of Kashmir.

Upper Paleozoic

Devonian fossils and corals are found in grey limestone in the central Himalayas and in black limestone in the Chitral area. The Carboniferous is composed of two distinct sequences, the upper Carboniferous Po, and the lower Carboniferous Lipak. Fossils of brachiopods and some trilobites are found in the calcareous and sandy rocks of the Lipak series. The Syringothyris limestone in Kashmir also belongs to the Lipak. The Po series overlies the Lipak series, and the Fenestella shales are interbedded within a sequence of quartzites and dark shales. In many places Carboniferous strata are overlaid by grey agglomeratic slates, believed to be of volcanic origin. Many genera of productids are found in the limestones of the Permo-Triassic, which has led to these rocks being referred to as "productus limestone". This limestone is of marine origin and is divided into three distinct lithostratigraphic units based on the productus chronology: the Late Permian Chideru, which contains many ammonites, the Late — Middle Permian Virgal, and the Middle Permian Amb unit.

Mesozoic

In the Triassic the Ceratite beds, named after the ammonite ceratite, consist of arenaceous limestones, calcerous sandstones and marls. The Jurassic consists of two distinct units. The Kioto limestone, extends from the lower the middle Jurassic with a thickness 2,000 feet (610 m) to 3,000 feet (914 m). The upper Jurassic is represented by the Spiti black shales, and stretches from the Karakoram to Sikkim. Cretaceous rocks are cover an extensive area in India. In South India, the sedimentary rocks are divided into four stages; the Niniyur, the Ariyalur, the Trichinopoly(a district in the Madras Presidency, covering present-day districts of Tiruchirappalli, Karur, Ariyalur and Perambalur), and the Utatur stages. In the Utatur stage the rocks host phosphatic nodules, which constitute an important source of phosphates in the country. In the central provinces, the well developed beds of Lameta contain fossil records which are helpful in estimating the age of the Deccan Traps. This sequence of basaltic rocks was formed near the end of the Cretaceous period due to volcanic activity. These lava flows occupy an area of 200,000 square miles (520,000 km2). These rocks are a source of high quality building stone and also provide a very fertile clayey loam, particularly suited to cotton cultivation.

Cenozoic

Tertiary period

In this period the Himalayan orogeny began, and the volcanism associated with the Deccan Traps continued. The rocks of this era have valuable deposits of petroleum and coal. Sandstones of Eocene age are found in Punjab, which grade into chalky limestones with oil seepages. Further north the rocks found in the Simla area are divided into three series, the Sabathu series consisting of grey and red shales, the Dagshai series comprising bright red clays and the Kasauli series comprising sandstones. Towards the east in Assam, Nummulitic limestone is found in the Khasi hills. Oil is associated with these rocks of the Oligo-Miocene age. Along the foothills of the Himalayas the Siwalik molasse is composed of sandstones, conglomerates and shales with thicknesses of 16,000 feet (4,877 m) to 20,000 feet (6,096 m) and ranging from Eocene to Pliocene. These rocks are famous for their rich fossil vertebrate fauna including many fossil hominoids.

Quaternary period

The alluvium which is found in the Indo-Gangetic plain belongs to this era. It was eroded from the Himalayas by the rivers and the monsoons. These alluvial deposits consist of clay, loam, silt etc. and are divided into the older alluvium and the newer alluvium. The older alluvium is called Bhangar and is present in the ground above the flood level of the rivers. Khaddar or newer alluvium is confined to the river channels and their flood plains. This region has some of the most fertile soil found in the country as new silt is continually laid down by the rivers every year.

Earthquakes

The Indian subcontinent has a history of devastating earthquakes. The major reason for the high frequency and intensity of the earthquakes is that the Indian plate is driving into Asia at a rate of approximately 47 mm/year. Geographical statistics of India show that almost 54% of the land is vulnerable to earthquakes. A World Bank & United Nations report shows estimates that around 200 million city dwellers in India will be exposed to storms and earthquakes by 2050.

Center for Seismology

Center for Seismology, Ministry of Earth Sciences is nodal agency of Government of India dealing with various activities in the field of seismology and allied disciplines. The major activities currently being pursued by the Center for Seismology include, a) earthquake monitoring on 24X7 basis, including real time seismic monitoring for early warning of tsunamis, b) Operation and maintenance of national seismological network and local networks c) Seismological data centre and information services, d) Seismic hazard and risk related studies e) Field studies for aftershock / swarm monitoring, site response studies f) earthquake processes and modelling, etc. The MSK (Medvedev-Sponheuer-Karnik) intensity broadly associated with the various seismic zones is VI (or less), VII, VIII and IX (and above) for Zones 2, 3, 4 and 5, respectively, corresponding to Maximum Considered Earthquake (MCE). The IS code follows a dual design philosophy: (a) under low probability or extreme earthquake events (MCE) the structure damage should not result in total collapse, and (b) under more frequently occurring earthquake events, the structure should suffer only minor or moderate structural damage. The specifications given in the design code (IS 1893: 2002) are not based on detailed assessment of maximum ground acceleration in each zone using a deterministic or probabilistic approach. Instead, each zone factor represents the effective period peak ground accelerations that may be generated during the maximum considered earthquake ground motion in that zone.

Each zone indicates the effects of an earthquake at a particular place based on the observations of the affected areas and can also be described using a descriptive scale like Modified Mercalli intensity scale or the Medvedev–Sponheuer–Karnik scale.

Zone 5

Zone 5 covers the areas with the highest risks zone that suffers earthquakes of intensity MSK IX or greater. The IS code assigns zone factor of 0.36 for Zone 5. Structural designers use this factor for earthquake resistant design of structures in Zone 5. The zone factor of 0.36 is indicative of effective (zero period) level earthquake in this zone. It is referred to as the Very High Damage Risk Zone. The region of Kashmir, the western and central Himalayas, North and Middle Bihar, the North-East Indian region and the Rann of Kutch fall in this zone.

Generally, the areas having trap rock or basaltic rock are prone to earthquakes.

Zone 4

This zone is called the High Damage Risk Zone and covers areas liable to MSK VIII. The IS code assigns zone factor of 0.24 for Zone 4. The Indo-Gangetic basin and the capital of the country (Delhi), Jammu and Kashmir fall in Zone 4. In Maharashtra, the Patan area (Koyananager) is also in zone no-4. In Bihar the northern part of the state like- Raksaul, Near the border of India and Nepal, is also in zone no-4 that "almost 80 percent of buildings in Delhi will yield to a major quake and in case of an unfortunate disaster, the political hub of India in Lutyens Delhi, the glitz of Connaught Place and the magnificence of the Walled City will all come crumbling down."

Saket Suman of The Statesman reported on New Delhi's proximity to a major quake in his report

Zone 3

The Andaman and Nicobar Islands, parts of Kashmir, Western Himalayas fall under this zone. This zone is classified as Moderate Damage Risk Zone which is liable to MSK VII. and also 7.8 The IS code assigns zone factor of 0.16 for Zone 3.

Zone 2

This region is liable to MSK VI or less and is classified as the Low Damage Risk Zone. The IS code assigns zone factor of 0.10 (maximum horizontal acceleration that can be experienced by a structure in this zone is 10% of gravitational acceleration) for Zone 2.

Zone 1

Since the current division of India into earthquake hazard zones does not use Zone 1, no area of India is classed as Zone 1.

Future changes in the classification system may or may not return this zone to use.

Political geography

India is divided into 29 states (further subdivided into districts) and 7 union territories.

India's borders run a total length of 15,106.70 km (9,386.87 mi). Its borders with Pakistan and Bangladesh were delineated according to the Radcliffe Line, which was created in 1947 during Partition of India. Its western border with Pakistan extends up to 3,323 km (2,065 mi), dividing the Punjab region and running along the boundaries of the Thar Desert and the Rann of Kutch. This border runs along the Indian states of Jammu & Kashmir, Rajasthan, Gujarat, and Punjab. Both nations delineated a Line of Control (LoC) to serve as the informal boundary between the Indian and Pakistan-administered areas of Kashmir. According to India's claim, it also shares a 106 km (66 mi) border with Afghanistan in northwestern Kashmir, which is under Pakistani control.

India's border with Bangladesh runs 4,096.70 km (2,545.57 mi). West Bengal, Assam, Meghalaya, Tripura and Mizoram are the States which share the border with Bangladesh. Before 2015, there were 92 enclaves of Bangladesh on Indian soil and 106 enclaves of India were on Bangladeshi soil. These enclaves were eventually exchanged in order to simplify the border. After the exchange, India lost roughly 40 km² (10,000 acres) to Bangladesh.

The Line of Actual Control (LAC) is the effective border between India and the People's Republic of China. It traverses 4,057 km along the Indian states of Jammu and Kashmir, Uttarakhand, Himachal Pradesh, Sikkim and Arunachal Pradesh. The border with Burma (Myanmar) extends up to 1,643 km (1,021 mi) along the southern borders of India's northeastern states viz. Arunachal Pradesh, Nagaland, Manipur and Mizoram. Located amidst the Himalayan range, India's border with Bhutan runs 699 km (434 mi). Sikkim, West Bengal, Assam and Arunachal Pradesh are the States, which share the border with Bhutan. The border with Nepal runs 1,751 km (1,088 mi) along the foothills of the Himalayas in northern India. Uttarakhand, Uttar Pradesh, Bihar, West Bengal and

Sikkim are the States, which share the border with Nepal. The Siliguri Corridor, narrowed sharply by the borders of Bhutan, Nepal and Bangladesh, connects peninsular India with the northeastern states.

Responsibilities and authorities

The Constitution of India distributes the sovereign powers exercisable with respect to the territory of any State between the Union and that State. "Article 73 broadly stated, provides that the executive power of the Union shall extend to the matters with respect to which Parliament has power to make laws. Article 162 similarly provides that the executive power of a State shall extend to the matters with respect to which the Legislature of a State has power to make laws. The Supreme Court has reiterated this position when it ruled in the Ramanaiah case that the executive power of the Union or of the State broadly speaking, is coextensive and coterminous with its respective legislative power." (italics in original)

History

Pre-Independence

The Indian Subcontinent has been ruled by many different ethnic groups throughout its history, each instituting their own policies of administrative division in the region. During the British Raj, the original administrative structure was mostly kept, and India was divided into provinces (also called Presidencies) that were directly governed by the British and princely states which were nominally controlled by a local prince or raja loyal to the British Empire, who held de facto sovereignty (suzerainty) over the princely states.

1947-50

Between 1947 and 1950, the territories of the princely states were politically integrated into the Indian Union. Most were merged into existing provinces; others were organised into new provinces, such as Rajputana, Himachal Pradesh, Madhya Bharat, and Vindhya Pradesh, made up of multiple princely states; a few, including Mysore, Hyderabad, Bhopal, and Bilaspur, became separate provinces. The new Constitution of India, which came into force on 26 January 1950, made India a sovereign democratic republic. The new republic was also declared to be a "Union of States". The constitution of 1950 distinguished between three main types of states:

- Part A states, which were the former governors' provinces of British India, were ruled by an elected governor and state legislature. The nine Part A states were Assam, Bihar, Bombay, Madhya Pradesh (formerly Central Provinces and Berar), Madras, Orissa, Punjab (formerly East Punjab), Uttar Pradesh (formerly the United Provinces), and West Bengal.
- The eight Part B states were former princely states or groups of princely states, governed by a rajpramukh, who was usually the ruler of a constituent state, and

an elected legislature. The rajpramukh was appointed by the President of India. The Part B states were Hyderabad, Jammu and Kashmir, Madhya Bharat, Mysore, Patiala and East Punjab States Union (PEPSU), Rajasthan, Saurashtra, and Travancore-Cochin.

- The ten Part C states included both the former chief commissioners' provinces and some princely states, and each was governed by a chief commissioner appointed by the President of India. The Part C states were Ajmer, Bhopal, Bilaspur, Coorg, Delhi, Himachal Pradesh, Cutch, Manipur, Tripura, and Vindhya Pradesh.
- The only Part D state was the Andaman and Nicobar Islands, which were administered by a lieutenant governor appointed by the central government.

States Reorganization (1951-56)

The Union Territory of Puducherry was created in 1954 comprising the previous French enclaves of Pondichéry, Karaikal, Yanam and Mahé. Andhra State was created on October 1, 1953 from the Telugu-speaking northern districts of Madras State.

The States Reorganisation Act of 1956 reorganized the states based on linguistic lines resulting in the creation of the new states. As a result of this act, Madras State retained its name with Kanyakumari district added to from Travancore-Cochin. Andhra Pradesh was created with the merger of Andhra State with the Telugu-speaking districts of Hyderabad State in 1956. Kerala was created with the merger of Malabar district and the Kasaragod taluk of South Canara districts of Madras State with Travancore-Cochin. Mysore State was re-organized with the addition of districts of Bellary and South Canara (excluding Kasaragod taluk) and the Kollegal taluk of Coimbatore district from the Madras State, the districts of Belgaum, Bijapur, North Canara and Dharwad from Bombay State, the Kannada-majority districts of Bidar, Raichur and Gulbarga from Hyderabad State and the province of Coorg. The Laccadive Islands which were divided between South Canara and Malabar districts of Madras State were united and organized into the union territory of Lakshadweep.

Bombay State was enlarged by the addition of Saurashtra State and Kutch State, the Marathi-speaking districts of Nagpur Division of Madhya Pradesh and Marathwada region of Hyderabad State. Rajasthan and Punjab gained territories from Ajmer and Patiala and East Punjab States Union respectively and certain territories of Bihar was transferred to West Bengal.

Post 1956

Bombay State was split into the linguistic states of Gujarat and Maharashtra on 1 May 1960 by the Bombay Reorganisation Act. Nagaland was formed on 1 December 1963. The Punjab Reorganisation Act of 1966 resulted in the creation of Haryana on 1 November and transferring the northern districts of Punjab to Himachal Pradesh. The act also designated Chandigarh as a union territory and the shared capital of Punjab and Haryana.

Madras state was renamed Tamil Nadu in 1968. North-eastern states of Manipur, Meghalaya and Tripura were formed on 21 January 1972. Mysore State was renamed as Karnataka in 1973. On 16 May 1975, Sikkim became the 22nd state of the Indian Union and monarchy was abolished. In 1987, Arunachal Pradesh and Mizoram became states on 20 February, followed by Goa on 30 May, while Goa's northern exclaves of Daman and Diu ans Dadra and Nagar Haveli became a separate union territory.

In November 2000, three new states were created namely, Chhattisgarh from eastern Madhya Pradesh, Uttaranchal from northwest Uttar Pradesh (renamed Uttarakhand in 2007) and Jharkhand from southern districts of Bihar. Orissa was renamed as Odisha in 2011. Telangana was created on June 2, 2014 by bifurcating Andhra Pradesh and comprises ten districts in northwestern Andhra Pradesh.

Current proposals

History

Before independence, India was divided into British-administered provinces and nominally autonomous princely states, which were governed by British administration. After the partition of India, some of these administrative divisions became part of the Dominion of Pakistan, whilst the remaining states and provinces formed the Dominion of India. The colonial system of administration continued until 1956 when the States Reorganisation Act abolished the provinces and princely states in favour of new states which were based on language and ethnicity.

Several new states and union territories have been created out of existing states since 1956. The Bombay Reorganisation Act split Bombay State into the linguistic states of Gujarat and Maharashtra on 1 May 1960. Nagaland was created on 1 December 1963. The Punjab Reorganisation Act of 1966 created a new Hindi-speaking state of Haryana from the southern districts of Punjab state, transferred the northern districts of Punjab to Himachal Pradesh, and designated a union territory around Chandigarh, the shared capital of Punjab and Haryana.

Statehood was conferred upon Himachal Pradesh on 25 January 1971, Manipur, Meghalaya and Tripura. The Kingdom of Sikkim joined the Indian Union as a state on 26 April 1975. In 1987, Arunachal Pradesh and Mizoram became states on 20 February, followed by Goa on 30 May, while Goa's northern exclaves of Daman and Diu became a separate union territory.

Three new states were created in November 2000: Chhattisgarh (1 November) was created out of eastern Madhya Pradesh; Uttaranchal (9 November), which was renamed Uttarakhand in 2007, was created out of the mountainous districts of northwest Uttar Pradesh; and Jharkhand (15 November) was created out of the southern districts of Bihar. On 2 June 2014, Telangana was separated from Andhra Pradesh as a new state.

Assam

Karbi Anglong

Karbi Anglong is one of the two districts of Assam. Karbi Anglong was previously known as Mikir Hills. It was part of the Excluded Areas and Partially Excluded Areas (the present North East India) during British India. The British India government had never included this area under their government jurisdiction. Thereby no government development work or activity were done, nor any tax levied from the hills, including Karbi Anglong (then Mikir Hills). The first memorandum for a Karbi homeland was presented to Governor Reid on 28 October 1940 by Semsonsing Ingti and Khorsing Terang at Mohongdijua, Mikir Hills (now Karbi Anglong). Then the Karbi leaders were part of the All Party Hill Leaders' Conference (APHLC) formed on 6 July 1960. The movement again gained momentum when the Karbi Anglong District Council passed a resolution demanding a Separate State in 1981. Then again from 1986 through the leadership of Autonomous State Demand Committee (ASDC) demanded Autonomous statehood of Karbi Anglong & Dima Hasao under Article 244(A). In 2002, the Karbi Anglong Autonomous Council again passed another resolution to press for statehood. Besides there were several Memoranda submitted at different times by several organisations. The demand for Separate State of Karbi Anglong took a violent turn on 31 July 2013 where student demonstrators burst out in anger burning almost every government building. Following which, the elected political leaders of Karbi Anglong jointly submitted a memorandum to the Prime Minister of India demanding a separate State. The Prime Minister had given them his assurance to discuss the matter.

Bodoland

The agitation for the creation of a separate Bodoland state resulted in an agreement between the Indian Government, the Assam state government and the Bodo Liberation Tigers Force. Per that agreement of 10 February 2003, the Bodoland Territorial Council, an entity subordinate to the government of Assam, was created to govern four districts covering 3082 Bodo-majority villages in Assam. Elections to the council were held on 13 May 2003, and Hagrama Mahillary was sworn in as chief of the 46-member council on 4 June 2003.

Bihar

Mithila

Mithila is proposed to cover the Maithili speaking regions of Bihar and Jharkhand. There are 24 Maithili-speaking districts in Bihar: Araria, Begusarai, Bhagalpur, (Banka), Darbhanga, East Champaran Katihar, Khagaria, Kishanganj, Madhepura, Madhubani, Muzaffarpur, Purnea, Saharasa, Samastipur, Sheohar, Sitamarhi, Supaul, Vaishali, and West Champaran, Munger, Jamui. There are six Maithili-speaking districts in Jharkhand: Deoghar, Dumka, godda, Jamtara, Pakaur, and Sahebganj. There is no consensus on a proposed capital, Muzaffarpur, Barauni and Darbhnaga have been suggested by different persons and groups.

Bhojpur

There have been demands for a Bhojpur state, made up of Bhojpuri speaking districts of western Bihar, eastern Uttar Pradesh and northern Chhattisgarh and Jharkhand.

Gujarat

Kutch, Saurashtra and Bhilistan

Kutch Region or Cutch State and Saurashtra Region are aspirant states both as separate or combined Saurashtra was formed by union of different princely states and Kutch was a separate princely state which became border state after independence of India. Saurashtra and Kutch were Part-B and Part-C states of India respectively. Both were separate states till 1956 and later merged with Bombay state following the States Reorganisation Act. They became part of Gujarat state after bifurcation of Bombay state on 1 May 1960 following Mahagujarat Movement. Some people demand return of statehood to Saurashtra and Kutch citing slow development of the regions. Apart from these two separate state-hood demands there is as demand for separate Bhilistan state. Sourashtra State and Kutch State separately existed from 1947 to 1956.

Movement for separate Saurashtra state was initiated in 1972 by advocate Ratilal Tanna, who was close aide of former Prime Minister Morarji Desai. As per Saurashtra Sankalan Samiti, more than 300 organisations across the Saurashtra region support the demand of the separate State. Samiti also claims that compared to other parts of Gujarat, Saurashtra is underdeveloped. Big industrial projects are coming near Ahmedabad and Vadodara, while Saurashtra is being ignored. It is claimed that, People of Saurashtra are facing shortage of drinking water and even youths are forced to migrate in search of jobs. No development is made along the coastline and if Saurashtra had its own state government the region would have done much better. Sourashtra has separate identity from rest of Gujarat and has its own Sourashtra language dialect. Sourashtra people have their own diaspora all over world including that in Tamil Nadu for centuries.

At the time of integration of the princely state of Kutch with India in 1947, the accession was done on the condition that Kutch would retain the status of a separate state. It enjoyed this status till 1960, when a separate state of Gujarat was carved out of Maharashtra and Kutch was merged with it. The main reason behind a separate state is cultural and geographical distance from Gandhinagar. The latter, according to KRSS, is also a hindrance to the development of the region. Kutch is still governed by an administration in Gandhinagar, which sits 400 km away. In 1960, Kutch was promised an autonomous development board under Article 371(2) of the Constitution, which never came into existence due to lack of political will. Narmada water does not reach the farms of this region, which is basically a desert land.

Karnataka

Karu Nadu

Karu Nadu, locally known as North Karnataka, is a geographical region consisting of mostly semi-arid plateau from 300 to 730 metres (980 to 2,400 ft) elevation that constitutes the northern part of the South Indian state of Karnataka. It is drained by the Krishna River and its tributaries the Bhima, Ghataprabha, Malaprabha, and Tungabhadra. Karu Nadu lies within the Deccan thorn scrub forests ecoregion, which extends north into eastern Maharashtra.

It includes the districts of Belgaum, Bijapur, Bagalkot, Bidar, Bellary, Gulbarga, Yadagiri, Raichur, Gadag, Dharwad, Haveri and Koppal district Major cities in the region are Belgaum, Hubli, Dharwad, Bellary, Bijapur, Gulbarga, Bidar, Ranebennur, Chikodi, Hospet and Gokak.

Kalyana Karnataka

Kalyana Karnataka is a Kannada speaking region of Hyderabad State ruled by the Nizams of Hyderabad until 1948 and after merging with India union, the region was the part of Hyderabad State until 1956. The Hyderabad-Karanataka region comprises Bidar, Yadgir, Raichur, Koppal Bellary and Gulbarga is in the present state of Karnataka, The Kalyana Karnataka region is the second largest arid region in India.

Kalyana Karnataka was a term coined by noted Kannada activist Dr. Chidananda Murthy. Kalyana Karnataka is also called as Gulbarga division. As recent as October 2014 there are demands from organisations fighting for cause of this region such as Karnataka Rajya Raitha Sangha and Hyderabad-Karnataka Abhivradhi Horata Samithi.

Tulu Nadu

Tulu Nadu is a region on the border between the states of Karnataka and Kerala in southern India. The demand for a separate state is based on a distinct culture and language (Tulu, which does not have official status), and neglect of the region by the two state governments. To counter these demands and accusations, the Karnataka and Kerala state governments have created the Tulu Sahitya Academy to preserve and promote Tuluva culture. The proposed state would comprise three existing districts; Dakshina Kannada and Udupi in Karnataka, and Kasaragod in Kerala.

Jammu and Kashmir

Jammu

Although Jammu is part of the disputed Kashmir region, it is not geographically part of the Kashmir valley nor the Ladakh region. The Jammu Division is inhabited by the native Dogra people who are historically, culturally, linguistically, and geographically connected with the historical Jammu of the Punjab region and the Pahari regions of the former Punjab Hills States that know comprise the state of Himachal Pradesh. Most of Jammu and Kashmir's Hindus live in the Jammu region and are closely related to the Punjabi-speaking peoples in the Punjab state; many speak Dogri, earlier considered a dialect of Punjabi and now is one of the official languages of India.

Kashmir

The proposed Kashmir state comprises the Kashmir valley region in Jammu & Kashmir. Ethnic Kashmiri leaders have called for the trifurcation of the Jammu and Kashmir state citing it as the only solution to fix the Kashmir conflict in India. Kashmiri writer and opinion leader Ghulam Nabi Khayal has given his support for an independent Union Territory of Ladakh and for the Jammu region to be merged into Punjab or given a separate statehood.

Ladakh

Ladakh, comprising a sizeable chunk of eastern Jammu and Kashmir, has asked for Union Territory status as part of a desire to protect its culture. People mainly speak Ladakhi. The Ladakh Autonomous Hill Development Council(LAHDC), was originally created in 1993 to serve the Ladakhi people's demand for separation from Jammu and Kashmir by becoming a Union Territory. In early October 2015, the Bharatiya Janata Party's manifesto for the Ladakh Autonomous Hill Development Council, Leh election included a promise for Union Territory status. The BJP went on to get 18 out of the 24 seats it contested, a clear majority.

Madhya Pradesh

Vindhya Pradesh, Baghelkhand and Bundelkhand

Vindhya Pradesh is a former state of India. It occupied an area of 23,603 sq. miles. It was created in 1948, shortly after Indian independence, from the territories of the princely states in the eastern portion of the former Central India Agency. It was named for the Vindhya Range, which runs through the center of the province. The capital of the state was Rewa. It lay between Uttar Pradesh to the north and Madhya Pradesh to the south, and the enclave of Datia, which lay a short distance to the west, was surrounded by the state of Madhya Bharat.

Vindhya Pradesh was merged into Madhya Pradesh in 1956, following the States Reorganisation Act. In 2000, Sriniwas Tiwari, ex-speaker of the Madhya Pradesh assembly, called for nine districts to be separated from Madhya Pradesh to create a new state of Vindhya Pradesh, although this was rejected by the Chief Minister of Madhya Pradesh. Separate Bundelkhand and Baghelkhand states instead of single Vindhya Pradesh is as well advocated to accommodate districts claimed by Bundelkhand and Baghelkhand from neighboring Uttar Pradesh state.

Mahakoshal and Gondwana

Mahakoshal is a region which lies in the upper or eastern reaches of the Narmada River valley in the Indian state of Madhya Pradesh. Cities and districts of the region include Jabalpur, Katni, Narsinghpur, Mandla, Dindori, Satna, Seoni and Chhindwara. The largest city and a possible capital is Jabalpur. Organisations such as Mahakaushal Mukti Morcha and Bharatiya Janashakti have demanded separate statehood.

It is alleged that though the Mahakoshal region is rich in minerals, forests, water and land resources, related industries were set up in nearby states. Also, the region has a distinct cultural identity owing to Jabalpur city, known as the Sanskardhani (Cultural Capital) of the State, one of the oldest towns of Central India. Culturally and socially, the Mahakoshal region differs greatly from the neighbouring Vindhya Pradesh. One of the key reasons for this is said to be that large parts of Mahakoshal were under direct British rule from the nineteenth century onwards, turning it into a relatively progressive, modern and liberal area and infusing democratic values into its body politic. Casteism and feudalism are said to be not as deeply rooted in this region as they are Vindhya Pradesh.

A parallel demand for a state of Gondwana from the same Mahakoshal region of Madhya Pradesh has arisen owing to the fact that vast areas of Mahakoshal were ruled by Gond kings and even today, Mandla, Chinndwara, Dindori, Seoni and Balaghat have a predominantly Gond tribal population. Tribals constitute 64 per cent of the total population of Dindori district. For Mandla, the corresponding figure is 57 per cent. The Gondwana Gantantra party (GGP) was established in 1991, with the objective to struggle for the creation of a separate Gondwana State comprising regions that were ruled by Gonds. The Gondwana Gantantra party (GGP) has since divided into numerous factions such as Rashtriya Gondwana party and Gondwana Mukti Dal.

Malwa

There are sporadic demands for a separate Malwa state with the probable capital at Indore. The region includes the Madhya Pradesh districts of Agar, Dewas, Dhar, Indore, Jhabua, Mandsaur, Neemuch, Rajgarh, Ratlam, Shajapur, Ujjain, and parts of Guna district and Sehore, and the Rajasthan districts of Jhalawar and parts of Banswara and Pratapgarh.

The main language of Malwa is Malvi, although Hindi is widely spoken in the cities. This Indo-European language is subclassified as Indo-Aryan. The language is sometimes referred to as Malavi or Ujjaini. Malvi is part of the Rajasthani branch of languages; Nimadi is spoken in the Nimar region of Madhya Pradesh and in Rajasthan. The dialects of Malvi are, in alphabetical order, Bachadi, Bhoyari, Dholewari, Hoshangabadi, Jamral, Katiyai, Malvi Proper, Patvi, Rangari, Rangri and Sondwari. A survey in 2001 found only four dialects: Ujjaini (in the districts of Ujjain, Indore, Dewas and Sehore), Rajawari (Ratlam, Mandsaur and Neemuch), Umadwari (Rajgarh) and Sondhwari (Jhalawar, in Rajasthan). About 55% of the population of Malwa can converse in and about 40% of the population is literate in Hindi, the official language of the Madhya Pradesh state.

Maharashtra

Vidarbha

Vidarbha is a region that comprises the Amravati and Nagpur divisions of eastern Maharashtra. The State Reorganisation Act of 1956 placed Vidarbha in Bombay State. Shortly after this, the States Reorganisation Commission recommended the creation of Vidarbha state with Nagpur as the capital, but instead it was included in Maharashtra state, which was formed on 1 May 1960. Support for a separate state of Vidarbha had been expressed by Loknayak Bapuji Aney and Brijlal Biyani Vidarbha. The demand for the creation of a separate state are based on allegations of neglect by the Maharashtra state government. Jambuwantrao Dhote led a popular struggle for Vidarbha statehood in the 1970s. Two politicians, N.K.P. Salve and Vasant Sathe, have led 21st century attempts to bring about a state of Vidarbha.

Khandesh

Khandesh is a region of central India, which forms the northwestern portion of Maharashtra state. Khandesh was the region demarcated as a boundary after which Dakkhan a.k.a. Deccan started. Originally The Khandesh state was founded and ruled by the Faruqi dynasty with the capital at Burhanpur which is now in Madhya Pradesh. Khandesh State had covered the area of the today's Jalgaon, Dhule, Nandurbar districts of Maharashtra state and Burhanpur district of Madhya Pradesh state. The terms "Khandesh" and "Deccan" thus connote historical and political affiliations, as well as geographical zones. Khandesh lies on the Northwestern corner of the Deccan plateau, in the valley of the Tapi River, and is bound to the north by the Satpura Range, to the east by the Berar (Vidarbha) region, to the south by the Hills of Ajanta, belonging to the Marathwada region of Maharashtra, and to the west by the northernmost ranges of the Western Ghats, and beyond them the coastal plain of Gujarat.

After India's independence in 1947, Bombay province became Bombay state, which in 1960 was divided into the linguistic states of Maharashtra and Gujarat. During the formation of the State of India, Burhanpur became the part of the state Of Madhya

Pradesh, and in 1960, East Khandesh became Jalgaon district, and West Khandesh became Dhule of the Maharashtra State.

Marathwada

Marathwada (IPA:Marāṭhvāḍā) is one of the five regions in Indian state of Maharashtra. The region coincides with the Aurangabad Division of Maharashtra. Marathwada become a part of Nizam of Hyderabad, which later came to be known as the princely state of Hyderabad but under the suzerainty of British India. Subsequently, through Operation Polo, a "police action" on September 17, 1948, the Indian army annexed Hyderabad to India and on November 1, 1956, Marathwada was transferred from Hyderabad State to Bombay State. On May 1, 1960, Bombay state was divided into Maharashtra and Gujarat states, Marathwada becoming a part of the former.

Konkan

Konkan is a rugged section of the western coastline of India. It consists of the coastal districts of Maharashtra, Goa and Karnataka. The ancient sapta-Konkan is a slightly larger region described in the Sahyadrikhanda which refers to it as "Parashuramakshetra".

NCR (National Capital Region)

DELHI , Baghpat, Muzaffarnagar, Gurgaon, Sonipat, Faridabad, Ghaziabad, Noida, Greater Noida forms the National Capital Region, with a population of about 22 million residents. The political administration of Delhi more closely resembles that of a state than a union territory, with its own legislature, high court and an executive council of ministers headed by a Chief Minister. New Delhi is jointly administered by the Union government and the local government of Delhi. The previous National Democratic Alliance government introduced a bill in Parliament in 2003, to grant full statehood to Delhi, but the legislation was not passed.

North East

Kuki land

The Kuki Hills was an independent hill country during the pre-British colonial period. It was merged by the colonial power into Manipur. The Kuki people under the leadership of Kuki State Demand Committee demand statehood for the Kuki areas in Manipur, i.e. Sadar Hills, Chandel, Churachandpur districts and some parts of Ukhrul, Tamenglong districts to be formed as Kukiland.

Odisha

Kosal

The Kosal region is the entire Western Odisha area located in Odisha state, between 19° 37'- 23° N latitude and 82° 28'- 85° 22' E longitudes comprising the districts of Sundargarh, Jharsuguda, Debagarh, Sambalpur, Bargarh, Sonepur, Boudh, Bolangir, Nuapada, Kalahandi, Nabarangpur, Aathmallik sub-division of Angul district and Kashipur block of Rayagada district. It is surrounded by Jharkhand state on the north, on the east by the dist of Keonjhar, Angul and Kandhamal; on the south by Rayagada, Koraput and on the west by Chhattisgarh state. This geographical area comes under the Western Odisha Development Council.

Tamil Nadu

Kongu Nadu

There have been demands for the creation of separate state of Kongu Nadu (also called Kongadesam, the ancient Chera Kingdom), comprising the regions of western Tamil Nadu, parts of southern Karanataka and northern Kerala with capital at Coimbatore, based on demography, culture, linguistics and other factors. There have been claims that the Kongu Nadu region has often been ignored by successive governments in spite of being the largest contributor to the state's economy. A number of political outfits including Kongunadu Makkal Desia Katchi, Kongu Vellala Goundergal Peravai and Tamil Nadu Kongu Ilaignar Peravai are active in the region claiming to fight for the rights of the region.

Uttar Pradesh

At least four states have been proposed to be carved out of Uttar Pradesh.

Braj Pradesh/Harit Pradesh/Paschimanchal

Harit Pradesh is a proposed state, which would comprise 22 districts of Western Uttar Pradesh, currently forming six divisions – Agra, Aligarh, Bareilly, Meerut, Moradabad, and Saharanpur. The most prominent advocate for the creation of the new state is Ajit Singh, the leader of the Rashtriya Lok Dal party. Mayawati also supported the formation of Harit Pradesh in December 2009.

There is another demand within the same region - Braj Pradesh, consisting of Agra division and Aligarh division from Uttar Pradesh and districts of Bharatpur and Gwalior from Rajasthan and Madhya Pradesh. The proposed capital would be in Agra. So far, Braj has remained as a historical and cultural region, rather than a political entity. Language of Braj is Braj Bhasha.

Awadh

The population of proposed Awadh state consisting of Awadhi speaking districts of central Uttar Pradesh would be approximately 50 million people, with an area of approximately 75,000 km2 and Lucknow as the capital.

Purvanchal

Purvanchal is a geographic region of north-central India, which comprises the eastern end of Uttar Pradesh state. It is bounded by Nepal to the north, Bihar state to the east, Bagelkhand region of Madhya Pradesh state to the south, the Awadh region of Uttar Pradesh to the west. Purvanchal comprises three divisions – Awadhi region in the west, Bhojpuri region in the east and the Baghelkhand region in the south. The most commonly spoken language in Purvanchal is Bhojpuri. Purvanchal area is represented by 23 Members of Parliament to the lower house of Indian Parliament, and 117 legislators in the 403 member Uttar Pradesh state assembly or Vidhan Sabha. Districts-Azamgarh, Ballia, Chandauli, Deoria, Ghazipur, Gorakhpur, Jaunpur, Kushinagar, Maharajganj, Mau, Mirzapur, Sant Kabir Nagar, Sant Ravidas Nagar, Siddharth Nagar, Varanasi.

As a fallout of Telangana creation movement, Mayawati proposed 13 Dec 2009 to carve Purvanchal out of Uttar Pradesh. Current movement for Purvanchal is spearheaded by politician Amar Singh.

Bundelkhand

Bundelkhand comprises parts of Uttar Pradesh and Madhya Pradesh. While the Bahujan Samaj Party government under Mayawati proposed in 2011 the creation of Bundelkhand from seven districts of Uttar Pradesh, organisations such as Bundelkhand Mukti Morcha (BMM) want it to include six districts from Madhya Pradesh as well. Uma Bharati of Bharatiya Janata Party promised a separate state of Bundelkhand within three years if her party was voted to power, during campaigning for the Loksabha Election, 2014 at Jhansi. Similar promise was made by Congress leader Pradeep Jain Aditya during Loksabha Election, 2014.

Since the early 1960s there has been a movement for establishing a Bundelkhand state or promoting development of the region. Bundelkhand is geographically the central part of India covering part of Madhya Pradesh and part of Uttar Pradesh. In spite of being rich in minerals, the people of Bundelkhand are very poor and the region is underdeveloped and underrepresented in state and central politics. Agrarian crisis and farmer's suicides is also cited as reason for separate statehood.

West Bengal

Gorkhaland

Gorkhaland is a proposed state covering areas inhabited by the ethnic Gorkha (Nepali) people, namely Darjeeling hills and Dooars in the northern part of West Bengal. The movement for Gorkhaland has gained momentum in the line of ethno-linguistic-cultural sentiment of the people who desire to identify themselves as Gorkha.

The demand for a separate administrative region has existed since 1907, when the Hillmen's is Association of Darjeeling submitted a memorandum to the Morley-Minto reforms committee. After Indian independence, the Akhil Bharatiya Gorkha League (ABGL) was the first political party from the region to demand greater identity for the Gorkha ethnic group and economic freedom for the community. In 1980, the Pranta Parishad of Darjeeling wrote to the then Prime Minister of India, Indira Gandhi, with the need to form a state for the Gorkhas.

The movement for a separate state of Gorkhaland gained serious momentum during the 1980s, when a violent agitation was carried out by Gorkha National Liberation Front (GNLF) led by Subhash Ghising. The agitation ultimately led to the establishment of a semiautonomous body in 1988 called the Darjeeling Gorkha Hill Council (DGHC) to govern certain areas of Darjeeling district. However, in 2008, a new party called the Gorkha Janmukti Morcha (GJM) raised the demand for a separate state of Gorkhaland once again. In 2011, GJM signed an agreement with the state and central governments for the formation of Gorkhaland Territorial Administration, a semiautonomous body that replaced the DGHC in the Darjeeling hills.

Kamtapur

Kamtapur in northern parts of West Bengal. The proposed state consists of the districts of Koch Behar, Jalpaiguri, and southern plains of Darjeeling including Siliguri city.

Sindh

In an interview with All India Radio, Sindhi political leader G.M. Syed advocated the independence of Sindh from Pakistan to form Sindhudesh, or confederation of Sindh with India. In a speech, Prime Minister of India Narendra Modi told the Sindhi diaspora in India that Sindh returning to India is an accomplishable dream.

According to Gul Agha, India is a country that is well suited to the secular Sufi mindset of the Sindhi people. There were an estimated 3.5 million Sindhis in India, when the number of SIndhis in Pakistan was roughly 32 million.

Smaller proposals

- Karaikal district is one of the four districts of Puducherry, lying 150 km (93 mi) south of Pondicherry. There is a movement advocating the formation of a separate union territory because of a perceived lack of development compared to the rest of Puducherry.
- Konkan, comprising the Konkani-speaking areas of Raigad, Ratnagiri, Thane, Mumbai, Navi Mumbai and Sindhudurg districts in Maharashtra.

List of states and union territories

States

Map	Name	ISO 3166-2 code	Date of formation	Population	Area (km2)	Official language(s)	Administrative capital	Largest city (if not the capital)	Population density (per km2)	Literacy Rate (%)	% of total population that is urban
1	Andhra Pradesh	AP	1953 Oct 1 (as Andhra State)	49,506,799	160,205	Telugu	HyderabadNote 1	Visakhapatnam	308	67.41%	29.6
2	Arunachal Pradesh	AR	1987 Feb 20	1,382,611	83,743	English	Itanagar		17	66.95	20.8
3	Assam	AS	1912 Apr 1 (as Assam Province)	31,169,272	78,550	Assamese, Bengali, Bodo	Dispur	Guwahati	397	73.18	12.9
4	Bihar	BR	1936 Apr 1	103,804,637	99,200	Hindi, Urdu	Patna		1,102	63.82	10.5
5	Chhattisgarh	CT	2000 Nov 1	25,540,196	135,194	Hindi	Naya Raipur	Raipur	189	71.04	20.1
6	Goa	GA	1987 May 30	1,457,723	3,702	Konkani	Panaji	Vasco	394	87.40	62.2
7	Gujarat	GJ	1960 May 1	60,383,628	196,024	Gujarati	Gandhinagar	Ahmedabad	308	79.31	37.4
8	Haryana	HR	1966 Nov 1	25,353,081	44,212	Hindi, Punjabi	Chandigarh (shared, Union Territory)	Faridabad	573	76.64	28.9
9	Himachal Pradesh	HP	1971 Jan 25	6,856,509	55,673	Hindi	Shimla		123	83.78	9.8
10	Jammu and Kashmir	JK	1947 Oct 26	12,548,926	222,236	Dogri, Kashmiri, Ladakhi, Urdu	Srinagar (summer) Jammu (winter)		124	68.74	24.8
11	Jharkhand	JH	2000 Nov 15	32,966,238	74,677	Hindi	Ranchi	Jamshedpur	414	67.63	22.2
12	Karnataka	KA	1956 Nov 1 (as Mysore State)	61,130,704	191,791	Kannada	Bengaluru		319	75.60	34.0
13	Kerala	KL	1956 Nov 1	33,387,677	38,863	Malayalam	Thiruvananthapuram		859	93.91	26.0
14	Madhya Pradesh	MP	1947 Aug 15	72,597,565	308,252	Hindi	Bhopal	Indore	236	70.63	26.5

15	Maharashtra	MH	1960 May 1	112,372,972	307,713	Marathi	Mumbai		365	82.91	42.4
16	Manipur	MN	1972 Jan 21	2,721,756	22,347	Manipuri	Imphal		122	79.85	25.1
17	Meghalaya	ML	1972 Jan 21	2,964,007	22,720	English, Garo, Hindi, Khasi, Pnar	Shillong		132	75.48	19.6
18	Mizoram	MZ	1987 Feb 20	1,091,014	21,081	Mizo, English	Aizawl		52	91.58	49.6
19	Nagaland	NL	1963 Dec 1	1,980,602	16,579	English	Kohima	Dimapur	119	80.11	17.2
20	Odisha	OR	1936 Apr 1 (as Odisha Province)	41,947,358	155,820	Odia	Bhubaneswar		269	73.45	15.0
21	Punjab	PB	1947 Aug 15 (as East Punjab)	27,704,236	50,362	Punjabi	Chandigarh (shared, Union Territory)	Ludhiana	550	76.68	33.9
22	Rajasthan	RJ	1950 Jan 26	68,621,012	342,269	Hindi	Jaipur		201	67.06	23.4
23	Sikkim	SK	1975 May 16	607,688	7,096	Bhutia, Gurung, Lepcha, Limbu, Manggar, Nepali, Newari, Sherpa, Sunwar, Tamang	Gangtok		86	82.20	11.1
24	Tamil Nadu	TN	1950 Jan 26 (as Madras State)	72,138,958	130,058	Tamil	Chennai		480	80.33	44.0
25	Telangana	TG	2014 Jun 2	35,193,978	114,840	Telugu, Urdu	HyderabadNote 1		307	66.50%	N/A
26	Tripura	TR	1972 Jan 21	3,671,032	10,492	Bengali, Tripuri	Agartala		350	87.75	17.1
27	Uttar Pradesh	UP	1902 Mar 22 (as United Provinces of Agra and Oudh)	199,581,477	243,286	Hindi, Urdu	Lucknow	Kanpur	828	69.72	20.8
28	Uttarakhand	UT	2000 Nov 9 (as Uttaranchal)	10,116,752	53,483	Hindi, Sanskrit	Dehradun		189	79.63	25.7
29	West Bengal	WB	1947 Aug 15	91,347,736	88,752	Bengali, Nepali	Kolkata		1,029	77.08	28.0

- ^Note 1 Andhra Pradesh was divided into two states, Telangana and a residual Andhra Pradesh on 2 June 2014. Hyderabad, located entirely within the borders of Telangana, is to serve as joint capital for both states for a period of time not exceeding ten years.

Union territories

Map	Name	ISO 3166-2 code	Population	Official language	Capital	Population density (per km2)	Literacy Rate(%)	% Urban Population
A	Andaman and Nicobar Islands	AN	379,944	English, Hindi	Port Blair	46	86.27	32.6
B	Chandigarh	CH	1,054,686	English, Hindi, Punjabi	Chandigarh	9,252	86.43	89.8
C	Dadra and Nagar Haveli	DN	342,853	English, Gujarati, Hindi, Marathi	Silvassa	698	77.65	22.9
D	Daman and Diu	DD	242,911	English, Gujarati, Hindi, Marathi	Daman	2,169	87.07	36.2
E	Lakshadweep	LD	64,429	English, Malayalam	Kavaratti	2,013	92.28	44.5
F	National Capital Territory of Delhi	DL	11,007,835	English, Hindi, Punjabi, Urdu	New Delhi	11,297	86.34	93.2
G	Puducherry	PY	1,244,464	English, Malayalam, Tamil, Telugu	Pondicherry	2,598	86.55	66.6

Physiographic regions

India can be divided into six physiographic regions. They are

1. The Northern Mountains
2. The Peninsular Plateaus

3. Indo Gangetic Plains
4. Thar Desert
5. The Coastal Plains
6. The Islands

The Northern Mountains

A great arc of mountains, consisting of the Himalayas of Nepal, Hindu Kush, and Patkai ranges define the northern Indian subcontinent. These were formed by the ongoing tectonic collision of the Indian and Eurasian plates. The mountains in these ranges include some of the world's tallest mountains which act as a natural barrier to cold polar winds. They also facilitate the monsoon winds which in turn influence the climate in India. Rivers originating in these mountains flow through the fertile Indo–Gangetic plains. These mountains are recognised by biogeographers as the boundary between two of the Earth's great ecozones: the temperate Palearctic that covers most of Eurasia and the tropical and subtropical Indomalaya ecozone which includes the Indian subcontinent, Southeast Asia and Indonesia.

The Himalayan range is the world's highest mountain range, with its tallest peak Mt. Everest (8,848 metres (29,029 ft)) on the Nepal–China border. They form India's northeastern border, separating it from northeastern Asia. They are one of the world's youngest mountain ranges and extend almost uninterrupted for 2,500 km (1,600 mi), covering an area of 500,000 km2 (190,000 sq mi). The Himalayas extend from Jammu and Kashmir in the north to Arunachal Pradesh in the east. These states along with Himachal Pradesh, Uttarakhand, and Sikkim lie mostly in the Himalayan region. Numerous Himalayan peaks rise over 7,000 m (23,000 ft) and the snow line ranges between 6,000 m (20,000 ft) in Sikkim to around 3,000 m (9,800 ft) in Kashmir. Kanchenjunga—on the Sikkim–Nepal border—is the highest point in the area administered by India. Most peaks in the Himalayas remain snowbound throughout the year. The Himalayas act as a barrier to the frigid katabatic winds flowing down from Central Asia. Thus, North India is kept warm or only mildly cooled during winter; in summer, the same phenomenon makes India relatively hot.

- The Karakoram is situated in the disputed state of Jammu and Kashmir. It has more than sixty peaks above 7,000 m (23,000 ft), including K2, the second highest peak in the world 8,611 m (28,251 ft). K2 is just 237 m (778 ft) smaller than the 8,848 m (29,029 ft) Mount Everest. The range is about 500 km (310 mi) in length and the most heavily glaciated part of the world outside of the polar regions. The Siachen Glacier at 76 km (47 mi) and the Biafo Glacier at 67 km (42 mi) rank as the world's second and third-longest glaciers outside the polar regions. Just to the west of the northwest end of the Karakoram, lies the Hindu Raj range, beyond which is the Hindu Kush range. The southern boundary of the Karakoram is formed by the Gilgit, Indus and Shyok rivers, which separate the range from the northwestern end of the Himalayas.
- The Patkai, or Purvanchal, are situated near India's eastern border with Burma. They were created by the same tectonic processes which led to the formation of

the Himalayas. The physical features of the Patkai mountains are conical peaks, steep slopes and deep valleys. The Patkai ranges are not as rugged or tall as the Himalayas. There are three hill ranges that come under the Patkai: the Patkai–Bum, the Garo–Khasi–Jaintia and the Lushai hills. The Garo–Khasi range lies in Meghalaya. Mawsynram, a village near Cherrapunji lying on the windward side of these hills, has the distinction of being the wettest place in the world, receiving the highest annual rainfall.

The Peninsular Plateaus

- The Vindhya range runs across most of central India, extending 1,050 km (650 mi). The average elevation of these hills is from 300 to 600 m (980 to 1,970 ft) and rarely goes above 700 metres (2,300 ft). They are believed to have been formed by the wastes created by the weathering of the ancient Aravali mountains. Geographically, it separates Northern India from Southern India. The western end of the range lies in eastern Gujarat, near its border with Madhya Pradesh, and runs east and north, almost meeting the Ganges at Mirzapur
- The Malwa Plateau is spread across Rajasthan, Madhya Pradesh and Gujarat. The average elevation of the Malwa plateau is 500 metres, and the landscape generally slopes towards the north. Most of the region is drained by the Chambal River and its tributaries; the western part is drained by the upper reaches of the Mahi River.
- Kutch Kathiawar plateau

  Kutch Kathiawar plateau is located in Gujarat state.

- The Deccan Plateau is a large triangular plateau, bounded by the Vindhyas to the north and flanked by the Eastern and Western Ghats. The Deccan covers a total area of 1.9 million km^2 (735,000 $mile^2$). It is mostly flat, with elevations ranging from 300 to 600 m (980 to 1,970 ft). The average elevation of the plateau is 2,000 feet (610 m) above sea level. The surface slopes from 3,000 feet (910 m) in the west to 1,500 feet (460 m) in the east. It slopes gently from west to east and gives rise to several peninsular rivers such as the Godavari, the Krishna, the Kaveri and the Mahanadi which drain into the Bay of Bengal. This region is mostly semi-arid as it lies on the leeward side of both Ghats. Much of the Deccan is covered by thorn scrub forest scattered with small regions of deciduous broadleaf forest. Climate in the Deccan ranges from hot summers to mild winters.
- The Chota Nagpur Plateau is situated in eastern India, covering much of Jharkhand and adjacent parts of Odisha, Bihar and Chhattisgarh. Its total area is approximately 65,000 km2 (25,000 sq mi) and is made up of three smaller plateaus — the Ranchi, Hazaribagh, and Kodarma plateaus. The Ranchi plateau is the largest, with an average elevation of 700 m (2,300 ft). Much of the plateau is forested, covered by the Chota Nagpur dry deciduous forests. Vast reserves of metal ores and coal have been found in the Chota Nagpur plateau. The Kathiawar peninsula in western Gujarat is bounded by the Gulf of Kutch and the

Gulf of Khambat. The natural vegetation in most of the peninsula is xeric scrub, part of the Northwestern thorn scrub forests ecoregion.

- The Satpura Range begins in eastern Gujarat near the Arabian Sea coast and runs east across Maharashtra, Madhya Pradesh and Chhattisgarh. It extends 900 km (560 mi) with many peaks rising above 1,000 m (3,300 ft). It is triangular in shape, with its apex at Ratnapuri and the two sides being parallel to the Tapti and Narmada rivers. It runs parallel to the Vindhya Range, which lies to the north, and these two east-west ranges divide the Indo–Gangetic plain from the Deccan Plateau located north of River Narmada.
- The Aravali Range is the oldest mountain range in India, running across Rajasthan from northeast to southwest direction, extending approximately 800 km (500 mi). The northern end of the range continues as isolated hills and rocky ridges into Haryana, ending near Delhi. The highest peak in this range is Guru Shikhar at Mount Abu, rising to 1,722 m (5,650 ft), lying near the border with Gujarat. The Aravali Range is the eroded stub of an ancient fold mountain system. The range rose in a Precambrian event called the Aravali–Delhi orogen. The range joins two of the ancient segments that make up the Indian craton, the Marwar segment to the northwest of the range, and the Bundelkhand segment to the southeast.
- The Western Ghats or Sahyadri mountains run along the western edge of India's Deccan Plateau and separate it from a narrow coastal plain along the Arabian Sea. The range runs approximately 1,600 km (990 mi) from south of the Tapti River near the Gujarat–Maharashtra border and across Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu to the southern tip of the Deccan peninsula. The average elevation is around 1,000 m (3,300 ft). Anai Mudi in the Anaimalai Hills 2,695 m (8,842 ft) in Kerala is the highest peak in the Western Ghats.
- The Eastern Ghats are a discontinuous range of mountains, which have been eroded and vivisected by the four major rivers of southern India, the Godavari, Mahanadi, Krishna, and Kaveri. These mountains extend from West Bengal to Odisha, Andhra Pradesh and Tamil Nadu, along the coast and parallel to the Bay of Bengal. Though not as tall as the Western Ghats, some of its peaks are over 1,000 m (3,300 ft) in height. The Nilgiri hills in Tamil Nadu lies at the junction of the Eastern and Western Ghats. Arma Konda (1,680 m (5,510 ft)) in Andhra Pradesh is the tallest peak in Eastern Ghats.

Indo-Gangetic plain

The Indo-Gangetic plains, also known as the Great Plains are large alluvial plains dominated by three main rivers, the Indus, Ganges, and Brahmaputra. They run parallel to the Himalayas, from Jammu and Kashmir in the west to Assam in the east, and drain most of northern and eastern India. The plains encompass an area of 700,000 km2 (270,000 sq mi). The major rivers in this region are the Ganges, Indus, and Brahmaputra along with their main tributaries–Yamuna, Chambal, Gomti, Ghaghara, Kosi, Sutlej, Ravi, Beas, Chenab, and Tista—as well as the rivers of the Ganges Delta, such as the Meghna.

The great plains are sometimes classified into four divisions:

- The Bhabar belt is adjacent to the foothills of the Himalayas and consists of boulders and pebbles which have been carried down by streams. As the porosity of this belt is very high, the streams flow underground. The Bhabar is generally narrow with its width varying between 6 to 15 km (3.7 to 9.3 mi).
- The Tarai belt lies south of the adjacent Bhabar region and is composed of newer alluvium. The underground streams reappear in this region. The region is excessively moist and thickly forested. It also receives heavy rainfall throughout the year and is populated with a variety of wildlife.
- The Bangar belt consists of older alluvium and forms the alluvial terrace of the flood plains. In the Gangetic plains, it has a low upland covered by laterite deposits.
- The Khadar belt lies in lowland areas after the Bangar belt. It is made up of fresh newer alluvium which is deposited by the rivers flowing down the plain.

The Indo-Gangetic belt is the world's most extensive expanse of uninterrupted alluvium formed by the deposition of silt by the numerous rivers. The plains are flat making it conducive for irrigation through canals. The area is also rich in ground water sources.The plains are one of the world's most intensely farmed areas. The main crops grown are rice and wheat, which are grown in rotation. Other important crops grown in the region include maize, sugarcane and cotton. The Indo-Gangetic plains rank among the world's most densely populated areas.

History

The region is known for the Indus Valley Civilization, which was responsible for the birth of ancient South Asian culture. The flat and fertile terrain has facilitated the repeated rise and expansion of various empires, including the Gupta empire, Kanauj, Magadha, the Maurya Empire, the Mughal Empire and the Sultanate of Delhi – all of which had their demographic and political centers in the Indo-Gangetic plain. During the Vedic and Epic eras of Indian history, this region was referred to as "Aryavarta" (Land of the Aryans) which was bordered on the west by the Indus river, on the east by Anga region of present-day easternmost part of Bihar and doorstep of Bengal and on the south by the Vindhya Mountain range. During the Islamic period, the Turkish, Afghan and Iranian rulers referred to this region as "Hindustan" (Land of the Hindus), deriving from the Persian term for the Indus River. This term was later used to refer to the whole of India but even into the modern era, the dialect of Hindi-Urdu spoken in this region is called Hindustani, a term which is also used for the local music and culture.

Geography

Some geographers subdivide the Indo-Gangetic Plain into several parts: the Sindh, Punjab, Doab, and Bengal regions. By another definition, the Indus-Ganga Plain is divided into two drainage basins by the Delhi Ridge; the western part consists of the Punjab Plain, and the eastern part consists of the Ganga–Brahmaputra drainage systems. This divide is only 300 metres above sea level, causing the perception that the Indus-Ganga Plain appears to be continuous between the two drainage basins.

The middle Ganga plain extends from the Yamuna River in the west to the state of West Bengal in the east. The lower Ganges plain and the Assam Valley are more verdant than the middle Ganga plain. The lower Ganga is centered in West Bengal, from which it flows into Bangladesh. After joining the Jamuna, a distributary of Brahmaputra, both rivers form the Ganges Delta. The Brahmaputra rises in Tibet as the Yarlung Zangbo River and flows through Arunachal Pradesh and Assam, before crossing into Bangladesh.

As a large plain, the exact extent can vary from source to source. Roughly, the Indo-Gangetic Plain stretches across:

- Kashmir in the north;
- the Punjab a provincial region of Pakistan and the Aravalli Range;
- the Himalayan foothills of Assam and Bangladesh in the east; and
- the Chota Nagpur Plateau in the south.

The fertile Terai region is the Nepalese extension of the Plain. The rivers encompassed are the Beas, the Chambal, the Chenab, the Ganga, the Gomti, the Indus, the Ravi, the Sutlej and the Yamuna. The soil is rich in silt, making the plain one of the most intensely farmed areas of the world. Even rural areas here are densely populated.

The Indus-Ganga plains, also known as the "Great Plains," are large floodplains of the Indus and the Ganga–Brahmaputra river systems. They run parallel to the Himalaya mountains, from Jammu and Kashmir in the west to Assam in the east and draining most of northern and eastern India. The plains encompass an area of 700,000 km² (270,000 mile²) and vary in width through their length by several hundred kilometres. The major rivers of this system are the Ganga and the Indus along with their tributaries; Beas, Yamuna, Gomti, Ravi, Chambal, Sutlej and Chenab.

Extent of the Indo-Gangetic plain across South Asia.The great plains are sometimes classified into four divisions:

- The Bhabar belt — is adjacent to the foothills of the Himalayas and consists of boulders and pebbles which have been carried down by the river streams. As the porosity of this belt is very high, the streams flow underground. The bhabar is generally narrow about 7–15 km wide.
- The Terai belt — lies next to the Bhabar region and is composed of newer alluvium. The underground streams reappear in this region. The region is excessively moist and thickly forested. It also receives heavy rainfall throughout the year and is populated with a variety of wildlife.

- The Bangar belt — consists of older alluvium and forms the alluvial terrace of the flood plains. In the Gangetic plains, it has a low upland covered by laterite deposits.
- The Khadir belt — lies in lowland areas after the Bangar belt. It is made up of fresh newer alluvium which is deposited by the rivers flowing down the plain.

The Indus-Ganga belt is the world's most extensive expanse of uninterrupted alluvium formed by the deposition of silt by the numerous rivers. The plains are flat and mostly treeless, making it conducive for irrigation through canals. The area is also rich in ground water sources.The plains are the world's most intensely farmed areas. The main crops grown are rice and wheat, which are grown in rotation. Others include maize, sugarcane and cotton. The Indo-Gangetic plains rank among the world's most densely populated areas.

Fauna

Until recent history, the open grasslands of the Indus-Ganga Plain were inhabited by several large species of animal. The open plains were home to large numbers of herbivores which included all three of the Asian rhinoceros (Indian rhinoceros, Javan rhinoceros, Sumatran rhinoceros). The open grasslands were in many ways similar to the landscape of modern Africa. Gazelle, buffalo, rhinos, elephants, lions, and hippo roamed the grasslands, the same way as they do in Africa today. Large herds of Indian elephants, gazelles, antelopes and horses lived alongside several species of wild cattle including the now-extinct aurochs. In the forested areas there were several species of wild pig, deer and muntjac. In the wetter regions close to the Ganga there would have been large herds of water buffalo grazing on the riverbanks along with extinct species of hippopotamus.

So many large animals would have supported a large population of predators as well. Indian wolves, dholes, striped hyenas, Asiatic cheetahs and Asiatic lions would have hunted large game on the open plains, while Bengal tigers and leopards would stalk prey in the surrounding woods and sloth bears hunt for termites in both of these areas. In the Ganges there were large concentrations of gharial, mugger crocodile and river dolphin controlling fish stocks and the occasional migrating herd crossing the river.

Agriculture

Farming on the Indus-Ganga Plain primarily consists of rice and wheat grown in rotation. Other crops include maize, sugarcane, and cotton.

The main source of rainfall is the southwest monsoon which is normally sufficient for general agriculture. The many rivers flowing out of the Himalayas provide water for major irrigation works.

Due to a rapidly growing population (as well as other factors), this area is considered at high risk for water shortages in the future.

The area constitutes the land between the river Brahmaputra and Aravli mountain ranges. The famous river Ganga and others such as Yamuna, Ghaghara and Chambal flow through the area.

Cities

Among the largest cities of the Indo-Gangetic plain are:

In Nepal:

Biratnagar, Janakpur, Lumbini and Kapilvastu.

In India:

Amritsar, Ludhiana, Bathinda, Chandigarh, Panipat, Faridabad, Delhi, Jaipur, Ahmedabad, Surat, Meerut, Agra, Kanpur, Lucknow, Allahabad, Varanasi, Patna, Bhagalpur, Asansol, Kolkata, Dibrugarh, Guwahati and Jorhat

In Bangladesh:

Dhaka and Khulna

In Pakistan:

Lahore, Faisalabad, Rawalpindi-Islamabad, Multan and Hyderabad

Administrative divisions

Because it is not fully possible to define the boundaries of the Indo-Gangetic Plain, it is also difficult to give an exact list of which administrative areas are part of the plain.

The areas that are completely or more than half in the plain are:

- Bangladesh (almost the whole country)
- India
  - Assam
  - Bihar
  - Delhi
  - Gujarat
  - Haryana
  - Punjab
  - Tripura
  - West Bengal
  - Uttar Pradesh
- Pakistan
  - Punjab

- Sindh, east of the Indus.

Small parts of the following administrative areas may also be part of the plain:

- India
  - Meghalaya
  - Jammu and Kashmir
  - Uttarakhand
- Pakistan
  - Balochistan
  - Khyber Pakhtunkhwa

Thar Desert

Thar desert, Rajasthan India

The Thar Desert (also known as the deserts) is by some calculations the world's seventh largest desert, by some others the tenth. It forms a significant portion of western India and covers an area of 200,000 to 238,700 km2 (77,200 to 92,200 sq mi). The desert continues into Pakistan as the Cholistan Desert. Most of the Thar Desert is situated in Rajasthan, covering 61% of its geographic area.

About 10 percent of this region comprises sand dunes, and the remaining 90 percent consist of craggy rock forms, compacted salt-lake bottoms, and interdunal and fixed dune areas. Annual temperatures can range from 0 °C (32 °F) in the winter to over 50 °C (122 °F) during the summer. Most of the rainfall received in this region is associated with the short July–September southwest monsoon that brings 100 to 500 mm (3.9 to 19.7 in) of precipitation. Water is scarce and occurs at great depths, ranging from 30 to 120 metres (98 to 394 ft) below the ground level. Rainfall is precarious and erratic, ranging from below 120 mm (4.7 in) in the extreme west to 375 mm (14.8 in) eastward.The only river in this region is Luni. The soils of the arid region are generally sandy to sandy-loam in texture. The consistency and depth vary as per the topographical features. The low-lying loams are heavier may have a hard pan of clay, calcium carbonate or gypsum.

In western India, the Kutch region in Gujarat and Koyna in Maharashtra are classified as a Zone IV region (high risk) for earthquakes. The Kutch city of Bhuj was the epicentre of the 2001 Gujarat earthquake, which claimed the lives of more than 1,337 people and injured 166,836 while destroying or damaging near a million homes. The 1993 Latur earthquake in Maharashtra killed 7,928 people and injured 30,000. Other areas have a moderate to low risk of an earthquake occurring.

Geography

The Thar Desert extends between the Aravalli Hills in the north-east, the Great Rann of Kutch along the coast and the alluvial plains of the Indus River in the west and north-west. Most of the desert is covered by huge shifting sand dunes that receive sediments from the alluvial plains and the coast. The sand is highly mobile due to strong winds occurring before the onset of the monsoon. The Luni River is the only river integrated into the desert. Rainfall is limited to 100–500 mm (3.9–19.7 in) per year, mostly falling from July to September.

Salt water lakes in the Thar Desert include the Sambhar, Kuchaman, Didwana in Rajasthan and Kharaghoda in Gujarat. These lakes receive rain water during monsoon and evaporate during the dry season. The salt is derived by the weathering of rocks in the region.

Desertification control

The soil of the Thar Desert remains dry for much of the year and is prone to wind erosion. High velocity winds blow soil from the desert, depositing some on neighboring fertile lands, and causing shifting sand dunes within the desert. Sand dunes are stabilised by erecting micro-windbreak barriers with scrub material and subsequent afforestation of the treated dunes with seedlings of shrubs such as phog, senna, castor oil plant and trees such as gum acacia, Prosopis juliflora and lebbek tree. The 649 km (403 mi) long Indira Gandhi Canal brings fresh water to the Thar Desert. It was conceived to halt spreading of the desert to fertile areas.

There are few local tree species suitable for planting in the desert, which are slow growing. Therefore, exotic tree species were introduced for plantation. Many species of Eucalyptus, Acacia, Cassia and other genera from Israel, Australia, US, Russia, Zimbabwe, Chile, Peru and Sudan have been tried in Thar Desert. Acacia tortilis has proved to be the most promising species for desert afforestation and the jojoba is another promising species of economic value found suitable for planting in these areas.

Protected areas

There are several protected areas in the Thar Desert:

- in Pakistan:
  - the Nara Desert Wildlife Sanctuary covers 6,300 km2 (2,400 sq mi);
  - the Rann of Kutch Wildlife Sanctuary.
- in India:
  - the Desert National Park covers 3,162 km2 (1,221 sq mi) and represents the Thar Desert ecosystem, it includes 44 villages. Its diverse fauna includes the great Indian bustard (Chirotis nigricaps), blackbuck, chinkara, fox, Bengal fox, wolf, and caracal. Seashells and massive fossilized tree trunks in this park record the geological history of the desert;
  - the Tal Chhapar Sanctuary covers 7 km2 (2.7 sq mi) and is an Important Bird Area. It is located in the Churu District, 210 km (130 mi) from Jaipur,

in the Shekhawati region. This sanctuary is home to a large population of blackbuck, fox and caracal such as partridge and sand grouse;

- Sundha Mata Conservation Reserve is a protected area of 117.49 km2 (45.36 sq mi) and is located in the Jalore District.

Biodiversity

Fauna

Stretches of sand in the desert are interspersed by hillocks and sandy and gravel plains. Due to the diversified habitat and ecosystem, the vegetation, human culture and animal life in this arid region is very rich in contrast to the other deserts of the world. About 23 species of lizard and 25 species of snakes are found here and several of them are endemic to the region.

Some wildlife species, which are fast vanishing in other parts of India, are found in the desert in large numbers such as the blackbuck (Antilope cervicapra), chinkara (Gazella bennettii) and Indian wild ass (Equus hemionus khur) in the Rann of Kutch. They have evolved excellent survival strategies, their size is smaller than other similar animals living in different conditions, and they are mainly nocturnal. There are certain other factors responsible for the survival of these animals in the desert. Due to the lack of water in this region, transformation of the grasslands into cropland has been very slow. The protection provided to them by a local community, the Bishnois, is also a factor. Other mammals of the Thar Desert include a subspecies of red fox (Vulpes vulpes pusilla) and the caracal.

The region is a haven for 141 species of migratory and resident birds of the desert. One can see eagles, harriers, falcons, buzzards, kestrel and vultures. There are short-toed eagles (Circaetus gallicus), tawny eagles (Aquila rapax), greater spotted eagles (Aquila clanga), laggar falcons (Falco jugger) and kestrels. There are also a number of reptiles.

The Indian peafowl is a resident breeder in the Thar region. The peacock is designated as the national bird of India and the provincial bird of the Punjab (Pakistan). It can be seen sitting on khejri or pipal trees in villages or Deblina.

Vegetation

The natural vegetation of this dry area is classed as Northwestern thorn scrub forest occurring in small clumps scattered more or less openly. Density and size of patches increase from west to east following the increase in rainfall. The natural vegetation of the Thar Desert is composed of the following tree, shrub and herb species:

- trees and shrubs: Acacia jacquemontii, Balanites roxburghii, Ziziphus zizyphus, Ziziphus nummularia, Calotropis procera, Suaeda fruticosa, Crotalaria burhia, Aerva javanica, Clerodendrum multiflorum, Leptadenia pyrotechnica, Lycium barbarum, Grewia tenax, Commiphora mukul, Euphorbia neriifolia, Cordia sinensis, Maytenus emarginata, Capparis decidua, Mimosa hamata

- herbs and grasses: Ochthochloa compressa, Dactyloctenium scindicum, Cenchrus biflorus, Cenchrus setigerus, Lasiurus scindicus, Cynodon dactylon, Panicum turgidum, Panicum antidotale, Dichanthium annulatum, Sporobolus marginatus, Saccharum spontaneum, Cenchrus ciliaris, Desmostachya bipinnata, Eragrostis species, Ergamopagan species, Phragmites species, Tribulus terrestris, Typha species, Sorghum halepense, Citrullus colocynthis

The endemic floral species include Calligonum polygonoides, Prosopis cineraria, Acacia nilotica, Tamarix aphylla, Cenchrus biflorus.

People

The Thar Desert is the most densely populated desert in the world, with a population density of 83 people per km2. In India, the inhabitants comprise Hindus, Muslims, and Sikhs. In Pakistan, inhabitants include Sindhis and Kolhis.

About 40% of the total population of Rajasthan live in the Thar Desert. The main occupation of the people is agriculture and animal husbandry. A colourful culture rich in tradition prevails in this desert. The people have a great passion for folk music and folk poetry.

Jodhpur, the largest city in the region, lies in the scrub forest zone. Bikaner and Jaisalmer are located in the desert proper. A large irrigation and power project has reclaimed areas of the northern and western desert for agriculture. The small population is mostly pastoral, and hide and wool industries are prominent.

The desert's part in Pakistan also has a rich multifaceted culture, heritage, traditions, folk tales, dances and music due to its inhabitants who belong to different religions, sects and castes.

Thar in ancient literature

The Indian epics describe this region as Lavanasagara (Salt-ocean). The Ramayana mentions Lavanasagara (the Salt-ocean) when Rama goes to attack Lanka with the army of vanaras. Rama uses his agneyashtra-amogha to dry up the sea named drumakulya situated on north of Lavanasagara. A fresh water source named Pushkar surrounded by Marukantara was created.

According to Jain cosmology, Jambūdvīpa is at the centre of Madhyaloka, or the middle part of the universe, where the humans reside. Jambūdvīpaprajñapti or the treatise on the island of roseapple tree contains a description of Jambūdvīpa and life biographies of Ṛṣabha and King Bharata. Jambūdvīpa continent is surrounded by ocean Lavanoda (Salt-ocean).

The Sarasvati River is one of the chief Rigvedic rivers mentioned in ancient Hindu texts. The Nadistuti hymn in the Rigveda (10.75) mentions the Sarasvati between the Yamuna in the east and the Sutlej in the west, and later Vedic texts like Tandya and Jaiminiya Brahmanas as well as the Mahabharata mention that the Sarasvati dried up in a desert.

Most scholars agree that at least some of the references to the Sarasvati in the Rigveda refer to the Ghaggar-Hakra River, while the Helmand River is often quoted as the locus of the early Rigvedic river. Whether such a transfer of the name has taken place, either from the Helmand to the Ghaggar-Hakra, or conversely from the Ghaggar-Hakra to the Helmand, is a matter of dispute.

There is also a small present-day Sarasvati River (Sarsuti) that joins the Ghaggar.

The epic Mahabharata mentions the Kamyaka Forest situated on the western boundary of the Kuru Kingdom (Kuru Proper and Kurujangala), on the banks of the Sarasvati River to the west of the Kurukshetra plain, which contained a lake known as Kamyaka. The Kamyaka forest is mentioned as being situated at the head of the Thar desert, near Lake Trinavindu. The Pandavas, on their way to exile in the woods, left Pramanakoti on the banks of the Ganges and went towards Kurukshetra, travelling in a western direction and crossing the Yamuna and Drishadvati rivers. They finally reached the banks of the Sarasvati River where they saw the forest of Kamyaka, the favourite haunt of ascetics, situated on a level and wild plain on the banks of the Sarasvati (3-5,36) abounding in birds and deer (3,5). There the Pandavas lived in an ascetic asylum (3,10). It took three days for Pandavas to reach the Kamyaka forest, setting out from Hastinapura, on their chariots (3,11).

In the Rigveda there is also mention of a river named Aśvanvatī along with the river Drishadvati. Some scholars consider both the Sarasvati and Aśvanvatī to be the same river.

Human habitations on the banks of Sarasvati and Drishadvati had shifted to the east and south directions prior to the Mahabharata period. At that time the present day Bikaner and Jodhpur areas were known as Kurujangala and Madrajangala provinces.

The Desert National Park, Jaisalmer has a collection of fossils of animals and plants 180 million years old.

Desert economy

Agriculture

The Thar is one of most heavily populated desert areas in the world with the main occupations of its inhabitants agriculture and animal husbandry. Agriculture is not a dependable proposition in this area because after the rainy season, at least one third of crops fail. Animal husbandry, trees and grasses, intercropped with vegetables or fruit trees, is the most viable model for arid, drought-prone regions. The region faces frequent droughts. Overgrazing due to high animal populations, wind and water erosion, mining and other industries have resulted in serious land degradation.

Agricultural production is mainly from kharif crops, which are grown in the summer season and seeded in June and July. These are then harvested in September and October and include bajra, pulses such as guar, jowar (Sorghum vulgare), maize (zea mays), sesame and groundnuts. Over the past few decades the development of irrigation features including canals and tube wells have changed the crop pattern with desert districts in Rajasthan now producing rabi crops including wheat, mustard and cumin seed along with cash crops.

The Thar region of Rajasthan is a major opium production and consumption area. The Indira Gandhi Canal irrigates northwestern Rajasthan while the Government of India has started a centrally sponsored Desert Development Program based on watershed management with the objective of preventing the spread of desert and improving the living conditions of people in the desert.

Livestock

In the last 15–20 years, the Rajasthan desert has seen many changes, including a manifold increase of both the human and animal population. Animal husbandry has become popular due to the difficult farming conditions. At present, there are ten times more animals per person in Rajasthan than the national average, and overgrazing is also a factor affecting climatic and drought conditions.

A large number of farmers in Thar desert depend on animal husbandry for their livelihood. Cows, buffalos, sheep, goats, camels, and oxen consists of major cattle population. Barmer district has the highest cattle population out of which sheep and goats are in majority. Some of the best breeds of bullocks such as Kankrej (Sanchori) and Nagauri are from desert region.

Thar region of Rajasthan is the biggest wool-producing area in India. Chokla, Marwari, Jaisalmeri, Magra, Malpuri, Sonadi, Nali and Pungal breeds of sheep are found in the region. Of the total wool production in India, 40-50% comes from Rajasthan. The sheep-wool from Rajasthan is considered best for carpet making industry in the world. The wool of Chokla breed of sheep is considered of superior quality. The breeding centres have been developed for Karakul and Merino sheep at Suratgarh, Jaitsar and Bikaner. Some important mills for making Woolen thread established in desert area are: Jodhpur Woolen Mill, Jodhpur; Rajasthan Woolen Mill, Bikaner and India Woolen Mill, Bikaner. Bikaner is the biggest mandi (market place) of wool in Asia.

The live stock depends for grazing on common lands in villages. During famine years in the desert the nomadic rebari people move with large herds of sheep and camel to the forested areas of south Rajasthan or nearby states like Madhya Pradesh for grazing the cattle.

The importance of animal husbandry can be understood from the organization of large number of cattle fairs in the region. Cattle fairs are normally named after the folk-deities. Some of major cattle fairs held are Ramdevji cattle fair at Manasar in Nagaur district, Tejaji cattle fair at Parbatsar in Nagaur district, Baldeo cattle fair at Merta city in Nagaur district, Mallinath cattle fair at Tilwara in barmer district. Live stock is very important to the Thar desert people.

Agroforestry

Forestry has an important part to play in the amelioration of the conditions in semi-arid and arid lands. If properly planned, forestry can make an important contribution to the general welfare of the people living in desert areas. The living standard of the people in the desert is low. They can not afford other fuels like gas, kerosene etc. Fire wood is their main fuel, of the total consumption of wood about 75 percent is firewood. The forest cover in desert is low. Rajasthan has a forest area of 31150 km2. which is about 9% of the geographical area. The forest area is mainly in southern districts of Rajasthan like Udaipur and Chittorgarh. The minimum forest area is in Churu district only 80 km2. Thus the forest is insufficient to fulfill the needs of firewood and grazing in desert districts. This diverts the much needed cattledung from the field to the hearth. This in turn results into the decrease in agricultural production. Agroforestry model is best suited to the people of desert. Some Institutes have done good work in Agroforestry.

The scientists of Central Arid Zone Research Institute (CAZRI), have successfully developed and improved dozens of traditional and non-traditional crops/fruits, such as Ber trees (like plums) that produce much larger fruits than before (lemon-size) and can thrive with minimal rainfall. These trees have become a profitable option for farmers. One example from a case study of horticulture showed that in situation of budding in 35 plants of Ber and Guar (Gola, Seb & Mundia variety developed in CAZRI), using only one hectare of land, yielded 10,000 kg. of Ber and 250 kg. of Guar, which translates into double or even triple profit.

Arid Forest Research Institute, (AFRI) situated at Jodhpur is another national level institute in the region. It is one of the institutes of the Indian Council of Forestry Research and Education (ICFRE) working under the Ministry of Environment & Forests, Govt. of India. The Objective of the Institute is to carry out scientific research in forestry in order to provide technologies to increase the vegetative cover and to conserve the biodiversity in the hot arid and semi arid region of Rajasthan, Gujarat and Dadara & Nagar Haveli union territory.

The most important tree species in terms of providing a livelihood in Thar desert communities is Prosopis cineraria.

Prosopis cineraria provides wood of construction class. It is used for house-building, chiefly as rafters, posts scantlings, doors and windows, and for well construction water pipes, upright posts of Persian wheels, agricultural implements and shafts, spokes, fellows and yoke of carts. It can also be used for small turning work and tool-handles. Container manufacturing is another important wood-based industry, which depends heavily on desert-grown trees.

Prosopis cineraria is much valued as a fodder tree. The trees are heavily lopped particularly during winter months when no other green fodder is available in the dry tracts. There is a popular saying that death will not visit a man, even at the time of a famine, if he has a Prosopis cineraria, a goat and a camel, since the three together are some what said to sustain a man even under the most trying condition. The forage yield per tree varies a great deal. On an average, the yield of green forage from a full grown tree is expected to be about 60 kg with complete lopping having only the central leading shoot, 30 kg when the lower two third crown is lopped and 20 kg when the lower one third crown is lopped. The leaves are of high nutritive value. Feeding of the leaves during winter when no other green fodder is generally available in rain-fed areas is thus profitable. The pods have a sweetish pulp and are also used as fodder for livestock.

Prosopis cineraria is most important top feed species providing nutritious and highly palatable green as well as dry fodder, which is readily eaten by camels, cattle, sheep and goats, constituting a major feed requirement of desert livestock. Locally it is called Loong. Pods are locally called sangar or sangri. The dried pods locally called Kho-Kha are eaten. Dried pods also form rich animal feed, which is liked by all livestock. Green pods also form rich animal feed, which is liked by drying the young boiled pods. They are also used as famine food and known even to prehistoric man. Even the bark, having an astringent bitter taste, was reportedly eaten during the severe famine of 1899 and 1939. Pod yield is nearly 1.4 quintals of pods/ha with a variation of 10.7% in dry locations.

Prosopis cineraria wood is reported to contain high calorific value and provide high quality fuel wood. The lopped branches are good as fencing material. Its roots also encourage nitrogen fixation, which produces higher crop yields.

Tecomella undulata is one more tree species, locally known as Rohida, which is found in Thar Desert regions of northwest and western India. It is another important medium-sized tree of great use in Agroforestry, that produces quality timber and is the main source of timber amongst the indigenous tree species of desert regions. The trade name of the tree species is Desert teak or Marwar teak.

Tecomella undulata is mainly used as a source of timber. Its wood is strong, tough and durable. It takes a fine finish. Heartwood contains quinoid. The wood is excellent for firewood and charcoal. Cattle and goats eat leaves of the tree. Camels, goats and sheep consume flowers and pods.

Tecomella undulata plays an important role in the ecology. It acts as a soil-binding tree by spreading a network of lateral roots on the top surface of the soil. It also acts as a windbreak and helps in stabilizing shifting sand dunes. It is considered as the home of birds and provides shelter for other desert wildlife. Shade of tree crown is shelter for the cattle, goats and sheep during summer days.

Tecomella undulata has medicinal properties as well. The bark obtained from the stem is used as a remedy for syphilis. It is also used in curing urinary disorders, enlargement of spleen, gonorrhoea, leucoderma and liver diseases. Seeds are used against abscess.

Ecotourism

Desert safaris on camels have become increasingly popular around Jaisalmer. Domestic and international tourists frequent the desert seeking adventure on camels for anything from a day to several days. This ecotourism industry ranges from cheaper backpacker treks to plush Arabian night style campsites replete with banquets and cultural performances. During the treks tourists are able to view the fragile and beautiful ecosystem of the Thar desert. This form of tourism provides income to many operators and camel owners in Jaisalmer as well as employment for many camel trekkers in the desert villages nearby. People from various parts of the world come to see the Pushkar ka Mela (Pushkar Fair) and oases.

Industry

Rajasthan is pre-eminent in quarrying and mining in India. The Taj Mahal was built with white marble mined from Makrana in Nagaur district. The state is the second largest source of cement in India. It has rich salt deposits at Sambhar. Jodhpur sandstone is mostly used in monuments, important buildings, residential buildings, and such. This stone is termed "chittar patthar". Jodhpur has also got mines of red stone locally known as ghatu patthar used in construction. Sandstone is found in Jodhpur and Naguar districts. Jalore is biggest centre of granite processing units.

Lignite coal deposits are there at places Giral, Kapuradi, Jalipa, Bhadka in Barmer district; Plana, Gudha, Bithnok, Barsinghpur, Mandla Charan, Raneri Hadla in Bikaner district and Kasnau, Merta, Lunsar etc., in Nagaur district. Lignite based Thermal power plant has been established at Giral in Barmer district. Jindal group is working on 1080 Megawatt power project in private sector at village Bhadaresh in Barmer district. "Neweli Lignite Barsinghpur Project" is in progress to establish two thermal power units of capacity 125 megawatts each at Barsinghpur in Bikaner district. Reliance Energy is working on establishing power generation through underground gasification technique in Barmer district with an outlay of about 30 billion rupees.

There is large storage of good quality petroleum in Jaisalmer and Barmer districts. The main places with deposits of petroleum are Baghewal, Kalrewal, and Tawariwal in Jaisalmer district and Gudha Malani area in Barmer district. Barmer district has started petroleum production on commercial scale. Barmer district is in the news due to its large oil basin. The British exploration company Cairn Energy started production of oil on a large scale. Mangala, Bhagyam and Aishwariya are the major oil fields in the district. This is India's biggest oil discovery in 22 years. This promises to transform the local economy, which has long suffered from the harshness of the desert.

The Government of India initiated departmental exploration for oil in 1955-56 in the Jaisalmer area, Oil India Limited's discovered natural gas in 1988 in the Jaisalmer basin. Also known for their fine leather messenger bags made from wild camels native to the area.

The Thar desert seems an ideal place for generation of electricity from wind power. According to an estimate Rajasthan state has got a potential of 5500 Megawatt wind power generation as such it is in the priority of the state govt. Rajasthan State Power Corporation has established its first wind power-based power plant at Amarsagar in Jaisalmer district. Some leading companies in the field are working on establishing wind mills in Barmer, Jaisalmer and Bikaner districts. Solar energy also has a great potential in this region as most of the days during a year are cloud free. Solar energy based plant has been established at Bhaleri in Churu district to convert hard water into drinking water.

Salt water lakes

There are a number of salt water lakes in Thar desert. These are Sambhar, Pachpadra, Tal Chhapar, Falaudi and Lunkaransar where Sodium chloride salt is produced from salt water. The Didwana lake produces Sodium Sulphate salt. Ancient Archaeological evidences of habitations have been recovered from Sambhar and Didwana lakes which shows their antiquity and historical importance.

Water and housing in the desert

Water scarcity plays an important role in shaping life in all parts of Thar. Natural (tobas) or man-made (johads), both types of small, intermittent ponds, are often the only source of water for animals and humans in the true desert areas. The lack of a constant water supply causes much of the local population to live as nomads. Most human settlements are found near the two seasonal streams of the Karon-Jhar hills. Potable groundwater is also rare in the Thar desert. Supplies are often sour due to dissolved minerals, and are only available deep underground. Wells that successfully bear sweet water attract nearby settlement, but are difficult to dig, possibly claiming the lives of the well-diggers.

According to 1980 housing census in Pakistan, there were 241,326 housing units of one or two very small rooms. The degree of crowding was six persons per housing unit and three persons per room. For most of the housing units (approximately 76 per cent), the main construction material of outer walls is unbaked bricks whereas wood is used in 10 per cent and baked bricks or stones with mud bonding in 8 per cent housing units. A large number of families still live in jhugis or huts which are housing units formed with straws and thin wood-sticks. The wind storm proves these jhugis unsustainable all the times. But the poverty leaves no other option to these jhugiwalas (people living in jhugis).

The river Luni is the only natural water source that drains inside a lake in the desert. It originates in the Pushkar valley of the Aravalli Range, near Ajmer and ends in the marshy lands of Rann of Kutch in Gujarat, after travelling a distance of 530 km. The Luni flows through part of Ajmer, Barmer, Jalor, Jodhpur, Nagaur, Pali, and Sirohi districts and Mithavirana Vav Radhanpur region of Banaskantha North Gujarat. Its major tributaries are the Sukri, Mithri, Bandi, Khari, Jawai, Guhiya and Sagi from the left, and the Jojari River from the right.

The Ghaggar is another intermittent river in India, flowing during the monsoon rains. It originates in the Shivalik Hills of Himachal Pradesh and flows through Punjab and Haryana to Rajasthan; just southwest of Sirsa, Haryana and by the side of talwara jheel in Rajasthan, this seasonal river feeds two irrigation canals that extend into Rajasthan. It terminates in Hanumangarh district.

The Rajasthan Canal system is the major irrigation scheme of the Thar Desert and is conceived to reclaim it and also to check spreading of the desert to fertile areas. It is world's largest irrigation which is being extended in an attempt to make the desert arable. It runs south-southwest in Punjab and Haryana but mainly in Rajasthan for a total of 650 kilometers and ends near Jaisalmer, in Rajasthan. After the construction of the Indira Gandhi Canal, irrigation facilities were available over an area of 6770 km^2 in Jaisalmer district and 37 km^2 in Barmer district. Irrigation had already been provided in an area of 3670 km^2 in Jaisalmer district. The canal has transformed the barren deserts of this district into rich and lush fields. Crops of mustard, cotton, and wheat now flourish in this semi-arid western region replacing the sand there previously.

Besides providing water for agriculture, the canal will supply drinking water to hundreds of people in far-flung areas. As the second stage of work on the canal progresses rapidly, there is hope that it will enhance the living standards of the people of the state.

Desert for recreation

Thar Desert provides the recreational value in terms of desert festivals organized every year. Rajasthan desert festivals are celebrated with great zest and zeal. This festival is held once a year during winters. Dressed in brilliantly hued costumes, the people of the desert dance and sing haunting ballads of valor, romance and tragedy. The fair has snake charmers, puppeteers, acrobats and folk performers. Camels, of course, play a stellar role in this festival, where the rich and colorful folk culture of Rajasthan can be seen.

Camels are an integral part of the desert life and the camel events during the Desert Festival confirm this fact. Special efforts go into dressing the animal for entering the spectacular competition of the best-dressed camel. Other interesting competitions on the fringes are the moustache and turban tying competitions, which not only demonstrate a glorious tradition but also inspire its preservation. Both the turban and the moustache have been centuries old symbols of honor in Rajasthan.

Evenings are meant for the main shows of music and dance. Continuing till late into the night, the number of spectators swells up each night and the grand finale, on the full moon night, takes place by silvery sand dunes.

Coasts

The Eastern Coastal Plain is a wide stretch of land lying between the Eastern Ghats and the oceanic boundary of India. It stretches from Tamil Nadu in the south to West Bengal in the east. The Mahanadi, Godavari, Kaveri, and Krishna rivers drain these plains. The temperature in the coastal regions often exceeds 30 °C (86 °F), and is coupled with high levels of humidity. The region receives both the northeast monsoon and southwest monsoon rains. The southwest monsoon splits into two branches, the Bay of Bengal branch and the Arabian Sea branch. The Bay of Bengal branch moves northwards crossing northeast India in early June. The Arabian Sea branch moves northwards and discharges much of its rain on the windward side of Western Ghats. Annual rainfall in this region averages between 1,000 and 3,000 mm (39 and 118 in). The width of the plains varies between 100 and 130 km (62 and 81 mi). The plains are divided into six regions—the Mahanadi delta, the southern Andhra Pradesh plain, the Krishna-Godavari deltas, the Kanyakumari coast, the Coromandel Coast, and sandy coastal.

The Western Coastal Plain is a narrow strip of land sandwiched between the Western Ghats and the Arabian Sea, ranging from 50 to 100 km (31 to 62 mi) in width. It extends from Gujarat in the north and extends through Maharashtra, Goa, Karnataka, and Kerala. Numerous rivers and backwaters inundate the region. Mostly originating in the Western Ghats, the rivers are fast-flowing, usually perennial, and empty into estuaries. Major rivers flowing into the sea are the Tapi, Narmada, Mandovi and Zuari. Vegetation is mostly deciduous, but the Malabar Coast moist forests constitute a unique ecoregion. The Western Coastal Plain can be divided into two parts, the Konkan and the Malabar Coast.

Islands

The Lakshadweep and the Andaman and Nicobar Islands are India's two major island formations and are classified as union territories.

The Lakshadweep Islands lie 200 to 300 km (120 to 190 mi) off the coast of Kerala in the Arabian sea with an area of 32 km2 (12 sq mi). They consist of twelve atolls, three reefs, and five submerged banks, with a total of about 35 islands and islets.

The Andaman and Nicobar Islands are located between 6° and 14° north latitude and 92° and 94° east longitude. They consist of 572 isles, lying in the Bay of Bengal near the Burmese coast. They are located 1,255 km (780 mi) from Kolkata (Calcutta) and 193 km (120 mi) from Cape Negrais in Burma. The territory consists of two island groups, the Andaman Islands and the Nicobar Islands. The Andaman Islands consists of 204 small islands across a total length of 352 km (219 mi). India's only active volcano, Barren Island is situated here. It last erupted in May 2005. The Narcondum is a dormant volcano and there is a mud volcano at Baratang. Indira Point, India's southernmost land point, is situated in the Nicobar islands at 6°45′10″N and 93°49′36″E, and lies just 189 km (117 mi) from the Indonesian island of Sumatra, to the southeast. The highest point is Mount Thullier at 642 m (2,106 ft).

Other significant islands in India include Diu daman, a former Portuguese enclave; Majuli, a river island of the Brahmaputra; Elephanta in Bombay Harbour; and Sriharikota, a barrier island in Andhra Pradesh. Salsette Island is India's most populous island on which the city of Mumbai (Bombay) is located. Forty-two islands in the Gulf of Kutch constitute the Marine National Park.

Andaman and Nicobar

- Car Nicobar
- Great Andaman
- Great Nicobar

Andhra Pradesh

- Bhavani
- Diviseema
- Hope
- Sriharikota

Daman and Diu

- Diu

Goa

- Chorao
- Divar

Gujarat

- Bet Dwarka

Karnataka

- Shivanasamudram
- St. Mary

Kerala

- Munroe
- Vallarpadam
- Vypin
- Willington

Kochen (Payyanur)

Lakshadweep

- Kavvayi
- Lakshadweep
- Minicoy
- Netrani

Maharashtra

- Butcher
- Cross
- Elephanta
- Middle Ground
- Oyster Rock
- Salsette

Puducherry

- Isukathippa

Tamil Nadu

- Pamban
- Quibble
- Srirangam

- Gulf of Mannar
  - Vaan, 16.00 ha 8°50′11″N 78°12′38″E / 8.83639°N 78.21047°E / 8.83639; 78.21047
  - Koswari, 19.50 ha 8°52′08″N 78°13′30″E / 8.86879°N 78.22506°E / 8.86879; 78.22506
  - Vilanguchalli, 0.95 ha 8°56′17″N 78°16′11″E / 8.93815°N 78.26969°E / 8.93815; 78.26969
  - Kariyachalli, 16.46 ha 8°57′15″N 78°15′08″E / 8.95409°N 78.25235°E / 8.95409; 78.25235
  - Uppu Thanni, 22.94 ha, elevation 4 m 9°05′21″N 78°29′29″E / 9.08921°N 78.49148°E / 9.08921; 78.49148
  - Puluvini Challi, 6.12 ha, elevation 5.5 m 9°06′12″N 78°32′13″E / 9.10320°N 78.53688°E / 9.10320; 78.53688
  - Nalla Thanni, 101.00 ha, elevation 11.9 m 9°06′24″N 78°34′44″E / 9.10667°N 78.57885°E / 9.10667; 78.57885;
  - Anaipar, 11.00 ha, elevation 2.1 m 9°09′11″N 78°41′41″E / 9.15294°N 78.69481°E / 9.15294; 78.69481
  - Vali Munai, 6.72 ha, elevation 1.2 m 9°09′13″N 78°43′50″E / 9.15354°N 78.73052°E / 9.15354; 78.73052
  - Poovarasan Patti, 0.50 ha, elevation 1.2 m 9°09′15″N 78°46′01″E / 9.15413°N 78.76695°E / 9.15413; 78.76695
  - Appa, 28.63 ha, elevation 6.4 m 9°09′57″N 78°49′33″E / 9.16582°N 78.82596°E / 9.16582; 78.82596
  - Talairi, 75.15 ha, elevation 2.7 m 9°10′53″N 78°54′24″E / 9.18133°N 78.90673°E / 9.18133; 78.90673
  - Valai 10.10 ha, elevation 3.0 m 9°11′03″N 78°56′19″E / 9.18421°N 78.93866°E / 9.18421; 78.93866
  - Mulli, 10.20 ha, elevation 1.2 m 9°11′11″N 78°58′05″E / 9.18641°N 78.96810°E / 9.18641; 78.96810;
  - Musal, 124.00 ha, elevation 0.9 m 9°11′57″N 79°04′31″E / 9.19912°N 79.07530°E / 9.19912; 79.07530
  - Manoli, 25.90 ha 9°12′56″N 79°07′42″E / 9.21564°N 79.12834°E / 9.21564; 79.12834
  - Manoli-Putti 2.34 ha 9°12′57″N 79°07′41″E / 9.21581°N 79.12800°E / 9.21581; 79.12800
  - Poomarichan 16.58 ha 9°14′43″N 79°10′48″E / 9.24538°N 79.17993°E / 9.24538; 79.17993
  - Pullivasal, 29.95 ha 9°14′13″N 79°11′28″E / 9.23699°N 79.19100°E / 9.23699; 79.19100
  - Kurusadai, 65.80 ha 9°14′49″N 79°12′34″E / 9.24690°N 79.20945°E / 9.24690; 79.20945

West Bengal

- Sagar
- South Talpatti

Water bodies

Rivers in India.

India has around 14,500 km of inland navigable waterways. There are twelve rivers which are classified as major rivers, with the total catchment area exceeding 2,528,000 km2 (976,000 sq mi). All major rivers of India originate from one of the three main watersheds:

1. The Himalaya and the Karakoram ranges
2. Vindhya and Satpura range in central India
3. Sahyadri or Western Ghats in western India

The Himalayan river networks are snow-fed and have a perennial supply throughout the year. The other two river systems are dependent on the monsoons and shrink into rivulets during the dry season. The Himalayan rivers that flow westward into Pakistan are the Indus, Jhelum, Chenab, Ravi, Beas, and Sutlej.

The Ganges-Brahmaputra-Meghana system has the largest catchment area of about 1,600,000 km2 (620,000 sq mi). The Ganges Basin alone has a catchment of about 1,100,000 km2 (420,000 sq mi). The Ganges originates from the Gangotri Glacier in Uttarakhand. It flows southeast, draining into the Bay of Bengal. The Yamuna and Gomti rivers also arise in the western Himalayas and join the Ganges in the plains. The Brahmaputra originates in Tibet, China, where it is known as the Yarlung Tsangpo River (or "Tsangpo"). It enters India in the far-eastern state of Arunachal Pradesh, then flows west through Assam. The Brahmaputra merges with the Ganges in Bangladesh, where it is known as the Jamuna River.

The Chambal, another tributary of the Ganges, via the Yamuna, originates from the Vindhya-Satpura watershed. The river flows eastward. Westward-flowing rivers from this watershed are the Narmada and Tapti, which drain into the Arabian Sea in Gujarat. The river network that flows from east to west constitutes 10% of the total outflow.

The Western Ghats are the source of all Deccan rivers, which include the through Godavari River, Krishna River and Kaveri River, all draining into the Bay of Bengal. These rivers constitute 20% of India's total outflow.

The heavy southwest monsoon rains cause the Brahmaputra and other rivers to distend their banks, often flooding surrounding areas. Though they provide rice paddy farmers with a largely dependable source of natural irrigation and fertilisation, such floods have killed thousands of people and tend to cause displacements of people in such areas.

Major gulfs include the Gulf of Cambay, Gulf of Kutch, and the Gulf of Mannar. Straits include the Palk Strait, which separates India from Sri Lanka; the Ten Degree Channel, which separates the Andamans from the Nicobar Islands; 'and the Eight

Degree Channel, which separates the Laccadive and Amindivi Islands from the Minicoy Island to the south. Important capes include the Kanyakumari (formerly called Cape Comorin), the southern tip of mainland India; Indira Point, the southernmost point in India (on Great Nicobar Island); Rama's Bridge, and Point Calimere. The Arabian Sea lies to the west of India, the Bay of Bengal and the Indian Ocean lie to the east and south, respectively. Smaller seas include the Laccadive Sea and the Andaman Sea. There are four coral reefs in India, located in the Andaman and Nicobar Islands, the Gulf of Mannar, Lakshadweep, and the Gulf of Kutch. Important lakes include Sambhar Lake, the country's largest saltwater lake in Rajasthan, Vembanad Lake in Kerala, Kolleru Lake in Andhra Pradesh, Loktak Lake in Manipur, Dal Lake in Kashmir, Chilka Lake(lagoon lake) in Orrisa, and Sasthamkotta Lake in Kerala.

The Indo-Gangetic Plains

Known as Ganga-Satluj Ka Maidaan, this area is drained by 16 major rivers. The major Himalayan Rivers are the Indus, Ganges, and Brahmaputra. These rivers are long,and are joined by many large and important tributaries. Himalayan rivers have long courses from their source to sea.(in India Arabian sea and Bay of Bengal)

Ganges River System

The major rivers in this system are (in order of merging, from west to east)

- Ganga - Starting from Gangotri Glacier, Uttarakhand
- Chambal -Flows through Madhya Pradesh, Rajasthan and merges into Yamuna in Uttar Pradesh
- Betwa - Not Himalayan river, covers Madhya Pradesh and Uttar Pradesh before merging into Yamuna
- Yamuna - Yamuna runs its most of the course parallel to Ganga before contributing its water to Ganga at Allahabad
- Gomti - Starts near the junction of three borders viz. Nepal, Uttarakhand and UP
- Ghaghra - Starts in Nepal near Uttarakhand
- Son - Not Himalayan river, covers MP, UP, Jharkhand and Bihar. Largest of Ganga's southern tributaries
- Gandak - Starts from Nepal
- Kosi - Starts from Bihar, near Indo-Nepal border
- Brahmaputra - Merges with Ganga to form the grand river (but short in length) - Padma in Bangladesh. By now, flow velocity of both rivers slow down to considerable extent as they are in plains now.

Before entering Bangladesh, Ganga leaves a distributary Hugli, which provides water for irrigation in West Bengal

Indus River System

The 'Indus River originates in the northern slopes of the Kailash range near Lake Mansarovar in Tibet. Although most of the river's course runs through neighbouring Pakistan, as per as regulation of Indus water treaty of 1960, India can use only 20 percent of the water in this river. A portion of it does run through Indian territory, as do parts of the courses of its five major tributaries, listed below. These tributaries are the source of the name of the Punjab of South Asia; the name is derived from the punch ("five") and aab ("water"), hence the combination of the words (Punjab) means "land with the water of five rivers". The Indus is 3,200 kilometres (2,000 mi) long.

The major rivers in Indus river system are (in order of their length):

- Indus - 3,200 kilometres (2,000 mi)
- Chenab - 960 kilometres (600 mi)
- Jhelum - 813 kilometres (505 mi)
- Ravi - 720 kilometres (450 mi)
- Sutlej - 529 kilometres (329 mi)
- Beas - 460 kilometres (290 mi)
- Shyok
- Zanskar

Annual flows and other data

India experiences an average precipitation of 1,170 millimetres (46 in) per year, or about 4,000 cubic kilometres (960 cu mi) of rains annually. Some 80 percent of its area experiences rains of 750 millimetres (30 in) or more a year. However, this rain is not uniform in time or geography. Most of the rains occur during its monsoon seasons (June to September), with the northeast and north receiving far more rains than India's west and south. Other than rains, the melting of snow year round over the Himalayas feeds the northern rivers to varying degrees. The southern rivers, however experience more flow variability over the year. For the Himalayan basin, this leads to flooding in some months and water scarcity in others. Despite extensive river system, safe clean drinking water as well as irrigation water supplies for sustainable agriculture are in shortage across India, in part because it has, as yet, harnessed a small fraction of its available and recoverable surface water resource. India harnessed 761 cubic kilometres (183 cu mi) (20 percent) of its water resources in 2010, part of which came from unsustainable use of groundwater. Of the water it withdrew from its rivers and groundwater wells, India dedicated about 688 cubic kilometres (165 cu mi) to irrigation, 56 cubic kilometres (13 cu mi) to municipal and drinking water applications and 17 cubic kilometres (4.1 cu mi) to industry.

According to 2011 report of the Food and Agriculture Organization of the United Nations, India's basin wise distribution of catchment area and utilizable surface water resources is presented in the following table:

Basin number	River basin unit	Region	Draining into	Catchment area	Average runoff	Additional available

				(% of river irrigated India)	(km3)	surface water (km3)
1.1	Ganges (GBM)	North	Bangladesh	26.5	525.02	250
1.2	Brahmaputra (GBM)	Northeast	Bangladesh	6	537.24	24
1.3	Meghna/Barak (GBM)	East	Bangladesh	1.5	48.36	
2	Other Northeast rivers	Northeast	Myanmar, Bangladesh	1.1	31	
3	Subernarekha	East-southeast	Bay of Bengal	0.9	12.37	
4	Brahmani-Baitarani	East-southeast	Bay of Bengal	1.6	28.48	6.8
5	Mahanadi	Central-east	Bay of Bengal	4.4	66.88	18.3
6	Godavari	Central	Bay of Bengal	9.7	110.54	50
7	Krishna	Central	Bay of Bengal	8	78.12	76.3
8	Pennar	Southeast	Bay of Bengal	1.7	6.32	58
9	Kaveri	South	Bay of Bengal	2.5	21.36	6.9
10	East flowing rivers between Mahanadi and Pennar	Central-east	Bay of Bengal	2.7	22.52	19
11	East flowing rivers between Kanyakumari and Pennar	Southeast	Bay of Bengal	3.1	16.46	13.1
12	West flowing rivers between Tadri and Kanyakumari	Southwest	Arabian Sea	1.7	113.53	16.7
13	West flowing rivers between Tapi and Tadri	Southwest	Arabian Sea	1.7	87.41	24.3
14	Tapi	Central-west	Arabian Sea	2	14.88	11.9
15	Narmada	Central-west	Arabian Sea	3.1	45.64	14.5
16	Mahi	Northwest	Arabian Sea	1.1	11.02	34.5
17	Sabarmati	Northwest	Arabian Sea	0.7	3.81	3.1
18	West flowing rivers between Kutsh and Saurashtra	Northwest	Arabian Sea	10	15.1	1.9
19	Rajasthan inland basin	Northwest	India	0	Negligible	15

20	Indus tributaries	Northwest	Pakistan, India	10	73.31	46
	Total (per International Treaty)			100	1869.37	

The Peninsular River System

The main water divide in peninsular rivers is formed by the Western Ghats, which run from north to south close to the western coast. Most of the major rivers of the peninsula such as the Mahanadi, the Godavari, the Krishna and the Kaveri flow eastwards and drain into the Bay of Bengal. These rivers make delta at their mouths. The Narmada, Periyar and Tapti are the only long rivers, which flow west and make estuaries.

Wetlands

India's wetland ecosystem is widely distributed from the cold and arid located in the Ladakh region of Jammu and Kashmir, and those with the wet and humid climate of peninsular India. Most of the wetlands are directly or indirectly linked to river networks. The Indian government has identified a total of 71 wetlands for conservation and are part of sanctuaries and national parks. Mangrove forests are present all along the Indian coastline in sheltered estuaries, creeks, backwaters, salt marshes and mudflats. The mangrove area covers a total of 4,461 km2 (1,722 sq mi), which comprises 7% of the world's total mangrove cover. Prominent mangrove covers are located in the Andaman and Nicobar Islands, the Sundarbans delta, the Gulf of Kutch and the deltas of the Mahanadi, Godavari and Krishna rivers. Parts of Maharashtra, Karnataka and Kerala also have large mangrove covers.

The Sundarbans delta is home to the largest mangrove forest in the world. It lies at the mouth of the Ganges and spreads across areas of Bangladesh and West Bengal. The Sundarbans is a UNESCO World Heritage Site, but is identified separately as the Sundarbans (Bangladesh) and the Sundarbans National Park (India). The Sundarbans are intersected by a complex network of tidal waterways, mudflats and small islands of salt-tolerant mangrove forests. The area is known for its diverse fauna, being home to a large variety of species of birds, spotted deer, crocodiles and snakes. Its most famous inhabitant is the Bengal tiger. It is estimated that there are now 400 Bengal tigers and about 30,000 spotted deer in the area.

The Rann of Kutch is a marshy region located in northwestern Gujarat and the bordering Sindh province of Pakistan. It occupies a total area of 27,900 km2 (10,800 sq mi). The region was originally a part of the Arabian Sea. Geologic forces such as earthquakes resulted in the damming up of the region, turning it into a large saltwater lagoon. This area gradually filled with silt thus turning it into a seasonal salt marsh. During the monsoons, the area turn into a shallow marsh, often flooding to knee-depth. After the monsoons, the region turns dry and becomes parched.

Climate

precipitation and their seasonality.

Based on the Köppen system, India hosts six major climatic subtypes, ranging from arid desert in the west, alpine tundra and glaciers in the north, and humid tropical regions supporting rainforests in the southwest and the island territories. The nation has four seasons: winter (January–February), summer (March–May), a monsoon (rainy) season (June–September) and a post-monsoon period (October–December)'.

The Himalayas act as a barrier to the frigid katabatic winds flowing down from Central Asia.' Thus, North India is kept warm or only mildly cooled during winter; in summer, the same phenomenon makes India relatively hot. Although the Tropic of Cancer—the boundary between the tropics and subtropics—passes through the middle of India, the whole country is considered to be tropical.

Summer lasts between March and June in most parts of India. Temperatures can exceed 40 °C (104 °F) during the day. The coastal regions exceed 30 °C (86 °F) coupled with high levels of humidity. In the Thar desert area temperatures can exceed 45 °C (113 °F). The rain-bearing monsoon clouds are attracted to the low-pressure system created by the Thar Desert. The southwest monsoon splits into two arms, the Bay of Bengal arm and the Arabian Sea arm. The Bay of Bengal arm moves northwards crossing northeast India in early June. The Arabian Sea arm moves northwards and deposits much of its rain on the windward side of Western Ghats. Winters in peninsula India see mild to warm days and cool nights. Further north the temperature is cooler. Temperatures in some parts of the Indian plains sometimes fall below freezing. Most of northern India is plagued by fog during this season. The highest temperature recorded in India was 50.6 °C (123.1 °F) in Alwar, Rajasthan. The lowest was −45 °C (−49 °F) in Kashmir.

History

During the Triassic period of some 251–199.6 Ma, the Indian subcontinent was part of a vast supercontinent known as Pangaea. Despite its position within a high-latitude belt at 55–75° S—as opposed to its current position between 5 and 35° N, latitudes now occupied by Greenland and parts of the Antarctic Peninsula—India likely experienced a humid temperate climate with warm and frost-free weather, though with well-defined seasons. India later merged into the southern supercontinent Gondwana, a process beginning some 550–500 Ma. During the Late Paleozoic, Gondwana extended from a point at or near the South Pole to near the equator, where the Indian craton (stable continental crust) was positioned, resulting in a mild climate favourable to hosting high-biomass ecosystems. This is underscored by India's vast coal reserves—much of it from the late Paleozoic sedimentary sequence—the fourth-largest reserves in the world. During the Mesozoic, the world, including India, was considerably warmer than today. With the coming of the Carboniferous, global cooling stoked extensive glaciation, which spread northwards from South Africa towards India; this cool period lasted well into the Permian.

Tectonic movement by the Indian Plate caused it to pass over a geologic hotspot—the Réunion hotspot—now occupied by the volcanic island of Réunion. This resulted in a massive flood basalt event that laid down the Deccan Traps some 60–68 Ma, at the end of the Cretaceous period. This may have contributed to the global Cretaceous–Paleogene extinction event, which caused India to experience significantly reduced insolation. Elevated atmospheric levels of sulphur gases formed aerosols such as sulphur dioxide and sulphuric acid, similar to those found in the atmosphere of Venus; these precipitated as acid rain. Elevated carbon dioxide emissions also contributed to the greenhouse effect, causing warmer weather that lasted long after the atmospheric shroud of dust and aerosols had cleared. Further climatic changes 20 million years ago, long after India had crashed into the Laurasian landmass, were severe enough to cause the extinction of many endemic Indian forms. The formation of the Himalayas resulted in blockage of frigid Central Asian air, preventing it from reaching India; this made its climate significantly warmer and more tropical in character than it would otherwise have been.

Regions

India is home to an extraordinary variety of climatic regions, ranging from tropical in the south to temperate and alpine in the Himalayan north, where elevated regions receive sustained winter snowfall. The nation's climate is strongly influenced by the Himalayas and the Thar Desert. The Himalayas, along with the Hindu Kush mountains in Pakistan, prevent cold Central Asian katabatic winds from blowing in, keeping the bulk of the Indian subcontinent warmer than most locations at similar latitudes. Simultaneously, the Thar Desert plays a role in attracting moisture-laden southwest summer monsoon winds that, between June and October, provide the majority of India's rainfall. Four major climatic groupings predominate, into which fall seven climatic zones that, as designated by experts, are defined on the basis of such traits as temperature and precipitation. Groupings are assigned codes (see chart) according to the Köppen climate classification system.

Tropical wet

A tropical rainy climate governs regions experiencing persistent warm or high temperatures, which normally do not fall below 18 °C (64 °F). India hosts two climatic subtypes- tropical monsoon climate, tropical wet and dry climate that fall under this group.

2) The most humid is the tropical wet climate—also known as a tropical monsoon climate—that covers a strip of southwestern lowlands abutting the Malabar Coast, the Western Ghats, and southern Assam. India's two island territories,

Lakshadweep and the Andaman and Nicobar Islands, are also subject to this climate. Characterised by moderate to high year-round temperatures, even in the foothills, its rainfall is seasonal but heavy—typically above 2,000 mm (79 in) per year. Most rainfall occurs between May and November; this moisture is enough to sustain lush forests and other vegetation for the rest of the mainly dry year. December to March are the driest months, when days with precipitation are rare. The heavy monsoon rains are responsible for the exceptional biodiversity of tropical wet forests in parts of these regions.

3) In India a tropical wet and dry climate is more common. Noticeably drier than areas with a tropical monsoon climate, it prevails over most of inland peninsular India except for a semi arid rain shadow east of the Western Ghats. Winter and early summer are long and dry periods with temperatures averaging above 18 °C (64 °F). Summer is exceedingly hot; temperatures in low-lying areas may exceed 50 °C (122 °F) during May, leading to heat waves that can each kill hundreds of Indians. The rainy season lasts from June to September; annual rainfall averages between 750–1,500 mm (30–59 in) across the region. Once the dry northeast monsoon begins in September, most precipitation in India falls on Tamil Nadu, leaving other states comparatively dry.

The Ganges Delta lies mostly in the tropical wet climate zone: it receives between 1,500 to 2,000 mm (59 to 79 in) of rainfall each year in the western part, and 2,000 to 3,000 mm (79 to 118 in) in the eastern part. The coolest month of the year, on average, is January; April and May are the warmest months. Average temperatures in January range from 14 to 25 °C (57 to 77 °F), and average temperatures in April range from 25 to 35 °C (77 to 95 °F). July is on average the wettest month: over 330 mm (13 in) of rain falls on the delta.

Tropical dry

A tropical arid and semi-arid climate dominates regions where the rate of moisture loss through evapotranspiration exceeds that from precipitation; it is subdivided into three climatic subtypes- tropical semi-arid steppe, arid climate, tropical and sub-tropical steppe climate.

1) The first, a tropical semi-arid steppe climate, (Hot semi-arid climate) predominates over a long stretch of land south of Tropic of Cancer and east of the Western Ghats and the Cardamom Hills. The region, which includes Karnataka, inland Tamil Nadu, western Andhra Pradesh, and central Maharashtra, gets between 400–750 millimetres (15.7–29.5 in) annually. It is drought-prone, as it tends to have less reliable rainfall due to sporadic lateness or failure of the southwest monsoon. Karnataka is divided into three zones – coastal, north interior and south interior. Of these, the coastal zone receives the heaviest rainfall with an average rainfall of about 3,638.5 mm per annum, far in excess of the state average of 1,139 mm (45 in). In contrast to norm, Agumbe in the Shivamogga district receives the second highest

annual rainfall in India. North of the Krishna River, the summer monsoon is responsible for most rainfall; to the south, significant post-monsoon rainfall also occurs in October and November. In December, the coldest month, temperatures still average around 20–24 °C (68–75 °F). The months between March to May are hot and dry; mean monthly temperatures hover around 32 °C, with 320 millimetres (13 in)precipitation. Hence, without artificial irrigation, this region is not suitable for permanent agriculture.

2) Most of western Rajasthan experiences an arid climatic regime (Hot desert climate). Cloudbursts are responsible for virtually all of the region's annual precipitation, which totals less than 300 millimetres (11.8 in). Such bursts happen when monsoon winds sweep into the region during July, August, and September. Such rainfall is highly erratic; regions experiencing rainfall one year may not see precipitation for the next couple of years or so. Atmospheric moisture is largely prevented from precipitating due to continuous downdrafts and other factors. The summer months of May and June are exceptionally hot; mean monthly temperatures in the region hover around 35 °C (95 °F), with daily maxima occasionally topping 50 °C (122 °F). During winters, temperatures in some areas can drop below freezing due to waves of cold air from Central Asia. There is a large diurnal range of about 14 °C (25.2 °F) during summer; this widens by several degrees during winter.To the west, in Gujarat, diverse climate conditions obtain. The winters are mild, pleasant, and dry with average daytime temperatures around 29 °C (84 °F) and nights around 12 °C (54 °F) with virtually full sun and clear nights. Summers are hot and dry with daytime temperatures around 41 °C (106 °F) and nights no lower than 29 °C (84 °F). In the weeks before the monsoon temperatures are similar to the above, but high humidity makes the air more uncomfortable. Relief comes with the monsoon. Temperatures are around 35 °C (95 °F) but humidity is very high; nights are around 27 °C (81 °F). Most of the rainfall occurs in this season, and the rain can cause severe floods. The sun is often occluded during the monsoon season.

3) East of the Thar Desert, the Punjab-Haryana-Kathiawar region experiences a tropical and sub-tropical steppe climate. Haryana's climate resembles other states of the northern plains: extreme summer heat of up to 50 °C and winter cold as low as 1 °C. May and June are hottest; December and January are coldest. Rainfall is varied, with the Shivalik Hills region being the wettest and the Aravali Hills region being the driest. About 80% of the rainfall occurs in the monsoon season of July–September, which can cause flooding. The Punjabi climate is also governed by extremes of hot and cold. Areas near the Himalayan foothills receive heavy rainfall whereas those eloigned from them are hot and dry. Punjab's three-season climate sees summer months that spans from mid-April to the end of June. Temperatures typically range from–2 °C to 40 °C, but can reach 47 °C (117 °F) in summer and −4 °C in winter. The zone, a transitional climatic region separating tropical desert from humid sub-tropical savanna and forests, experiences temperatures that are less extreme than those of the desert. Average annual rainfall is 300–650 millimetres (11.8–25.6 in), but is very unreliable; as in much of the rest of

India, the southwest monsoon accounts for most precipitation. Daily summer temperature maxima rise to around 40 °C (104 °F); this results in natural vegetation typically comprises short, coarse grasses.

Subtropical humid

Most of Northeast India and much of North India are subject to a humid subtropical climate. Though they experience hot summers, temperatures during the coldest months may fall as low as 0 °C (32 °F). Due to ample monsoon rains, India has only one subtype of this climate under the Köppen system: Cwa. In most of this region, there is very little precipitation during the winter, owing to powerful anticyclonic and katabatic (downward-flowing) winds from Central Asia.

Humid subtropical regions are subject to pronounced dry winters. Winter rainfall—and occasionally snowfall—is associated with large storm systems such as "Nor'westers" and "Western disturbances"; the latter are steered by westerlies towards the Himalayas. Most summer rainfall occurs during powerful thunderstorms associated with the southwest summer monsoon; occasional tropical cyclones also contribute. Annual rainfall ranges from less than 1,000 millimetres (39 in) in the west to over 2,500 millimetres (98 in) in parts of the northeast. As most of this region is far from the ocean, the wide temperature swings more characteristic of a continental climate predominate; the swings are wider than in those in tropical wet regions, ranging from 24 °C (75 °F) in north-central India to 27 °C (81 °F) in the east.

Mountain

India's northernmost areas are subject to a montane, or alpine, climate. In the Himalayas, the rate at which an air mass's temperature falls per kilometre (3,281 ft) of altitude gained (the dry adiabatic lapse rate) is 9.8 °C/km. In terms of environmental lapse rate, ambient temperatures fall by 6.5 °C (11.7 °F) for every 1,000 metres (3,281 ft) rise in altitude. Thus, climates ranging from nearly tropical in the foothills to tundra above the snow line can coexist within several hundred metres of each other. Sharp temperature contrasts between sunny and shady slopes, high diurnal temperature variability, temperature inversions, and altitude-dependent variability in rainfall are also common.

The northern side of the western Himalayas, also known as the trans-Himalayan belt, has a cold desert climate. It is a region of barren, arid, frigid and wind-blown wastelands. Areas south of the Himalayas are largely protected from cold winter winds coming in from the Asian interior. The leeward side (northern face) of the mountains receives less rain.

The southern slopes of the western Himalayas, well-exposed to the monsoon, get heavy rainfall. Areas situated at elevations of 1,070–2,290 metres (3,510–7,510 ft) receive the heaviest rainfall, which decreases rapidly at elevations above 2,290 metres (7,513 ft). Most precipitation occurs as snowfall during the late winter and spring months.The Himalayas experience their heaviest snowfall between December and February and at elevations above 1,500 metres (4,921 ft). Snowfall increases with elevation by up to several dozen millimetres per 100 metre (~2 in; 330 ft) increase. Elevations above 6,000 metres (19,685 ft) never experience rain; all precipitation falls as snow.

Seasons

The India Meteorological Department (IMD) designates four climatological seasons:

- Winter, occurring from December to March. The year's coldest months are December and January, when temperatures average around 10–15 °C (50–59 °F) in the northwest; temperatures rise as one proceeds towards the equator, peaking around 20–25 °C (68–77 °F) in mainland India's southeast.
- Summer or pre-monsoon season, lasting from April to June (April to July in northwestern India). In western and southern regions, the hottest month is April; for northern regions of India, May is the hottest month. Temperatures average around 32–40 °C (90–104 °F) in most of the interior.
- Monsoon or rainy season, lasting from July to September. The season is dominated by the humid southwest summer monsoon, which slowly sweeps across the country beginning in late May or early June. Monsoon rains begin to recede from North India at the beginning of October. South India typically receives more rainfall.
- Post-monsoon or autumn season, lasting from October to November. In the northwest of India, October and November are usually cloudless. Tamil Nadu receives most of its annual precipitation in the northeast monsoon season.

The Himalayan states, being more temperate, experience an additional season, spring, which coincides with the first weeks of summer in southern India. Traditionally, Indians note six seasons or Ritu, each about two months long. These are the spring season (Sanskrit: vasanta), summer (grīṣma), monsoon season (varṣā), autumn (śarada), winter (hemanta), and prevernal season (śiśira). These are based on the astronomical division of the twelve months into six parts. The ancient Hindu calendar also reflects these seasons in its arrangement of months.

Winter

Once the monsoons subside, average temperatures gradually fall across India. As the Sun's vertical rays move south of the equator, most of the country experiences moderately cool weather; temperatures change by about per degree of latitude. December and January are the coldest months, with mean temperatures of in Indian Himalayas. Mean temperatures are higher in the east and south.

In northwestern India region, virtually cloudless conditions prevail in October and November, resulting in wide diurnal temperature swings; as in much of the Deccan Plateau, they register at 16–20 °C (61–68 °F). However, from January to February, "western disturbances" bring heavy bursts of rain and snow. These extra-tropical low-pressure systems originate in the eastern Mediterranean Sea. They are carried towards India by the subtropical westerlies, which are the prevailing winds blowing at North India's range of latitude. Once their passage is hindered by the Himalayas, they are unable to proceed further, and they release significant precipitation over the southern Himalayas.

There is a huge variation in the climatic conditions of Himachal Pradesh due to variation in altitude (450–6500 metres). The climate varies from hot and sub-humid tropical (450–900 metres) in the southern low tracts, warm and temperate (900–1800 metres), cool and temperate (1900–2400 metres) and cold glacial and alpine (2400–4800 metres) in the northern and eastern high elevated mountain ranges. By October, nights and mornings are very cold. Snowfall at elevations of nearly 3000 m is about 3 m and lasts from December start to March end. Elevations above 4500 m support perpetual snow. The spring season starts from mid February to mid April. The weather is pleasant and comfortable in the season. The rainy season starts at the end of the month of June. The landscape lushes green and fresh. During the season streams and natural springs are replenished. The heavy rains in July and August cause a lot of damage resulting into erosion, floods and landslides. Out of all the state districts, Dharamsala receives the highest rainfall, nearly about 3,400 mm (134 in). Spiti is the driest area of the state, where annual rainfall is below 50 mm. The six Himalayan states (Jammu and Kashmir in the extreme north, Himachal Pradesh, Uttarakhand, Sikkim, Northern West Bengal and Arunachal Pradesh) experience heavy snowfall, Manipur and Nagaland are not located in the Himalayas but experience snowfall; in Jammu and Kashmir, blizzards occur regularly, disrupting travel and other activities.

The rest of North India, including the Indo-Gangetic Plain and Madhya Pradesh almost never receives snow. Temperatures in the plains occasionally fall below freezing, though never for more one or two days. Winter highs in Delhi range from 16 to 21 °C (61 to 70 °F). Nighttime temperatures average 2–8 °C (36–46 °F). In the plains of Punjab, lows can fall below freezing, dropping to around −6 °C (21 °F) in Amritsar. Frost sometimes occurs, but the hallmark of the season is the notorious fog, which frequently disrupts daily life; fog grows thick enough to hinder visibility and disrupt air travel 15–20 days annually. In Bihar in middle of the Ganges plain, hot weather sets in and the summer lasts until the middle of June. The highest temperature is often registered in May which is the hottest time. Like the rest of the north, Bihar also experiences dust-storms, thunderstorms and dust raising winds during the hot season. Dust storms having a velocity of 48–64 km/h (30–40 mph) are most frequent in May and with second maximum in April and June. The hot winds (loo) of Bihar plains blow during April and May with an average velocity of 8–16 km/h (5–10 mph). These hot winds greatly affects human comfort during this season. Rain follows. The rainy season begins in June. The rainiest months are July and August. The rains are the gifts of the southwest monsoon. There are in Bihar three distinct areas where rainfall exceeds 1,800 mm (71 in). Two of them are in the northern and northwestern portions of the state; the third lies in the area around Netarhat. The southwest monsoon normally withdraws from Bihar in the first week of October. Eastern India's climate is much milder, experiencing moderately warm days and cool nights. Highs range from 23 °C (73 °F) in Patna to 26 °C (79 °F) in Kolkata (Calcutta); lows average from 9 °C (48 °F) in Patna to 14 °C (57 °F) in Kolkata. In Madhya Pradesh which is towards the south-western side of the Gangetic Plain similar conditions prevail albeit with much less humidity levels. Capital Bhopal averages low of 9 °C (48 °F) and high of 24 °C (75 °F).

Frigid winds from the Himalayas can depress temperatures near the Brahmaputra River. The Himalayas have a profound effect on the climate of the Indian subcontinent and the Tibetan plateau by preventing frigid and dry Arctic winds from blowing south into the subcontinent, which keeps South Asia much warmer than corresponding temperate regions in the other continents. It also forms a barrier for the monsoon winds, keeping them from travelling northwards, and causing heavy rainfall in the Terai region instead. The Himalayas are indeed believed to play an important role in the formation of Central Asian deserts such as the Taklamakan and Gobi. The mountain ranges prevent western winter disturbances in Iran from travelling further east, resulting in much snow in Kashmir and rainfall for parts of Punjab and northern India. Despite being a barrier to the cold northernly winter winds, the Brahmaputra valley receives part of the frigid winds, thus lowering the temperature in Northeast India and Bangladesh. The Himalayas, which are often called "The Roof of the World", contain the greatest area of glaciers and permafrost outside of the poles. Ten of Asia's largest rivers flow from there. The two Himalayan states in the east, Sikkim and Arunachal Pradesh, receive substantial snowfall. The extreme north of West Bengal centred on Darjeeling experiences snowfall, but only rarely.

In South India, particularly the hinterlands of Maharashtra, parts of Karnataka, and Andhra Pradesh, somewhat cooler weather prevails. Minimum temperatures in western Maharashtra and Chhattisgarh hover around 10 °C (50 °F); in the southern Deccan Plateau, they reach 16 °C (61 °F). Coastal areas—especially those near the Coromandel Coast and adjacent low-elevation interior tracts—are warm, with daily high temperatures of 30 °C (86 °F) and lows of around 21 °C (70 °F). The Western Ghats, including the Nilgiri Range, are exceptional; lows there can fall below freezing. This compares with a range of 12–14 °C (54–57 °F) on the Malabar Coast; there, as is the case for other coastal areas, the Indian Ocean exerts a strong moderating influence on weather. The region averages 800 millimetres (31 in) per year, most of which falls between October and December. The topography of the Bay of Bengal and the staggered weather pattern prevalent during the season favours the northeast monsoon, which has a tendency to cause cyclones and hurricanes rather than steady precipitation. As a result, the coast is hit by what can mildly be termed as inclement weather almost every year between October and January.

Summer

Summer in northwestern India starts from April and ends in July, and in the rest of the country from March to June. The temperatures in the north rise as the vertical rays of the Sun reach the Tropic of Cancer. The hottest month for the western and southern regions of the country is April; for most of North India, it is May. Temperatures of 50 °C (122 °F) and higher have been recorded in parts of India during this season. Another striking feature of summer is the Loo (wind). These are strong, gusty, hot, dry winds that blow during the day in India. Direct exposure to these winds may be fatal. In cooler regions of North India, immense pre-monsoon squall-line thunderstorms, known locally as "Nor'westers", commonly drop large hailstones. In Himachal Pradesh, Summer lasts from mid April till the end of June and most parts become very hot (except in alpine zone which experience mild summer) with the average temperature ranging from 28 °C (82 °F) to 32 °C (90 °F). Winter lasts from late November till mid March. Snowfall is generally common in alpine tracts that are above 2,200 metres (7,218 ft), especially those in the higher- and trans-Himalayan regions. Near the coast the temperature hovers around 36 °C (97 °F), and the proximity of the sea increases the level of humidity. In southern India, the temperatures are higher on the east coast by a few degrees compared to the west coast.

By May, most of the Indian interior experiences mean temperatures over 32 °C (90 °F), while maximum temperatures often exceed 40 °C (104 °F). In the hot months of April and May, western disturbances, with their cooling influence, may still arrive, but rapidly diminish in frequency as summer progresses. Notably, a higher frequency of such disturbances in April correlates with a delayed monsoon onset (thus extending summer) in northwest India. In eastern India, monsoon onset dates have been steadily advancing over the past several decades, resulting in shorter summers there.

Altitude affects the temperature to a large extent, with higher parts of the Deccan Plateau and other areas being relatively cooler. Hill stations, such as Ootacamund ("Ooty") in the Western Ghats and Kalimpong in the eastern Himalayas, with average maximum temperatures of around 25 °C (77 °F), offer some respite from the heat. At lower elevations, in parts of northern and western India, a strong, hot, and dry wind known as the Looblows in from the west during the daytime; with very high temperatures, in some cases up to around 45 °C (113 °F); it can cause fatal cases of sunstroke. Tornadoes may also occur, concentrated in a corridor stretching from northeastern India towards Pakistan. They are rare, however; only several dozen have been reported since 1835.

Monsoon

The southwest summer monsoon, a four-month period when massive convective thunderstorms dominate India's weather, is Earth's most productive wet season. A product of southeast trade winds originating from a high-pressure mass centred over the southern Indian Ocean, the monsoonal torrents supply over 80% of India's annual rainfall. Attracted by a low-pressure region centred over South Asia, the mass spawns surface winds that ferry humid air into India from the southwest. These inflows ultimately result from a northward shift of the local jet stream, which itself results from rising summer temperatures over Tibet and the Indian subcontinent. The void left by the jet stream, which switches from a route just south of the Himalayas to one tracking north of Tibet, then attracts warm, humid air.

The main factor behind this shift is the high summer temperature difference between Central Asia and the Indian Ocean. This is accompanied by a seasonal excursion of the normally equatorial intertropical convergence zone (ITCZ), a low-pressure belt of highly unstable weather, northward towards India. This system intensified to its present strength as a result of the Tibetan Plateau's uplift, which accompanied the Eocene–Oligocene transition event, a major episode of global cooling and aridification which occurred 34–49 Ma.

The southwest monsoon arrives in two branches: the Bay of Bengal branch and the Arabian Sea branch. The latter extends towards a low-pressure area over the Thar Desert and is roughly three times stronger than the Bay of Bengal branch. The monsoon typically breaks over Indian territory by around 25 May, when it lashes the Andaman and Nicobar Islands in the Bay of Bengal. It strikes the Indian mainland around 1 June near the Malabar Coast of Kerala. By 9 June, it reaches Mumbai; it appears over Delhi by 29 June. The Bay of Bengal branch, which initially tracks the Coromandal Coast northeast from Cape Comorin to Orissa, swerves to the northwest towards the Indo-Gangetic Plain. The Arabian Sea branch moves northeast towards the Himalayas. By the first week of July, the entire country experiences monsoon rain; on average, South India receives more rainfall than North India. However, Northeast India receives the most precipitation. Monsoon clouds begin retreating from North India by the end of August; it withdraws from Mumbai by 5 October. As India further cools during September, the southwest monsoon weakens. By the end of November, it has left the country.

Monsoon rains impact the health of the Indian economy; as Indian agriculture employs 600 million people and composes 20% of the national GDP, good monsoons correlate with a booming economy. Weak or failed monsoons (droughts) result in widespread agricultural losses and substantially hinder overall economic growth. Yet such rains reduce temperatures and can replenish groundwater tables, rivers.

Post-monsoon

During the post-monsoon months of October to December, a different monsoon cycle, the northeast (or "retreating") monsoon, brings dry, cool, and dense air masses to large parts of India. Winds spill across the Himalayas and flow to the southwest across the country, resulting in clear, sunny skies. Though the India Meteorological Department (IMD) and other sources refers to this period as a fourth ("post-monsoon") season, other sources designate only three seasons. Depending on location, this period lasts from October to November, after the southwest monsoon has peaked. Less and less precipitation falls, and vegetation begins to dry out. In most parts of India, this period marks the transition from wet to dry seasonal conditions. Average daily maximum temperatures range between 28 and 34 °C (82 and 93 °F).

The northeast monsoon, which begins in September, lasts through the post-monsoon seasons, and only ends in March. It carries winds that have already lost their moisture out to the ocean (opposite from the summer monsoon). They cross India diagonally from northeast to southwest. However, the large indentation made by the Bay of Bengal into India's eastern coast means that the flows are humidified before reaching Cape Comorin and rest of Tamil Nadu, meaning that the state, and also some parts of Kerala, experience significant precipitation in the post-monsoon and winter periods. However, parts of West Bengal, Orissa, Andhra Pradesh, Karnataka and Mumbai also receive minor precipitation from the northeast monsoon.

Statistics

Shown below are temperature and precipitation data for selected Indian cities; these represent the full variety of major Indian climate types. Figures have been grouped by the four-season classification scheme used by the IMD; year-round averages and totals are also displayed.

Temperature

Average temperatures in various Indian cities (°C)													
—	Winter (Dec – Feb)			Summer (Mar – May)			Monsoon (Jun – Sep)			Post-monsoon (Oct – Nov)			Year-round
City	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Avg
Port Blair	23	26	28	25	27	29	25	27	27	25	26	28	27
Thiruvananthapuram	23	26	29	24	27	30	24	26	28	23	29	23	26
Bangalore	15	22	28	21	27	34	20	24	28	19	23	28	24
Nagpur	14	21	28	24	32	40	24	27	30	16	22	28	26
Bhopal	11	17	24	23	30	36	23	26	28	16	22	26	25
Guwahati	11	17	24	19	25	31	25	28	32	17	22	27	24
Lucknow	8	14	21	23	30	35	24	29	33	15	20	25	25
Jaisalmer	7	14	23	24	33	40	23	29	35	12	19	27	22
Dehradun	4	12	20	14	23	32	22	26	30	7	15	23	18
Amritsar	4	10	18	13	25	34	25	28	32	10	16	24	21
Shimla	1	5	9	10	14	18	15	18	20	7	10	13	13
Srinagar	−2	4	6	7	14	19	16	22	30	1	8	16	13
Leh	−13	−6	0	−1	6	12	10	16	24	−7	0	7	6

Precipitation

Average precipitation in various Indian cities (mm)

—	Winter (Jan – Feb)			Summer (Mar – May)			Monsoon (Jun – Sep)			Post-monsoon (Oct – Dec)			Year-round
City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Port Blair	40	20	10	60	360	480	400	400	460	290	220	150	2,890
Thiruvananthapuram	26	21	33	125	202	306	175	152	179	223	206	65	1,713
Bangalore	31	20	61	110	150	212	249	279	315	291	210	140	1,962
Nagpur	16	22	15	8	18	168	290	291	157	73	17	19	1,094
Bhopal	4	3	1	3	11	136	279	360	185	52	21	7	1,043
Guwahati	8	21	47	181	226	309	377	227	199	92	25	10	1,722
Lucknow	20	18	8	8	20	114	305	292	188	33	5	8	1,019
Jaisalmer	–	–	3	–	7	10	90	88	15	–	6	–	219
Dehradun	47	55	52	21	54	230	631	627	261	32	11	3	2,024
Amritsar	24	33	48	30	45	27	231	187	79	18	6	18	746
Shimla	60	60	60	50	60	170	420	430	160	30	10	20	1,530
Srinagar	74	71	91	94	61	36	58	61	38	31	10	33	658
Leh	12	9	12	6	7	4	16	20	12	7	3	8	116

Natural Disasters

Climate-related natural disasters cause massive losses of Indian life and property. Droughts, flash floods, cyclones, avalanches, landslides brought on by torrential rains, and snowstorms pose the greatest threats. Other dangers include frequent summer dust storms, which usually track from north to south; they cause extensive property damage in North India and deposit large amounts of dust from arid regions. Hail is also common in parts of India, causing severe damage to standing crops such as rice and wheat.

Landslides and Avalanches

Landslides are very common indeed in the Lower Himalayas. The young age of the region's hills result in labile rock formations, which are susceptible to slippages. Rising population and development pressures, particularly from logging and tourism, cause deforestation. The result is denuded hillsides which exacerbate the severity of landslides; since tree cover impedes the downhill flow of water. Parts of the Western Ghats also suffer from low-intensity landslides. Avalanches occurrences are common in Kashmir, Himachal Pradesh, and Sikkim.

Floods in India

Floods are the most common natural disaster in India. The heavy southwest monsoon rains cause the Brahmaputra and other rivers to distend their banks, often flooding surrounding areas. Though they provide rice paddy farmers with a largely dependable source of natural irrigation and fertilisation, the floods can kill thousands and displace millions. Excess, erratic, or untimely monsoon rainfall may also wash away or otherwise ruin crops. Almost all of India is flood-prone, and extreme precipitation events, such as flash floods and torrential rains, have become increasingly common in central India over the past several decades, coinciding with rising temperatures. Mean annual precipitation totals have remained steady due to the declining frequency of weather systems that generate moderate amounts of rain.

Cyclones in India

Intertropical Convergence Zone, may affect thousands of Indians living in the coastal regions. Tropical cyclogenesis is particularly common in the northern reaches of the Indian Ocean in and around the Bay of Bengal. Cyclones bring with them heavy rains, storm surges, and winds that often cut affected areas off from relief and supplies. In the North Indian Ocean Basin, the cyclone season runs from April to December, with peak activity between May and November. Each year, an average of eight storms with sustained wind speeds greater than 63 kilometres per hour (39 mph) form; of these, two strengthen into true tropical cyclones, which have sustained gusts greater than 117 kilometres per hour (73 mph). On average, a major (Category 3 or higher) cyclone develops every other year.

During summer, the Bay of Bengal is subject to intense heating, giving rise to humid and unstable air masses that produce cyclones. Many powerful cyclones, including the 1737 Calcutta cyclone, the 1970 Bhola cyclone, the 1991 Bangladesh cyclone and the 1999 Odisha cyclone have led to widespread devastation along parts of the eastern coast of India and neighboring Bangladesh. Widespread death and property destruction are reported every year in exposed coastal states such as Andhra Pradesh, Orissa, Tamil Nadu, and West Bengal. India's western coast, bordering the more placid Arabian Sea, experiences cyclones only rarely; these mainly strike Gujarat and, less frequently, Kerala.

In terms of damage and loss of life, Cyclone 05B, a supercyclone that struck Orissa on 29 October 1999, was the worst in more than a quarter-century. With peak winds of 160 miles per hour (257 km/h), it was the equivalent of a Category 5 hurricane. Almost two million people were left homeless; another 20 million people lives were disrupted by the cyclone. Officially, 9,803 people died from the storm; unofficial estimates place the death toll at over 10,100.

Floods and landslides

In the Lower Himalaya, landslides are common. The young age of the region's hills result in labile rock formations, which are susceptible to slippages. Rising population and development pressures, particularly from logging and tourism, cause deforestation. The result, denuded hillsides, exacerbates the severity of landslides, since tree cover impedes the downhill flow of water. Parts of the Western Ghats also suffer from low-intensity landslides. Avalanches occur in Kashmir, Himachal Pradesh, and Sikkim.

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Droughts

Indian agriculture is heavily dependent on the monsoon as a source of water. In some parts of India, the failure of the monsoons result in water shortages, resulting in below-average crop yields. This is particularly true of major drought-prone regions such as southern and eastern Maharashtra, northern Karnataka, Andhra Pradesh, Orissa, Gujarat, and Rajasthan. In the past, droughts have periodically led to major Indian famines. These include the Bengal famine of 1770, in which up to one third of the population in affected areas died; the 1876–1877 famine, in which over five million people died; the 1899 famine, in which over 4.5 million died; and the Bengal famine of 1943, in which over five million died from starvation and famine-related illnesses.

All such episodes of severe drought correlate with El Niño-Southern Oscillation (ENSO) events. El Niño-related droughts have also been implicated in periodic declines in Indian agricultural output. Nevertheless, ENSO events that have coincided with abnormally high sea surfaces temperatures in the Indian Ocean—in one instance during 1997 and 1998 by up to 3 °C (5 °F)—have resulted in increased oceanic evaporation, resulting in unusually wet weather across India. Such anomalies have occurred during a sustained warm spell that began in the 1990s. A contrasting phenomenon is that, instead of the usual high pressure air mass over the southern Indian Ocean, an ENSO-related oceanic low pressure convergence centre forms; it then continually pulls dry air from Central Asia, desiccating India during what should have been the humid summer monsoon season. This reversed air flow causes India's droughts. The extent that an ENSO event raises sea surface temperatures in the central Pacific Ocean influences the extent of drought.

Drought in India has resulted in tens of millions of deaths over the course of the 18th, 19th, and 20th centuries. Indian agriculture is heavily dependent on the climate of India: a favorable southwest summer monsoon is critical in securing water for irrigating Indian crops. In some parts of India, the failure of the monsoons result in water shortages, resulting in below-average crop yields. This is particularly true of major drought-prone regions such as southern and eastern Maharashtra, northern Karnataka, Andhra Pradesh, Odisha, Gujarat, and Telangana Rajasthan's

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Impact of El Niño

All such episodes of severe drought correlate with El Niño-Southern Oscillation (ENSO) events. El Niño-related droughts have also been implicated in periodic declines in Indian agricultural output. Nevertheless, ENSO events that have coincided with abnormally high sea surfaces temperatures in the Indian Ocean—in one instance during 1997 and 1998 by up to 3 °C (5 °F)—have resulted in increased oceanic evaporation, resulting in unusually wet weather across India. Such anomalies have occurred during a sustained warm spell that began in the 1990s. A contrasting phenomenon is that, instead of the usual high pressure air mass over the southern Indian Ocean, an ENSO-related oceanic low pressure convergence center forms; it then continually pulls dry air from Central Asia, desiccating India during what should have been the humid summer monsoon season. This reversed air flow causes India's droughts. The extent that an ENSO event raises sea surface temperatures in the central Pacific Ocean influences the degree of drought. Around 43 per cent of El Niño events are followed by drought in India.

Heat waves

A study from 2005 concluded that heat waves significantly increased in the frequency, persistence and spatial coverage in the decade 1991-2000, when compared to the period between 1971–80 and 1981-90. A severe heat wave in Orissa in 1998, resulted in nearly 1300 deaths. Based on observations, heat wave related mortality has increased in India prior to 2005. The 2015 Indian heat wave killed more than 2,500 people.

Extremes

Extreme Temperatures: Low

India's lowest recorded temperature was −45 °C (−49 °F) in Dras, Ladakh, in eastern Jammu and Kashmir; the reading was taken with non-standard equipment. Figures as low as −30.6 °C (−23 °F) have been taken in Leh, further east in Ladakh. However, temperatures on the disputed but Indian-controlled Siachen Glacier near Bilafond La (5,450 metres or 17,881 feet) and Sia La (5,589 metres or 18,337 feet) have fallen below −55 °C (−67 °F), while blizzards bring wind speeds in excess of 250 km/h (155 mph), or hurricane-force winds ranking at 12—the maximum—on the Beaufort scale. These conditions, not hostile actions, caused more than 97% of the roughly 15,000 casualties suffered among Indian and Pakistani soldiers during the Siachen conflict.

Extreme Temperatures: High

The highest reliable temperature reading was 50.6 °C (123.1 °F) in Alwar, Rajasthan in 1955. The India Meteorological Department doubts the validity of 55 °C (131 °F) readings reported in Orissa during 2005.

Rain

The average annual precipitation of 11,872 millimetres (467 in) in the village of Mawsynram, in the hilly northeastern state of Meghalaya, is the highest recorded in Asia, and possibly on Earth. The village, which sits at an elevation of 1,401 metres (4,596 ft), benefits from its proximity to both the Himalayas and the Bay of Bengal. However, since the town of Cherrapunji, 5 kilometres (3.1 mi) to the east, is the nearest town to host a meteorological office—none has ever existed in Mawsynram—it is officially credited as being the world's wettest place. In recent years the Cherrapunji-Mawsynram region has averaged between 9,296 and 10,820 millimetres (366 and 426 in) of rain annually, though Cherrapunji has had at least one period of daily rainfall that lasted almost two years. India's highest recorded one-day rainfall total occurred on 26 July 2005, when Mumbai received more than 650 mm (26 in); the massive flooding that resulted killed over 900 people.

Snowfall

Remote regions of Jammu and Kashmir such as Baramulla district in the east and the Pir Panjal Range in the southeast experience exceptionally heavy snowfall. In southern areas around Jammu the climate is typically monsoonal, though the region is sufficiently far west to average 40–100 mm (2–4 in) of rain monthly from January and March. In the hot season, Jammu city is very hot and can reach up to 40 °C (104 °F) while in July and August, very heavy—though erratic—rainfall occurs with monthly extremes of up to 650 millimetres (26 in). Rainfall declines in September; by October conditions are extremely dry, with temperatures of around 29 °C (84 °F). Across from the Pir Panjal range, the South Asian monsoon is no longer a factor and most precipitation falls in the spring from southwestern cloudbands. Because of its closeness to the Arabian Sea, Srinagar receives as much as 25 inches (635 mm) of rain from this source, with the wettest months being March to May with around 85 mm (3.3 inches) per month.

Leh and the Zanskars

North of the main Himalaya Range, even the southwestern cloudbands break up or founder; hence the climate of Leh and the Zanskars is extremely dry and cold. Annual precipitation is only around 100 mm (4 inches) per year and humidity is very low. This region is almost entirely above 3,000 metres (9,750 ft) above sea level; thus winters are extremely cold. In the Zanskars, the average January temperature is −20 °C (−4 °F) with extremes as low as −40 °C (−40 °F). All rivers freeze over; locals cross unbridged rivers in winter because summer glacier melt deepens the waters and inhibits fording. Summer in Leh and the Zanskars are a pleasantly warm 20 °C (68 °F), but the low humidity and thin air can render nights cold. Kashmir's highest recorded monthly snowfall occurred in February 1967, when 8.4 metres (27.6 ft) fell in Gulmarg, though the IMD has recorded snowdrifts up to 12 metres (39.4 ft)in several Kashmiri districts. In February 2005, more than 200 people died when, in four days, a western disturbance brought up to 2 metres (6.6 ft) of snowfall to parts of the state.

Global warming

Current sea level rise, increased cyclonic activity, increased ambient temperatures, and increasingly fickle precipitation patterns are effects of global warming that have affected or are projected to impact India. Thousands of people have been displaced by ongoing sea level rises that have submerged low-lying islands in the Sundarbans. Temperature rises on the Tibetan Plateau are causing Himalayan glaciers to retreat, threatening the flow rate of the Ganges, Brahmaputra, Yamuna, and other major rivers; the livelihoods of hundreds of thousands of farmers depend on these rivers. A 2007 World Wide Fund for Nature (WWF) report states that the Indus River may run dry for the same reason.

Severe landslides and floods are projected to become increasingly common in such states as Assam. Ecological disasters, such as a 1998 coral bleaching event that killed off more than 70% of corals in the reef ecosystems off Lakshadweep and the Andamans and was brought on by elevated ocean temperatures tied to global warming, are also projected to become increasingly common. Meghalaya and other northeastern states are also concerned that rising sea levels will submerge much of Bangladesh and spawn a refugee crisis. If severe climate changes occurs, Bangladesh and parts of India that border it may lose vast tracts of coastal land.

The Indira Gandhi Institute of Development Research has reported that, if the predictions relating to global warming made by the Intergovernmental Panel on Climate Change come to fruition, climate-related factors could cause India's GDP to decline by up to 9%. Contributing to this would be shifting growing seasons for major crops such as rice, production of which could fall by 40%. Around seven million people are projected to be displaced due to, among other factors, submersion of parts of Mumbai and Chennai if global temperatures were to rise by a mere 2 °C (3.6 °F). Such shifts are not new. Earlier in the Holocene epoch (4,800–6,300 years ago), parts of what is now the Thar Desert were wet enough to support perennial lakes; researchers have proposed that this was due to much higher winter precipitation, which coincided with stronger monsoons. Kashmir's erstwhile subtropical climate dramatically cooled 2.6–3.7 Ma and experienced prolonged cold spells starting 600,000 years ago.

Atmospheric pollution

Thick haze and smoke originating from burning biomass in northwestern India and air pollution from large industrial cities in northern India often concentrate over the Ganges Basin. Prevailing westerlies carry aerosols along the southern margins of the sheer-faced Tibetan Plateau towards eastern India and the Bay of Bengal. Dust and black carbon, which are blown towards higher altitudes by winds at the southern margins of the Himalayas, can absorb shortwave radiation and heat the air over the Tibetan Plateau. The net atmospheric heating due to aerosol absorption causes the air to warm and convect upwards, increasing the concentration of moisture in the mid-troposphere and providing positive feedback that stimulates further heating of aerosols.

Climatic regions of India

Tropical wet (humid) climate group

The regions belonging to this group experience persistent high temperatures which normally do not go below 18 °C even in the coolest month.

Tropical wet (dry,humid)

The west coastal lowlands, the Western Ghats, and southern parts of Assam have this climate type. It is characterised by high temperatures throughout the year, even in the hills. The rainfall here is seasonal, but heavy and is above 78 cm in a year. Most of the rain is received in the period from May to November, and is adequate for the growth of vegetation during the entire year. December to March are the dry months with very little rainfall. The heavy rain is responsible for the tropical wet forests in these regions, which consists of a large number of species of animals.Evergreen forests are the typical feature of the region.

Tropical wet and dry or savannah climate

Most of the plateau of peninsula India enjoys this climate, except a semi-arid tract to the east of the Western Ghats. Winter and early summer are long dry periods with temperature above 18 °C. Summer is very hot and the temperatures in the interior low level areas can go above 45 °C during May. The rainy season is from June to September and the annual rainfall is between 75 and 150 cm. Only central eastern Tamil Nadu falls under this tract and receives rainfall during the winter months of late November to January.

Dry climate group

Tropical semi-arid (steppe) climate

A long stretch of land situated to the south of Tropic of Cancer and east of the western ghats and the Cardamom Hills experiences this climate. It includes Karnataka, interior and western Tamil Nadu, western Andhra Pradesh and central Maharashtra.This area receives minimal rainfall due to being situated in the rainshadow area. This region is a famine prone zone with very unreliable rainfall which varies between 40 to 75 cm annually. Towards the north of Krishna River the summer monsoon is responsible for most of the rainfall, while to the south of the river rainfall also occurs in the months of October and November. The coldest month is December but even in this month the temperature remains between 20 °C and 24 °C. The months of March to May are hot and dry with mean monthly temperatures of around 32 °C. The vegetation mostly comprises grasses with a few scattered trees due to the rainfall. Hence this area is not very well suited for permanent agriculture.

Sub-tropical arid (desert) climate

Most of western Rajasthan falls under this climate type characterised by scanty rainfall. Cloud bursts are largely responsible for the all the rainfall seen in this region which is less than 30 cm. These happen when the monsoon winds penetrate this region in the months of July, August and September. The rainfall is very erratic and a few regions might not see rainfall for a couple of years. The summer months of May and June are very hot with mean monthly temperatures in the region of 35 °C and highs which can sometimes reach 50 °C. During winters the temperatures can drop below freezing in some areas due to cold wave. There is a large diurnal range of about 14 °C during summer which becomes higher by a few more degrees during winter. This extreme climate makes this a sparsely populated region of India.

Sub-tropical semi-arid (steppe) climate

The region towards the east of the tropical desert running from Punjab and Haryana to Kathiawar experiences this climate type. This climate is a transitional climate falling between tropical desert and humid sub-tropical, with temperatures which are less extreme than the desert climate. The annual rainfall is between 30 to 65 cm but is very unreliable and happens mostly during the summer monsoon season. Maximum temperatures during summer can rise to 40 °C. The vegetation mostly comprises short coarse grass. Some crops like jowar and bajra are also cultivated.

Sub-tropical humid climate group

The temperature during the coldest months in regions experiencing this climate falls between 18 and 0 °C.

Sub-tropical humid (wet) with dry winters

The foothills of the Himalayas, Punjab-Haryana plain adjacent to the Himalayas, Rajasthan east of the Aravalli range, Uttar Pradesh, Bihar and northern part of West Bengal and Assam experience this climate. The rainfall is received mostly in the summer and is about 65 cm in the west and increases to 250 cm annually to the east and near the Himalayas. The winters are mainly dry due to the land derived winter winds which blow down the lowlands of north India towards the Bay of Bengal. The summers are hot and temperatures can reach 46 °C in the lowlands. May and June are the hottest months. Winter months are mostly dry with feeble winds. Frost occurs for a few weeks in winter. The difference in rainfall between the east and the west gives rise to a wide difference in the natural vegetation.

Mountain climate or highland climate or alpine climate

In the Himalayan mountains the temperature falls by 0.6 °C for every 100 m rise in altitude and this gives rise to a variety of climates from nearly tropical in the foothills to tundra type above the snow line. One can also observe sharp contrast between temperatures of the sunny and shady slopes, high diurnal range of temperature, inversion of temperature, and variability of rainfall based on altitude.

The northern side of the western Himalayas also known as the trans-Himalayan belt is arid, cold and generally wind swept. The vegetation is sparse and stunted as rainfall is scanty and the winters are severely cold. Most of the snowfall is in the form of snow during late winter and spring months. The area to the south of the Himalayan range is protected from cold winds coming from interior of Asia during winter. The leeward side of the mountains receive less rain while the well exposed slopes get heavy rainfall. The places situated between 1070 and 2290 m altitudes receive the heaviest rainfall and the rainfall decreases rapidly above 2290m. The great Himalayan range witnesses heavy snowfall during winter months of December to February at altitudes above 1500m. The diurnal range of temperature is also high.

The states of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Arunachal Pradesh and Sikkim experience this kind of weather.

Geology

India's geological features are classified based on their era of formation. The Precambrian formations of Cudappah and Vindhyan systems are spread out over the eastern and southern states. A small part of this period is spread over western and central India. The Paleozoic formations from the Cambrian, Ordovician, Silurian and Devonian system are found in the Western Himalaya region in Kashmir and Himachal Pradesh. The Mesozoic Deccan Traps formation is seen over most of the northern Deccan; they are believed to be the result of sub-aerial volcanic activity. The Trap soil is black in colour and conducive to agriculture. The Carboniferous system, Permian System and Triassic systems are seen in the western Himalayas. The Jurassic system is seen in the western Himalayas and Rajasthan.

Tertiary imprints are seen in parts of Manipur, Nagaland, Arunachal Pradesh and along the Himalayan belt. The Cretaceous system is seen in central India in the Vindhyas and part of the Indo-Gangetic plains. The Gondowana system is seen in the Narmada River area in the Vindhyas and Satpuras. The Eocene system is seen in the western Himalayas and Assam. Oligocene formations are seen in Kutch and Assam. The Pleistocene system is found over central India. The Andaman and Nicobar Island are thought to have been formed in this era by volcanoes. The Himalayas were formed by the convergence and deformation of the Indo-Australian and Eurasian Plates. Their continued convergence raises the height of the Himalayas by 1 cm each year.

Soils in India can be classified into 8 categories: alluvial, black, red, laterite, forest, arid & desert, saline & alkaline and peaty & organic soils. Alluvial soil constitute the largest soil group in India, constituting 80% of the total land surface. It is derived from the deposition of silt carried by rivers and are found in the Great Northern plains from Punjab to the Assam valley. Alluvial soil are generally fertile but they lack nitrogen and tend to be phosphoric.

Black soil are well developed in the Deccan lava region of Maharashtra, Gujarat, and Madhya Pradesh. These contain high percentage of clay and are moisture retentive. Red soil are found in Tamil Nadu, Karnataka plateau, Andhra plateau, Chota Nagpur plateau and the Aravallis. These are deficient in nitrogen, phosphorus and humus. Laterite soils are formed in tropical regions with heavy rainfall. Heavy rainfall results in leaching out all soluble material of top layer of soil. These are generally found in Western ghats, Eastern ghats and hilly areas of northeastern states that receive heavy rainfall. Forest soils occur on the slopes of mountains and hills in Himalayas, Western Ghats and Eastern Ghats. These generally consist of large amounts of dead leaves and other organic matter called humus.

Plate tectonics

The Indian Craton was once part of the supercontinent of Pangaea. At that time, what is now India's southwest coast was attached to Madagascar and southern Africa, and what is now its east coast was attached to Australia. During the Jurassic Period about 160 Ma (ICS 2004), rifting caused Pangaea to break apart into two supercontinents, namely Gondwana (to the south) and Laurasia (to the north). The Indian Craton remained attached to Gondwana, until the supercontinent began to rift apart about in the early Cretaceous, about 125 million years ago (ICS 2004). The Indian Plate then drifted northward toward the Eurasian Plate, at a pace that is the fastest known movement of any plate. It is generally believed that the Indian Plate separated from Madagascar about 90 Million years ago (ICS 2004), however some biogeographical and geological evidence suggests that the connection between Madagascar and Africa was retained at the time when the Indian Plate collided with the Eurasian Plate about 50 Million years ago (ICS 2004). This orogeny, which is continuing today, is related to closure of the Tethys Ocean. The closure of this ocean which created the Alps in Europe, and the Caucasus range in western Asia, created the Himalaya Mountains and the Tibetan Plateau in South Asia. The current orogenic event is causing parts of the Asian continent to deform westward and eastward on either side of the orogen. Concurrently with this collision, the Indian Plate sutured on to the adjacent Australian Plate, forming a new larger plate, the Indo-Australian Plate.

Tectonic evolution

The earliest phase of tectonic evolution was marked by the cooling and solidification of the upper crust of the earth's surface in the Archaean Era (prior to 2.5 billion years) which is represented by the exposure of gneisses and granites especially on the Peninsula. These form the core of the Indian Craton. The Aravalli Range is the remnant of an early Proterozoic orogen called the Aravali-Delhi Orogen that joined the two older segments that make up the Indian Craton. It extends approximately 500 kilometres (311 mi) from its northern end to isolated hills and rocky ridges into Haryana, ending near Delhi.

Minor igneous intrusions, deformation (folding and faulting) and subsequent metamorphism of the Aravalli Mountains represent the main phase of orogenesis. The erosion of the mountains, and further deformation of the sediments of the Dharwarian group (Bijawars) marks the second phase. The volcanic activities and intrusions, associated with this second phase are recorded in the composition of these sediments.

Early to Late Proterozoic(2.5 to 0.54 billion years) calcareous and arenaceous deposits, which correspond to humid and semi-arid climatic regimes, were deposited the Cuddapah and Vindhyan basins. These basins which border or lie within the existing crystalline basement, were uplifted during the Cambrian (500 Ma (ICS 2004)). The sediments are generally undeformed and have in many places preserved their original horizontal stratification. The Vindhyans are believed to have been deposited between ~1700 and 650 Ma (ICS 2004).

Early Paleozoic rocks are found in the Himalayas and consist of southerly derived sediments eroded from the crystalline craton and deposited on the Indian platform.

In the Late Paleozoic, Permo-Carboniferous glaciations left extensive glacio-fluvial deposits across central India, in new basins created by sag/normal faulting. These tillites and glacially derived sediments are designated the Gondwanas series. The sediments are overlain by rocks resulting from a Permian marine transgression (270 Ma (ICS 2004)).

The late Paleozoic coincided with the deformation and drift of the Gondwana supercontinent. To this drift, the uplift of the Vindhyan sediments and the deposition of northern peripheral sediments in the Himalayan Sea, can be attributed.

During the Jurassic, as Pangea began to rift apart, large grabens formed in central India filling with Upper Jurassic and Lower Cretaceous sandstones and conglomerates.

By the Late Cretaceous India had separated from Australia and Africa and was moving northward towards Asia. At this time, prior to the Deccan eruptions, uplift in southern India resulted in sedimentation in the adjacent nascent Indian Ocean. Exposures of these rocks occur along the south Indian coast at Pondicherry and in Tamil Nadu.

At the close of the Mesozoic one of the greatest volcanic eruptions in earth's history occurred, the Deccan lava flows. Covering more than 500,000 square kilometres (193,051 sq mi) area, these mark the final break from Gondwana.

In the early Tertiary, the first phase of the Himalayan orogeny, the Karakoram phase occurred. The Himalayan orogeny has continued to the present day.

Major rock groups

Precambrian super-eon

A considerable area of peninsular India, the Indian Shield, consists of Archean gneisses and schists which are the oldest rocks found in India. The Precambrian rocks of India have been classified into two systems, namely the Dharwar system and the Archaean system.

The rocks of the Dharwar system are mainly sedimentary in origin, and occur in narrow elongated synclines resting on the gneisses found in Bellary district, Mysore and the Aravalis of Rajputana. These rocks are enriched in manganese and iron ore which represents a significant resource of these metals. They are also extensively mineralised with gold most notably the Kolar gold mines located in Kolar. In the north and west of India, the Vaikrita system, which occurs in Hundes, Kumaon and Spiti areas, the Dailing series in Sikkim and the Shillong series in Assam are believed to be of the same age as the Dharwar system.

The metamorphic basement consists of gneisses which are further classified into the Bengal gneiss, the Bundelkhand gneiss and the Nilgiri gneiss. The Nilgiri system comprises charnockites ranging from granites to gabbros.

Phanerozoic

Palaeozoic

Lower Paleozoic

Rocks of the earliest part of the Cambrian Period are found in the Salt range in Punjab and the Spiti are in central Himalayas and consist of a thick sequence of fossiliferous sediments. In the Salt range, the stratigraphy starts with the Salt Pseudomorph zone, which has a thickness of 450 feet (137 m) and consists of dolomites and sandstones. It is overlain by magnesian sandstones with a thickness of 250 feet (76 m), similar to the underlying dolomites. These sandstones have very few fossils. Overlying the sandstones is the Neobolus Shale, which is composed of dark shales with a thickness of 100 feet (30 m). Finally there is a zone consisting of red or purple sandstones having a thickness of 250 feet (76 m) to 400 feet (122 m) called the Purple Sandstone. These are unfossiliferous and show sun-cracks and worm burrows which are typical of subaerial weathering. The deposits in Spiti are known as the Haimanta system and they consist of slates, micaceous quartzite and dolomitic limestones. The Ordovician rocks comprise flaggy shales, limestones, red quartzites, quartzites, sandstones and conglomerates. Siliceous limestones belonging to the Silurian overlie the Ordovician rocks. These limestones are in turn overlain by white quartzite and this is known as Muth quartzite. Silurian rocks which contain typical Silurian fauna are also found in the Vihi district of Kashmir.

Upper Paleozoic

Devonian fossils and corals are found in grey limestone in the central Himalayas and in black limestone in the Chitral area. The Carboniferous is composed of two distinct sequences, the upper Carboniferous Po, and the lower Carboniferous Lipak.

Fossils of brachiopods and some trilobites are found in the calcareous and sandy rocks of the Lipak series. The Syringothyris limestone in Kashmir also belongs to the Lipak. The Po series overlies the Lipak series, and the Fenestella shales are interbedded within a sequence of quartzites and dark shales. In many places Carboniferous strata are overlaid by grey agglomeratic slates, believed to be of volcanic origin. Many genera of productids are found in the limestones of the Permo-Triassic, which has led to these rocks being referred to as "productus limestone". This limestone is of marine origin and is divided into three distinct lithostratigraphic units based on the productus chronology: the Late Permian Chideru, which contains many ammonites, the Late — Middle Permian Virgal, and the Middle Permian Amb unit.

Mesozoic

In the Triassic the Ceratite beds, named after the ammonite ceratite, consist of arenaceous limestones, calcerous sandstones and marls. The Jurassic consists of two distinct units. The Kioto limestone, extends from the lower the middle Jurassic with a thickness 2,000 feet (610 m) to 3,000 feet (914 m). The upper Jurassic is represented by the Spiti black shales, and stretches from the Karakoram to Sikkim. Cretaceous rocks are cover an extensive area in India. In South India, the sedimentary rocks are divided into four stages; the Niniyur, the Ariyalur, the Trichinopoly(a district in the Madras Presidency, covering present-day districts of Tiruchirappalli, Karur, Ariyalur and Perambalur), and the Utatur stages. In the Utatur stage the rocks host phosphatic nodules, which constitute an important source of phosphates in the country. In the central provinces, the well developed beds of Lameta contain fossil records which are helpful in estimating the age of the Deccan Traps. This sequence of basaltic rocks was formed near the end of the Cretaceous period due to volcanic activity. These lava flows occupy an area of 200,000 square miles (520,000 km2). These rocks are a source of high quality building stone and also provide a very fertile clayey loam, particularly suited to cotton cultivation.

Cenozoic

Tertiary period

In this period the Himalayan orogeny began, and the volcanism associated with the Deccan Traps continued. The rocks of this era have valuable deposits of petroleum and coal. Sandstones of Eocene age are found in Punjab, which grade into chalky limestones with oil seepages. Further north the rocks found in the Simla area are divided into three series, the Sabathu series consisting of grey and red shales, the Dagshai series comprising bright red clays and the Kasauli series comprising sandstones. Towards the east in Assam, Nummulitic limestone is found in the Khasi hills. Oil is associated with these rocks of the Oligo-Miocene age. Along the foothills of the Himalayas the Siwalik molasse is composed of sandstones, conglomerates and shales with thicknesses of 16,000 feet (4,877 m) to 20,000 feet (6,096 m) and ranging from Eocene to Pliocene. These rocks are famous for their rich fossil vertebrate fauna including many fossil hominoids.

Quaternary period

The alluvium which is found in the Indo-Gangetic plain belongs to this era. It was eroded from the Himalayas by the rivers and the monsoons. These alluvial deposits consist of clay, loam, silt etc. and are divided into the older alluvium and the newer alluvium. The older alluvium is called Bhangar and is present in the ground above the flood level of the rivers. Khaddar or newer alluvium is confined to the river channels and their flood plains. This region has some of the most fertile soil found in the country as new silt is continually laid down by the rivers every year.

Natural resources

India's total renewable water resources are estimated at 1,907.8 km3/year. Its annual supply of usable and replenshable groundwater amounts to 350 billion cubic metres. Only 35% of groundwater resources are being utilized. About 44 million tonnes of cargo is moved annually through the country's major rivers and waterways. Groundwater supplies 40% of water in India's irrigation canals. 56% of the land is arable and used for agriculture. Black soils are moisture-retentive and are preferred for dry farming and growing cotton, linseed, etc. Forest soils are used for tea and coffee plantations. Red soil have a wide diffusion of iron content.

Most of India's estimated 5.4 billion barrels (860,000,000 m3) in oil reserves are located in the Mumbai High, upper Assam, Cambay, the Krishna-Godavari and Cauvery basins. India possesses about seventeen trillion cubic feet of natural gas in Andhra Pradesh, Gujarat and Odisha. Uranium is mined in Andhra Pradesh. India has 400 medium-to-high enthalpy thermal springs for producing geothermal energy in seven "provinces" — the Himalayas, Sohana, Cambay, the Narmada-Tapti delta, the Godavari delta and the Andaman and Nicobar Islands (specifically the volcanic Barren Island.)

India is the world's biggest producer of mica blocks and mica splittings. India ranks second amongst the world's largest producers of barites and chromites. The Pleistocene system is rich in minerals. India is the third-largest coal producer in the world and ranks fourth in the production of iron ore. It is the fifth-largest producer of bauxite and crude steel, the seventh-largest of manganese ore and the eighth-largest of aluminium. India has significant sources of titanium ore, diamonds and limestone. India possesses 24% of the world's known and economically viable thorium, which is mined along shores of Kerala. Gold had been mined in the now-defunct Kolar Gold Fields in Karnataka.

General

The total cultivable area in India is 1,945,355 km² (56.78% of its total land area), which is shrinking due to population pressures and rapid urbanisation. India has a total water surface area of 360,400 km² and receives an average annual rainfall of

1,100 mm. Irrigation accounts for 92% of the water utilisation, comprising an area of 380 km² in 1974. It is expected to rise to 1,050 km² by 2025, with the balance accounted for by industrial and domestic consumers. India's inland water resources include rivers, canals, ponds and lakes, coupled with the east and west coasts of the Indian ocean and other gulfs and fisheries sector. In 2008, India had the world's third largest fishing industry.

India produces 4 fuels, 11 metallic, 52 non-metallic and 22 minor minerals. India's major mineral resources include Coal (4th largest reserves in the world), Iron ore, Manganese ore (7th largest reserve in the world as in 2013), Mica, Bauxite (5th largest reserve in the world as in 2013), Chromite, Natural gas, Diamonds, Limestone and Thorium (world's largest along coast of Kerala shores). India's oil reserves, found in Bombay High off the coast of Maharashtra, Gujarat, Rajasthan and in eastern Assam meet 25% of the country's demand.

A national level agency National Natural Resources Management System (NNRMS) was established in 1983 for integrated natural resources management in the country. It is supported by Planning Commission (India) and Department of Space.

Biotic resources

Biotic resources are obtained from the living and organic material. These include forest products, wildlife, crops and other living organisms. Most of these resources are renewable because they can regenerate themselves. Fossil fuels are considered as biotic because they are formed from decayed organic matter. Fossil fuels are non-renewable.

Forestry

India's land area includes regions with high rainfall to dry deserts, Coast line to Alpine regions. Around 21 percent of the total geographical area consists of Forests. Due to variations in climatic conditions and differences in altitude, different types of Forest are present in India including Tropical, Swamps, Mangrove and Alpine. Variety of forest vegetation is large. Forests are the main source of Fire woods, Paper, Spices, Drugs, Herbs, Gums and more. Forests contribute significant amount to nation's GDP.

History

Forestry in pre-1947

In 1840, the British colonial administration promulgated an ordinance called Crown Land (Encroachment) Ordinance. This ordinance targeted forests in Britain's Asian colonies, and vested all forests, wastes, unoccupied and uncultivated lands to the crown. The Imperial Forest Department was established in India in 1864. British state's monopoly over Indian forests was first asserted through the Indian Forest Act of 1865. This law simply established the government's claims over forests. The British colonial administration then enacted a further far-reaching Forest Act of 1878, thereby acquiring the sovereignty of all wastelands which in its definition included all forests. This Act also enabled the administration to demarcate reserved and protected forests. In the former, all local rights were abolished while in the latter some existing rights were accepted as a privilege offered by the British government to the local people which can be taken away if necessary. These colonial laws brought the forests under the centralised sovereignty of the state.

An FAO report claims it was believed in colonial times that the forest is a national resource which should be utilised for the interests of the government. Like coal and gold mines, it was believed that forests belonged to the state for exploitation. Forest areas became a source of revenue. For example, teak was extensively exploited by the British colonial government for ship construction, sal and pine in India for railway sleepers and so on. Forest contracts, such as that of biri pata (leaves of Diospyros melanoxylon), earned so much revenue that it was often used by the people involved in this business as a leverage for political power. These contracts also created forest zamindars (government recognised forest landowners). Additionally, as in Africa, some forests in India were earmarked by the government officials and the rulers with the sole purpose of using them for hunting and sport for the royalty and the colonial officials.

Forestry in India from 1947 to 1990

In 1953, the government nationalised the forests which were earlier with the zamindars. India also nationalised most of the forest wood industry and non-wood forest products industry. Over the years, many rules and regulations were introduced by India. In 1980, the Conservation Act was passed, which stipulated that the central permission is required to practice sustainable agro-forestry in a forest area. Violations or lack of permits was made a criminal offense. These nationalisation wave and laws intended to limit deforestation, conserve biodiversity, and save wildlife. However, the intent of these regulations was not matched by reality that followed. Neither investment aimed at sustainable forestry nor knowledge transfer followed once India had nationalised and heavily regulated forestry. Deforestation increased, biodiversity diminished and wildlife dwindled. India's rural population and impoverished families continued to ignore the laws passed in Delhi, and use the forests near them for sustenance.

India launched its National Forest Policy in 1988. This led to a programme named Joint Forest Management, which proposed that specific villages in association with the forest department will manage specific forest blocks. In particular, the protection of the forests would be the responsibility of the people. By 1992, seventeen states of India participated in Joint Forest Management, bringing about 2 million hectares of forests under protection. The effect of this initiative has been claimed to be positive.

Post 1990 Forestry in India

Since 1991, India has reversed the deforestation trend. Specialists of the United Nations report India's forest as well as woodland cover has increased. A 2010 study by the Food and Agriculture Organisation ranks India amongst the 10 countries with the largest forest area coverage in the world (the other nine being Russian Federation, Brazil, Canada, United States of America, China, Democratic Republic of the Congo, Australia, Indonesia and Sudan). India is also one of the top 10 countries with the largest primary forest coverage in the world, according to this study.

From 1990 to 2000, FAO finds India was the fifth largest gainer in forest coverage in the world; while from 2000 to 2010, FAO considers India as the third largest gainer in forest coverage.

Some 500,000 square kilometres, about 17% of India's land area, were regarded as Forest Area in the early 1990s. In FY 1987, however, actual forest cover was 640,000 square kilometres. Some claim, that because more than 50% of this land was barren or bushland, the area under productive forest was actually less than 350,000 square kilometres, or approximately 10% of the country's land area.

India's 0.6% average annual rate of deforestation for agricultural and non-lumbering land uses in the decade beginning in 1981 was one of the lowest in the world and on a par with Brazil.

Distribution of forests in Indian states

India is a large and diverse country. Its land area includes regions with some of the world's highest rainfall to very dry deserts, coast line to alpine regions, river deltas to tropical islands. The variety and distribution of forest vegetation is large: there are 600 species of hardwoods, including sal (Shorea robusta). India is one of the 17 mega biodiverse regions of the world.

Indian forests types include tropical evergreens, tropical deciduous, swamps, mangroves, sub-tropical, montane, scrub, sub-alpine and alpine forests. These forests support a variety of ecosystems with diverse flora and fauna.

Forest cover measurement methods

Prior to the 1980s, India deployed a bureaucratic method to estimate forest coverage. A land was notified as covered under Indian Forest Act, and then officials deemed this land area as recorded forest even if it was devoid of vegetation. By this forest-in-name-only method, the total amount of recorded forest, per official Indian records, was 71.8 million hectares. Any comparison of forest coverage number of a year before 1987 for India, to current forest coverage in India, is thus meaningless; it is just bureaucratic record keeping, with no relation to reality or meaningful comparison.

In the 1980s, space satellites were deployed for remote sensing of real forest cover. Standards were introduced to classify India's forests into the following categories:

- Forest Cover: defined as all lands, more than one hectare in area, with a tree canopy density of more than 10%. (Such lands may or may not be statutorily notified as forest area).
- Very Dense Forest: All lands, with a forest cover with canopy density of 70% and above
- Moderately Dense Forest: All lands, with a forest cover with canopy density of 40-70 %
- Open Forest: All lands, with forest cover with canopy density of 10 to 40%
- Mangrove Cover: Mangrove forest is salt tolerant forest ecosystem found mainly in tropical and sub-tropical coastal and/or inter-tidal regions. Mangrove cover is the area covered under mangrove vegetation as interpreted digitally from remote sensing data. It is a part of forest cover and also classified into three classes viz. very dense, moderately dense and open.
- Non Forest Land: defined as lands without any forest cover
- Scrub Cover: All lands, generally in and around forest areas, having bushes and or poor tree growth, chiefly small or stunted trees with canopy density less than 10%
- Tree Cover: Land with tree patches (blocks and linear) outside the recorded forest area exclusive of forest cover and less than the minimum mapable area of 1 hectare
- Trees Outside Forests: Trees growing outside Recorded Forest Areas

The first satellite recorded forest coverage data for India became available in 1987. India and the United States cooperated in 2001, using Landsat MSS with spatial resolution of 80 metres, to get accurate forest distribution data. India thereafter switched to digital image and advanced satellites with 23 metres resolution and software processing of images to get more refined data on forest quantity and forest quality. India now assesses its forest distribution data biennially.

2007 forest survey data

The 2007 forest census data thus obtained and published by the Government of India suggests the five states with largest area under forest cover as the following:

State	Area (in million hectares)
Madhya Pradesh	7.64
Arunachal Pradesh	6.8
Chhattisgarh	5.6
Odisha	4.83
Maharashtra	4.68

2013 forest survey data

According to India's 2013 forest survey report, the forest cover in top five states has increased, with the exception of Arunachal Pradesh:

State	Area (in million hectares)
Madhya Pradesh	7.75

Arunachal Pradesh	6.73
Chhattisgarh	5.6
Maharashtra	5.06
Odisha	5.03

Strategy to increase cover

In the 1970s, India declared its long-term strategy for forestry development to compose of three major objectives: to reduce soil erosion and flooding; to supply the growing needs of the domestic wood products industries; and to supply the needs of the rural population for fuelwood, fodder, small timber, and miscellaneous forest produce. To achieve these objectives, the National Commission on Agriculture in 1976 recommended the reorganisation of state forestry departments and advocated the concept of social forestry. The commission itself worked on the first two objectives, emphasising traditional forestry and wildlife activities; in pursuit of the third objective, the commission recommended the establishment of a new kind of unit to develop community forests. Following the leads of Gujarat and Uttar Pradesh, a number of other states also established community-based forestry agencies that emphasized programmes on farm forestry, timber management, extension forestry, reforestation of degraded forests, and use of forests for recreational purposes.

In the 1980s, such socially responsible forestry was encouraged by state community forestry agencies. They emphasized such projects as planting wood lots on denuded communal cattle-grazing grounds to make villages self-sufficient in fuelwood, to supply timber needed for the construction of village houses, and to provide the wood needed for the repair of farm implements. Both individual farmers and tribal communities were also encouraged to grow trees for profit. For example, in Gujarat, one of the more aggressive states in developing programmes of socioeconomic importance, the forestry department distributed 200 million tree seedlings in 1983. The fast-growing eucalyptus is the main species being planted nationwide, followed by pine and poplar.

In 2002, India set up a National Forest Commission to review and assess India's policy and law, its effect on India's forests, its impact of local forest communities, and to make recommendations to achieve sustainable forest and ecological security in India. The report made over 300 recommendations including the following:

- India must pursue rural development and animal husbandry policies to address local communities need to find affordable cattle fodder and grazing. To avoid destruction of local forest cover, fodder must reach these communities on reliable roads and other infrastructure, in all seasons year round.
- The Forest Rights Bill is likely to be harmful to forest conservation and ecological security. The Forest Rights Bill became a law since 2007.
- The government should work closely with mining companies. Revenue generated from lease of mines must be pooled into a dedicated fund to conserve and improve the quality of forests in the region where the mines are located.
- Power to declare ecologically sensitive areas must be with each Indian state.

- The mandate of State Forest Corporations and government owned monopolies must be changed.
- Government should reform regulations and laws that ban felling of trees and transit of wood within India. Sustainable agro-forestry and farm forestry must be encouraged through financial and regulatory reforms, particularly on privately owned lands.

India's national forest policy expects to invest US$ 26.7 billion by 2020, to pursue nationwide afforestation coupled with forest conservation, with the goal of increasing India's forest cover from 20% to 33%.

Effect of tribal population growth on forest flora and fauna

Due to faster tribal population growth in forest / tribal areas, naturally available forest resources (NTFP) in a sustainable manner are becoming inadequate for their basic livelihood. Many tribal are giving up their traditional livelihood and taking up farming and cattle rearing in the forest areas causing un-repairable damage to forests. The erstwhile protectors of forests are slowly turning into bane of forests and its wildlife. Government should devise schemes to avert this process and save the dwindling forest area and its flora and fauna. Tribal people have extraordinary understanding of forest flora and fauna which can be productively utilized. All the tribals shall be employed by the government in the expansion and protection of forests and its wildlife till their descendants get educated and diversify into industrial and service sectors.

Economics

Significant forest products of India include paper, plywood, sawnwood, timber, poles, pulp and matchwood, fuelwood, sal seeds, tendu leaves, gums and resins, cane and rattan, bamboo, grass and fodder, drugs, spices and condiments, herbs, cosmetics, tannins.

India is a significant importer of forest products. Logs account for 67% of all wood and wood products imported into India due to local preference for unprocessed wood. This preference is explained by the availability of inexpensive labor and the large number of productive sawmills. In trade year 2008-2009, India imported logs worth $1.14 billion, an increase of about 70% in just 4 years.

Indian market for unprocessed wood is mostly fulfilled with imports from Malaysia, Myanmar, Côte d'Ivoire, China and New Zealand.

India is growing market for partially finished and ready-to-assemble furniture. China and Malaysia account for 60% of this imported furniture market in India followed by Italy, Germany, Singapore, Sri Lanka, the United States, Hong Kong, and Taiwan.

The Indian market is accustomed to teak and other hardwoods that are perceived to be more resistant to termites, decay and are able to withstand the tropical climate.

Teak wood is typically seen as a benchmark with respect to grade and prices of other wood species. Major imported wood species are tropical woods such as mahogany, garjan, marianti, and sapeli. Plantation timber includes teak, eucalyptus, and poplar, as well as spruce, pine, and fir. India imports small quantities of temperate hardwoods such as ash, maple, cherry, oak, walnut, beech, etc. as squared logs or as lumber. India is the world's third largest hardwood log importer.

In 2009, India imported 332 million cubic metres of roundwood mostly for fuel wood application, 17.3 million cubic metres of sawnwood and wood-based panels, 7.6 million metric tonnes of paper and paperboard and about 4.5 million metric tonnes of wood and fiber pulp.

Biodiversity in Indian forests

Indian forests are more than trees and an economic resource. They are home to some of earth's unique flora and fauna.

Indian forests represent one of the 12 mega biodiverse regions of the world. India's Western Ghats and Eastern Himalayas are amongst the 32 biodiversity hotspots on earth.

India is home to 12% of world's recorded flora, some 47000 species of flowering and non-flowering plants. Over 59000 species of insects, 2500 species of fishes, 17000 species of angiosperms live in Indian forests. About 90000 animal species, representing over 7% of earth's recorded faunal species have been found in Indian forests. Over 4000 mammal species are found here. India has one of the richest variety of bird species on earth, hosting about 12.5% of known species of birds. Many of these flora and fauna species are endemic to India.

Indian forests and wetlands serve as temporary home to many migrant birds.

Trading in exotic birds

India was, until 1991, one of the largest exporters of wild birds to international bird markets. Most of the birds traded were parakeets and munias. Most of these birds were exported to countries in Europe and the Middle East.

In 1991, India passed a law that banned all trade and trapping of indigenous birds in the country. The passage of the law stopped the legal exports, but illegal trafficking has continued. In 2001, for example, an attempt to smuggle some 10,000 wild birds was discovered, and these birds were confiscated at the Mumbai international airport.

According to a WWF-India published report, trapping and trading of some 300 species of birds continues in India, representing 25% of known species in the country. Tens of thousands of birds are trapped from the forests of India, and traded every month to serve the demand for bird pets. Another market driver for bird trapping and trade is the segment of Indians who on certain religious occasions, buy birds in captivity and free them as an act of kindness to all living beings of the world. Trappers and traders know of the need for piety in these people, and ensure a reliable supply of wild birds so that they can satisfy their urge to do good.

The trappers, a detailed survey and investigation reveals are primarily tribal communities. The trappers lead a life of poverty and migrate over time. Their primary motivation was economics and the need to financially support their families.

Trapping and transport of trapped birds from India's forests has high injury and losses, as in other parts of the world. For every bird that reaches the market for a sale, many more die.

Abrar Ahmed, the WWF-India and TRAFFIC-India ornithologist, suggests the following as potentially effective means of stopping the harm caused by illegal trading of wild birds in India:

- Engage the tribal communities in a constructive way. Instead of criminalising their skills at finding, recognising, attracting and capturing birds, India should offer them employment to re-apply their skills through scientific management, protection and wildlife preservation.
- Allow captive and humane breeding of certain species of birds, to satisfy the market demand for pet birds.
- Better and continuous enforcement to prevent trapping practices, stop trading and end smuggling of wild birds of India through neighboring countries that have not banned trading of wild birds.
- Education and continued media exposure of the ecological and environmental harm done by wild bird trade, in order to reduce the demand for trapped wild birds as pets.

Conservation

The role of forests in the national economy and in ecology was further emphasized in the 1988 National Forest Policy, which focused on ensuring environmental stability, restoring the ecological balance, and preserving the remaining forests. Other objectives of the policy were meeting the need for fuelwood, fodder, and small timber for rural and tribal people while recognising the need to actively involve local people in the management of forest resources. Also in 1988, the Forest Conservation Act of 1980 was amended to facilitate stricter conservation measures. A new target was to increase the forest cover to 33% of India's land area from the then-official estimate of 23%. In June 1990, the central government adopted resolutions that combined forest science with social forestry, that is, taking the sociocultural traditions of the local people into. The cumulative area afforested during the 1951-91 period was nearly 179,000 square kilometres. However, despite large-scale tree planting programmes, forestry is one arena in which India has actually regressed since independence. Annual fellings at about four times the growth rate are a major cause. Widespread pilfering by villagers for firewood and fodder also represents a major decrement. In addition, the 1988 National Forest Policy noted, the forested area has been shrinking as a result of land cleared for farming and development programmes.

Between 1990 and 2010, as evidenced by satellite data, India has reversed the deforestation trend. FAO reports India's rate of forest addition has increased in recent years, and as of 2010, it is the third fastest in the world in increasing forest cover.

The 2009 Indian national forest policy document emphasizes the need to combine India's effort at forest conservation with sustainable forest management. India defines forest management as one where the economic needs of local communities are not ignored, rather forests are sustained while meeting nation's economic needs and local issues through scientific forestry.

Issues and threats

Chipko Movement

Chipko movement in India started in the 1970s around a dispute on how and who should have a right to harvest forest resources. Although the Chipko movement is now practically non-existent in Uttarakhand, the Indian state of its origin, it remains one of the most frequently deployed examples of an environmental and a people's movement in developing countries such as India. What caused Chipko is now a subject of debate; some neopopulists theorise Chipko as an environmental movement and an attempt to save forests, while others suggest that Chipko movement had nothing to do with eco-conservation, but was driven primarily to demand equal rights to harvest forests by local communities.

According to one set of writers: Since the early 1970s, as they realised that deforestation threatened not only the ecology but their livelihood in a variety of ways, people have become more interested and involved in conservation. The best known popular activist movement is the Chipko Movement, in which local women under the leadership of Chandi Prasad Bhatt and Sunderlal Bahuguna, decided to fight the government and the vested interests to save trees. The residents declared that they would embrace—literally "to stick to" (chipkna in Hindi)--trees to prevent cutting of ash trees in their district.

According to those who critique the ecological awareness and similar theories, Chipko had nothing to do with protecting forests, rather it was an economic struggle using the traditional Indian way of non-violence. These scientists point out that very little is left of the Chipko movements today in its region of origin save for its memory, even though the quality of forests and its use remains a critical issue for India. To explain the cause of Chipko movement, they find that government officials had ignored the subsistence issues of the local communities, who depended on forests for fuel, fodder, fertiliser and sustenance resources. These researchers claim that local interviews and fact finding confirms that local communities had filed complaints requesting the right to commercially exploit the forests around them. Their requests were denied, while permits to fell trees and exploit those same forests were granted to government-favoured non-resident contractors including a sporting company named Symonds. A protest that became Chipko movement followed. The movement grew and Indian government responded by imposing a 15-year ban on felling all trees above 1000 metres in the region directly as a result of the Chipko agitations. This legislation was deeply resented by many communities supporting Chipko because, the regulation further excluded the local people from the forest around them. Opposition to the legislation resulted in so-called 'Ped Katao Andolan' in the same region, a movement to cut the trees down in order to defy the new legislation. The people behind Chipko movement felt that the government did not understand or care about their economic situation.

Chipko movement, at the very least, suggests that forests in India are an important and integral resource for communities that live within these forests, or survive near the fringes of these forests.

Jhum cultivation

A major threat to forests of India are in its northeastern states. From ancient times, the locals have practiced slash-and-burn shifting cultivation to grow food. Locally called Jhum, it supports about 450,000 families in Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Assam and Meghalaya. Approximately 15,000 square kilometers of forest land is under jhum cultivation, and just a sixth of this land is actually producing any crop at any given year. The tribal people consider it a tradition, and economic ecosystem. However, the slash and burn causes damage to a dense forest, to soil, to flora and fauna, as well as pollution. The crop yields are very poor with jhum cultivation. Between 2010 and 2012, satellite studies confirmed a net loss of forest cover over these northeastern states. The lost forest includes primary dense forests. There is a concerted effort by the state government officials to educate, incentivize and train jhum dependent families to horticulture and other high value crops, along with an offer of food supply security. Bamboo-based textiles and value added forest products industries are also being encouraged by the local officials. States such as Arunachal Pradesh reported reduction in Jhum cultivation practice in 2013.

Timber mafia and forest cover

A 1999 publication claimed that protected forest areas in several parts of India, such as Jammu and Kashmir, Himachal Pradesh, Karnataka and Jharkhand, were vulnerable to illegal logging by timber mafias that have coopted or intimidated forestry officials, local politicians, businesses and citizenry.

Despite these local criminal and corruption issues, satellite data analysis and a 2010 FAO report finds India has added over 4 million hectares of forest cover, a 7% increase, between 1990 and 2010.

Forest rights

In 1969, forestry in India underwent a major change with the passage of the Forest Rights Act, a new legislation that sought to address the needs of forest dwelling communities that resulted from the failure to record their rights over forest land and resources. It also sought to bring in new forms of community conservation.

Fish

India has a long history in fishing and aquaculture. India has rich marine and inland water resources. It has an 8129 km long coastline. Inland fishery is carried out in Rivers, Reservoirs and Lakes. In Indian rivers more than 400 species of fish are found and many species are economically important. Shrimps, Sardines, Mackerels, Carangid, Croakers and other varieties are available. Major Fish species available are Carp, Catfish, Murrel and Weed fish. India is one of the major marine fish producer. In 2012-2013, 9 Lakh tonnes of Marine products was exported.

History

Macchi, a traditional Muslim caste of fishermen - Tashrih al-aqvam (1825)

Fishing and aquaculture in India has a long history. Kautilya's Arthashastra (321–300 B.C.) and King Someswara's Manasottara (1127 A.D.) each refer to fish culture. For centuries, India has had a traditional practice of fish culture in small ponds in Eastern India. Significant advances in productivity were made in the state of West Bengal in the early nineteenth century with the controlled breeding of carp in Bundhs (tanks or impoundments where river conditions are simulated). Fish culture received notable attention in Tamil Nadu (formerly the state of Madras) as early as 1911, subsequently, states such as West Bengal, Punjab, Uttar Pradesh, Gujarat, Karnataka and Andhra Pradesh initiated fish culture through the establishment of Fisheries Departments. In 2006, Indian central government initiated a dedicated organization focussed on fisheries, under its Ministry of Agriculture.

Brackishwater farming in India is also an age-old system confined mainly to the Bheries (manmade impoundments in coastal wetlands) of West Bengal and pokkali (salt resistant deepwater paddy) fields along the Kerala coast. With no additional knowledge and technology input, except that of trapping the naturally bred juvenile fish and shrimp seed, these systems have been sustaining production levels of between 500 and 750 kg/ha/year with shrimp contributing 20 to 25 percent of the total Indian production.

Growth

It rose from only 800,000 tons in FY 1950 to 4.1 million tons in the early 1990s. From 1990 through 2010, Indian fish industry growth has accelerated, reaching a total marine and freshwater fish production to about 8 million metric tons. Special efforts have been made to promote extensive and intensive inland fish farming, modernize coastal fisheries, and encourage deep-sea fishing through joint ventures. These efforts led to a more than fourfold increase in coastal fish production from 520,000 tons in FY 1950 to 3.35 million tons in FY 2013. The increase in inland fish production was even more dramatic, increasing almost eightfold from 218,000 tons in FY 1950 to 6.10 million tons in FY 2013. The value of fish and processed fish exports increased from less than 1 percent of the total value of exports in FY 1960 to 3.6 percent in FY 1993.

Between 1990 to 2007, fish production in India has grown at a higher rate than food grains, milk, eggs, and other food items.

Economic benefits

Fishing in India contributed over 1 percent of India's annual gross domestic product in 2008.

Fishing in India employs about 14.5 million people. The country's rich marine and inland water resources, fisheries and aquaculture offer an attractive and promising sector for employment, livelihood, and food security. Fish products from India are well received by almost half of world's countries, creating export-driven employment opportunities in India and greater food security for the world. During the past decades the Indian fisheries and aquaculture has witnessed improvements in craft, tackle and farming methods. Creation of required harvest and post-harvest infrastructure has been receiving due attention of the central and state governments. All this has been inducing a steady growth.

To harvest the economic benefits from fishing, India is adopting exclusive economic zone, stretching 200 nautical miles (370 km) into the Indian Ocean, encompasses more than 2 million square kilometers. In the mid-1980s, only about 33 percent of that area was being exploited. The potential annual catch from the area has been estimated at 4.5 million tons. In addition to this marine zone, India has about 14,000 km² of brackish water available for aquaculture, of which only 600 km² were being farmed in the early 1990s; about 16,000 km² of freshwater lakes, ponds, and swamps; and nearly 64,000 kilometers of rivers and streams.

In 1990, there were 1.7 million full-time fishermen, 1.3 million part-time fishermen, and 2.3 million occasional fishermen, many of whom worked as saltmakers, ferrymen, or seamen, or operated boats for hire. In the early 1990s, the fishing fleet consisted of 180,000 traditional craft powered by sails or oars, 26,000 motorized traditional craft, and some 34,000 mechanized boats.

Aquaculture

India laid the foundation for scientific carp farming in the country between 1970 and 1980, by demonstrating high production levels of 8 to 10 tonnes/hectare/year in an incubation center. The late 1980s saw the dawn of aquaculture in India and transformed fish culture into a more modern enterprise. With the economic liberalization of the early 1990s, fishing industry got a major investment boost.

India's breeding and culture technologies include primarily different species of carp; other species such as catfish, murrels and prawns are recent additions.

The culture systems adopted in the country vary greatly depending on the input available in any particular region as well as on the investment capabilities of the farmer. While extensive aquaculture is carried out in comparatively large water bodies with stocking of the fish seed as the only input beyond utilising natural productivity, elements of fertilisation and feeding have been introduced into semi-intensive culture. The different culture systems in Indian practice include:

- Intensive pond culture with supplementary feeding and aeration (10–15 tonnes/ha/yr)
- Composite carp culture (4–6 tonnes/ha/yr)
- Weed-based carp polyculture (3–4 tonnes/ha/yr)
- Integrated fish farming with poultry, pigs, ducks, horticulture, etc. (3–5 tonnes/ha/yr)
- Pen culture (3–5 tonnes/ha/yr)
- Cage culture (10–15 $kg/m^2/yr$)
- Running-water fish culture (20–50 $kg/m^2/yr$)

Aquaculture resources in India include 2.36 million hectares of ponds and tanks, 1.07 million hectares of beels, jheels and derelict waters plus in addition 0.12 million kilometers of canals, 3.15 million hectares of reservoirs and 0.72 million hectares of upland lakes that could be utilised for aquaculture purposes. Ponds and tanks are the prime resources for freshwater aquaculture in India. However, less than 10 percent of India's natural potential is used for aquaculture currently.

The FAO of the United Nations estimates that about 1.2 million hectares of potential brackishwater area available in India is suitable for farming, in addition to this, around 8.5 million hectares of salt affected areas are also available, of which about 2.6 million hectares could be exclusively utilised for aquaculture due to the unsuitability of these resources for other agriculture based activities. However, just like India's fresh water resources, the total brackishwater area under cultivation is only just over 13 percent of the potential water area available. India offers opportunities for highly productive farming of shrimp in its brackishwater resources.

Carp hatcheries in both the public and private sectors have contributed towards the increase in seed production from 6321 million fry in 1985–1986 to over 18500 million fry in 2007. There are 35 freshwater prawn hatcheries in the coastal states producing over 200 million seed per annum. Furthermore, the 237 shrimp hatcheries with a production capacity of approximately 11.425 billion post larvae per year are meeting the seed requirement of the brackish water shrimp farming sector.

Freshwater aquaculture activity is prominent in the eastern part of the country, particularly the states of West Bengal, Orissa and Andhra Pradesh with new areas coming under culture in the states of Punjab, Haryana, Assam and Tripura. Brackishwater aquaculture is mainly concentrated on the coasts of Andhra Pradesh, Tamil Nadu, Orissa and West Bengal. With regards to the market, while the main areas of consumption for freshwater fish are in West Bengal, Bihar, Orissa and northeast India, cultured brackishwater shrimps supply India's fish export industry.

Distribution of fish industry in Indian states

Fishing is a diverse industry in India. The table below presents the top ten fish harvesting states in India, for the 2007-2008 agriculture year.

Leading fish producing states in India, 2014–2015		
Rank	State	Total production (metric tonnes)
1	Andhra Pradesh	1,010,830
2	Gujarat	721,910
3	Kerala	667,330
4	Tamil Nadu	559,360
5	Maharashtra	556,450
6	West Bengal	349,480
7	Uttar Pradesh	325,950
8	Bihar	319,100
9	Karnataka	297,690

Between 2000 and 2010, the freshwater prawn farming in India has grown rapidly. The state of Andhra Pradesh dominates the sector with over 86 percent of the total production in India with approximately 60 percent of the total water area dedicated to prawn farming, followed by West Bengal. Mixed farming of freshwater prawn along with carp is also very much accepted as a technologically sound culture practice and a viable option for enhancing farm income. Thirty five freshwater prawn hatcheries, at present producing about 200 million seed per annum, cater for the requirements of the country.

Law and regulations

India has a federal structure of government. According to India's constitution, the power of enacting laws is split between India's central government and the Indian states. The state legislatures of India have the power to make laws and regulations with respect to a number of subject-matters, including water (i.e., water supplies, irrigation and canals, drainage and embankments, water storage and water power), land (i.e., rights in or over land, land tenure, transfer, and alienation of agricultural land), fisheries, as well as the preservation, protection and improvement of stock and the prevention of animal disease. There are many laws and regulations that may be relevant to fisheries and aquaculture adopted at state level.

At the central level, several key laws and regulations are relevant to fisheries and aquaculture. These include the British-era Indian Fisheries Act (1897), which penalizes the killing of fish by poisoning water and by using explosives; the Environment (Protection) Act (1986), being an umbrella act containing provisions for all environment related issues affecting fisheries and aquaculture industry in India. India also has enacted the Water (Prevention and Control of Pollution) Act (1974) and the Wild Life Protection Act (1972). All these legislations must be read in conjunction with one another, and with the local laws of a specific state, to gain a full picture of the law and regulations that are applicable to fisheries and aquaculture in India.'.'.'

Research and training

Fisheries research and training institutions are supported by central and state governments that deserve much of the credit for the expansion and improvements in the Indian fishing industry. The principal fisheries research institutions, all of which operate under the Indian Council of Agricultural Research, are the Central Marine Fisheries Research Institute at Kochi (formerly Cochin), Kerala; the Central Inland Fisheries Institute at Barrackpore, West Bengal; and the Central Institute of Fisheries Technology at Willingdon Island near Kochi. Most fishery training is provided by the Central Institute for Fishery Education in Mumbai, which has ancillary institutions in Barrackpore, Agra (Uttar Pradesh), and Hyderabad (Telangana). The Central Fisheries Corporation in Calcutta is instrumental in bringing about improvements in fishing methods, ice production, processing, storing, marketing, and constructing and repairing fishing vessels. Operating under a 1972 law, the Marine Products Export Development Authority(MPEDA), headquartered in Kochi, has made several market surveys abroad and has been instrumental in introducing and enforcing hygiene standards that have gained for Indian fishery export products a reputation for cleanliness and quality.

Programmes

The Government of India launched National Fisheries Development Board in 2006. Its headquarters are in Hyderabad, located in a fish shaped building. Its activity focus areas are:

- Intensive Aquaculture in Ponds and Tanks
- Fisheries Development in Reservoirs.
- Coastal Aquaculture
- Mariculture
- Seaweed Cultivation
- Infrastructure: Fishing Harbours and Landing Centres
- Fish Dressing Centres and Solar Drying of Fish
- Domestic Marketing
- Technology Upgradation
- Deep Sea Fishing and Tuna Processing

The implementation of two programs for inland fisheries—establishing fish farmers' development agencies and the National Programme of Fish Seed Development—has led to encouragingly increased production, which reached 1.5 million tons during FY 1990, up from 0.9 million tons in FY 1984. A network of 313 fish farmers' development agencies was functioning in 1992. Under the National Programme of Fish Seed Development, forty fish-seed hatcheries were commissioned. Fish-seed production doubled from 5 billion fry in FY 1983 to 10 billion fry in FY 1989. A new program using organic waste for aquaculture was started in FY 1986. Inland fish production as a percent of total fish production increased from 36 percent in FY 1980 to 40 percent by FY 1990.

Major harbours

Apart from five main fishing harbours--Mangalore (Karnataka), Kochi (Kerala), Chennai (Tamil Nadu), Vishakhapatnam (Andhra Pradesh), and Raichak in Kolkata (West Bengal)--twenty-three minor fishing harbors and ninety-five fish-landing centers are designated to provide landing and berthing facilities to fishing craft. The harbors at Vishakhapatnam, Kochi, and Roychowk were completed by 1980; the one at Madras was completed in the 1980s. A major fishing harbor was under construction at Sassoon Dock in Mumbai in the early 1990s, as were thirteen additional minor fishing harbors and eighteen small landing centers. By early 1990, there were 225 deep-sea fishing vessels operating in India's exclusive economic zone. Of these, 165 were owned by Indian shipping companies, and the rest were chartered foreign fishing vessels.

The government provides subsidies to poor fishermen so that they can motorize their traditional craft to increase the range and frequency of operation, with a consequent increase in the catch and earnings. A total of about 26,171 traditional craft had been motorized under the program by 1992.

Restrictions

The banning of trawling by chartered foreign vessels and the speedy motorization of traditional fishing craft in the 1980s led to a quantum jump in marine fish production in the late 1980s. The export of marine products rose from 97,179 tons (Rs531 billion) in FY 1987 to 210,800 tons (Rs17.4 trillion) in FY 1992, making India one of the world's leading seafood exporting nations. This achievement was largely a result of significant advancements in India's freezing facilities since the 1960s, advancements that enabled India's seafood products to meet international standards. Frozen shrimp, a high-value item, has become the dominant seafood export. Other significant export items are frozen frog legs, frozen lobster tails, dried fish, and shark fins, much of which is exported to seafood-loving Japan. During the eighth plan, marine products were identified as having major export potential.

Institutes

There are several specialized institutes that train fishermen. The Central Institute of Fisheries Nautical and Engineering Training in Juhu instructs operators of deep-sea fishing vessels and technicians for shore establishments. It has facilities in Madras and Vishakhapatnam for about 500 trainees a year. An Institute named "Fisheries Institute of Technology and Training" (FITT) was established with the participation of TATAs in Tamil Nadu, to improve the socioeconomic condition of fishers. The Integrated Fisheries Project, also headquartered in Kochi, was established for the processing, popularizing, and marketing of unusual fish. Another training organization, the Central Institute of Coastal Engineering for Fisheries in Bangalore, has done techno-economic feasibility studies on locations of fishing harbor sites and brackish-water fish farms. At present there are 19 Fisheries colleges and one fisheries university (CIFE: Central Institute of Fisheries Education, Mumbai)functioning in various states of the country,providing Professional Fisheries education with a view of developing Professionalism in the field of Fisheries. Among the fisheries colleges, Fisheries college and Research Institute located in Tuticorin, Tamil Nadu is the more popular college because of the maximum number of intake of MFSc and PhD candidates every year. Other colleges such as the College of Fisheries, Panangad, College of Fisheries, Mangalore are also working well for the professionalism.

To improve returns to fishermen and provide better products for consumers, several states have organized marketing cooperatives for fishermen. Nevertheless, most traditional fishermen rely on household members or local fish merchants for the disposal of their catches. In some places, marketing is carried on entirely by fisherwomen who carry small quantities in containers on their heads to nearby places. Good wholesale or retail markets are rare.

Coal

Coal mining in India started in 1774 through East India Company in the Raniganj Coalfield along the Western bank of Damodar River in the Indian State of West Bengal . Growth of the Indian coal mining started when steam locomotives were introduced in 1853. Production increased to Million tonnes. Production reached 30 million tonnes in 1946. After Independence, National Coal Development Corporation was set up and colleries were owned by Railways. India consumes coal mainly for Power sector. Other industries like cement, fertilizer, chemical and paper rely coal for energy requirements.

Coal Mining Regions

Coal reserves in India is one of the largest in the world. As on April 1, 2012, India had 293.5 billion metric tons (323.5 billion short tons) of the resource. The production of coal was 532.69 million metric tons (587.19 million short tons) in 2010-11. The production of lignite was 37.73 million metric tons (41.59 million short tons) in 2010-11. As on 2011, India ranked 3rd in world coal production. The energy derived from coal in

India is about twice that of energy derived from oil, whereas worldwide, energy derived from coal is about 30% less than energy derived from oil.

Distribution of coal reserve by states

State	Coal Reserves (in million metric tonnes)	Type of Coalfield
Tamil Nadu	80,356.21	Tertiary
Jharkhand	80,356.20	Gondwana
Orissa	71,447.41	Gondwana
Chhattisgarh	50,846.15	Gondwana
West Bengal	30,615.72	Gondwana
Madhya Pradesh	24,376.26	Gondwana
Telangana	22,154.86	Gondwana
Maharashtra	10,882.09	Gondwana
Uttar Pradesh	1,061.80	Gondwana
Meghalaya	576.48	Tertiary
Assam	510.52	Tertiary
Nagaland	315.41	Tertiary
Bihar	160.00	Gondwana
Sikkim	101.23	Gondwana
Arunachal Pradesh	90.23	Tertiary
Assam	2.79	Gondwana
TOTAL	293,497.15	

The top producing states are:

- Orissa - see Talcher in Angul district
- Chhattisgarh
- Jharkhand

Other notable coal-mining areas include:

- Singareni collieries in Khammam district, Telangana
- Jharia mines in Dhanbad district, Jharkhand
- Nagpur & Chandrapur district, Maharashtra
- Raniganj in Bardhaman district, West Bengal
- Neyveli lignite mines in Cuddalore district, Tamil Nadu
- Singrauli Coalfield and Umaria Coalfield in Madhya Pradesh

Nationalisation of coal mines

Right from its genesis, the commercial coal mining in modern times in India has been dictated by the needs of the domestic consumption. India has abundant domestic reserves of coal. Most of these are in the states of Jharkhand, Orissa, West Bengal, Bihar, Chhattisgarh, Telangana and Madhya Pradesh. On account of the growing needs of the steel industry, a thrust had to be given on systematic exploitation of coking coal reserves in Jharia coalfield. Adequate capital investment to meet the burgeoning energy needs of the country was not forthcoming from the private coal mine owners.

Unscientific mining practices adopted by some of them and poor working conditions of labor in some of the private coal mines became matters of concern for the Government. On account of these reasons, the Central Government took a decision to nationalize the private coal mines. The nationalization was done in two phases, the first with the coking coal mines in 1971-72 and then with the non-coking coal mines in 1973. In October, 1971, the Coking Coal Mines (Emergency Provisions) Act, 1971 provided for taking over in public interest of the management of coking coal mines and coke oven plants pending nationalization. This was followed by the Coking Coal Mines (Nationalization) Act, 1972 under which the coking coal mines and the coke oven plants other than those with the Tata Iron & Steel Company Limited and Indian Iron & Steel Company Limited, were nationalized on May 1, 1972 and brought under the Bharat Coking Coal Limited (BCCL), a new Central Government Undertaking. Another enactment, namely the Coal Mines (Taking Over of Management) Act, 1973, extended the right of the Government of India to take over the management of the coking and non-coking coal mines in seven States including the coking coal mines taken over in 1971. This was followed by the nationalization of all these mines on May 1, 1973 with the enactment of the Coal Mines (Nationalization) Act, 1973 which now is the piece of Central legislation determining the eligibility of coal mining in India.

All non-coking coal mines were nationalized in 1973 and placed under Coal Mines Authority of India. In 1975, Eastern Coalfields Limited, a subsidiary of Coal India Limited, was formed. It took over all the earlier private collieries in Raniganj Coalfield. Raniganj Coalfield covers an area of 443.50 square kilometres (171.24 sq mi) and has total coal reserves of 8,552.85 million metric tons (9,427.90 million short tons). Eastern Coalfields puts the reserves at 29.72 billion metric tons (32.76 billion short tons). That makes it the second largest coalfield in the country (in terms of reserves).

The North East Indian states enjoys special privileges under constitution of India. The Sixth Schedule of constitution and article 371 of constitution allows state governments to formulate its own policy in order to recognize customary tribal laws. For example, Nagaland has its own coal policy which allows its natives to mine coal from their respective lands. Similarly, coal mining in Meghalaya was rampant till imposition of ban on coal mining by National Green Tribunal. The Nagaland Coal and Meghalaya Coal has large buyers in North India, Central India and Eastern India.

Oil

India had about 750 Million metric tonne of proven oil reserves as April 2014 or 5.62 billion barrels as per EIA estimate for 2009, which is the second-largest amount in the Asia-Pacific region behind China. Most of India's crude oil reserves are located in the western coast (Mumbai High) and in the northeastern parts of the country, although considerable undeveloped reserves are also located in the offshore Bay of Bengal and in the state of Rajasthan. The combination of rising oil consumption and fairly unwavering production levels leaves India highly dependent on imports to meet the consumption needs. In 2010, India produced an average of about 33.69 million metric tonne of crude oil as on April 2010 or 877 thousand barrels per day as per EIA estimate of 2009. During 2006, India consumed an estimated 2.63 Mbbl/d (418,000 m3/d) of oil. The EIA estimates that India registered oil demand growth of 100,000 bbl/d (16,000 m3/d) during 2006. As of 2013 India Produces 30% of India's resources mostly in Rajasthan.

India's oil sector is dominated by state-owned enterprises, although the government has taken steps in past recent years to deregulate the hydrocarbons industry and support greater foreign involvement. India's state-owned Oil and Natural Gas Corporation is the largest oil company. ONGC is the leading player in India's upstream sector, accounting for roughly 75% of the country's oil output during 2006, as per Indian government estimates. As a net importer of all oil, the Indian Government has introduced policies aimed at growing domestic oil production and oil exploration activities. As part of the effort, the Ministry of Petroleum and Natural Gas crafted the New Exploration License Policy (NELP) in 2000, which permits foreign companies to hold 100% equity possession in oil and natural gas projects. However, to date, only a handful of oil fields are controlled by foreign firms. India's downstream sector is also dominated by state-owned entities, though private companies have enlarged their market share in past recent years.

Natural gas

As per the Ministry of petroleum, Government of India, India has 1,437 billion cubic metres (50.7×10^12 cu ft) of confirmed natural gas reserves as of April 2010. A huge mass of India's natural gas production comes from the western offshore regions, particularly the Mumbai High complex. The onshore fields in Assam, Andhra Pradesh, and Gujarat states are also major producers of natural gas. As per EIA data, India produced 996 billion cubic feet (2.82×1010 m3) of natural gas in 2004. India imports small amounts of natural gas. In 2004, India consumed about 1,089×10^9 cu ft (3.08×1010 m3) of natural gas, the first year in which the country showed net natural gas imports. During 2004, India imported 93×10^9 cu ft (2.6×109 m3) of liquefied natural gas (LNG) from Qatar.

As in the oil sector, India's state-owned companies account for the bulk of natural gas production. ONGC and Oil India Ltd. (OIL) are the leading companies with respect to production volume, while some foreign companies take part in upstream developments in joint-ventures and production sharing contracts. Reliance Industries, a privately owned Indian company, will also have a bigger role in the natural gas sector as a result of a large natural gas find in 2002 in the Krishna Godavari basin. The Gas Authority of India Ltd. (GAIL) holds an effective control on natural gas transmission and allocation activities. In December 2006, the Minister of Petroleum and Natural Gas issued a new policy that allows foreign investors, private domestic companies, and Government oil companies to hold up to 100% equity stakes in pipeline projects. While

GAIL's domination in natural gas transmission and allocation is not ensured by statute, it will continue to be the leading player in the sector because of its existing natural gas infrastructure.

Abiotic resources

Abiotic resources are obtained from the non-living and non-organic material. Some of the resources like Water and Air are Renewable. Other resources like Minerals are Non-renewable and exhaustible because they cannot be regenerated. Minerals can be categorized as Metallic, Non-Metallic and Minor minerals.

Metallic minerals

Metallic minerals are the minerals which contain one or more metallic elements. They occur in rare, naturally formed concentrations known as mineral deposits. Metallic minerals available from India are Zinc, Iron ore, Manganese ore, Gold, Bauxite, Silver, Lead, Tin, Copper and Chromite.

Copper

Copper has been used since ancient times. Details of Copper mining and metallurgy are available in ancient works like Arthashastra. Copper is mainly used in Industrial applications, Electrical/Electronic equipments and Consumer products such as utensils. Major resources of Copper are available at Rajasthan, Madhya pradesh and Jharkhand. As on 2010, India had 1.56 billion tonnes of Copper ore. India is one of the 20 major Copper producers. In 2008, India produced 7,10,000 tonnes of copper. Hindustan Copper Limited, a public sector company is the only producer of primary refined copper. Post-pillar method and Blast hole stoping method are used for Mining. Some of the domestic demand is met through scrap recycling. In India, Copper scrap is recycled through Direct melting, which is a hazardous process.

Zinc

Zinc is a bluish-white, lustrous, diamagnetic metal. It is also a fair conductor of electricity. References to medicinal uses of zinc are present in the Charaka Samhita. Ancient Zinc smelting technique was found at a zinc production site in Zawar, Rajasthan. Zinc is recovered from a number of different zinc ores. The types of zinc ores include sulfide, carbonate, silicate and oxide. It is used in corrosive resistant coating for Iron and Steel. Also used in Automotive, Electrical and Machinery industries. India is the World's fourth largest Zinc reserve as in 2013. Hindustan Zinc Limited is the main producer of Zinc in India. Most of the resources are available in Rajasthan. Minor amount of resources are available in Andhra Pradesh, Madhya Pradesh, Bihar and Maharashtra states.

Iron ore

India is the World's third biggest exporter of Iron ore as in 2013. As on 2010, India had 27 billion tonnes or resource (including Hematite and Magnetite). Major amount of Hematite is found in Orissa, Jharkhand, Chhattisgarh, Karnataka and Goa. Minor amount of Hematite is found in Andhra Pradesh, Assam, Bihar, Maharashtra, Madhya Pradesh, Meghalaya, Rajasthan and Uttar Pradesh. Major amount of Magnetite is found in Karnataka, Andhra Pradesh, Rajasthan and Tamil Nadu. Minor amount of Magnetite is found in Assam, Bihar, Goa, Jharkhand, Kerala, Maharashtra, Meghalaya and Nagaland. Mining is done by opencast method. Iron ore is mainly used for manufacturing of Pig iron, Sponge iron and Steel. It is also used in coal washeries, cement and glass industries. The public sector companies like National Mineral Development Corporation and Steel Authority of India contribute to 25% of the total production. Private companies including Tata Steel provides major contribution.

Chromite

It is an oxide of Chromium and Iron. It is the only commercial source of Chromium. As on 2010, India had 200 million tonnes of resource. Major amount of resources are available from Orissa (Cuttack and Jajpur districts). Minor amount of resources are available from Manipur, Nagaland, Karnataka, Jharkhand, Maharashtra, Tamil Nadu and Andhra Pradesh. In 2009-2010, India produced 3.41 million tonnes and ranked second in world production. It is mostly mined by opencast method. Chromium provides additional strength to the alloys and it is resistant to corrosion. So it is mainly used in Metallurgical applications. It can withstand sudden temperature changes makes it use in Refractories. It is also used in Chemical applications.

Non-metallic minerals

Non-metallic minerals are those which do not yield new products on melting. They are generally associated with sedimentary rocks. Non-Metallic minerals available from India are Phosphorite, Dolomite, Gypsum, Garnet, Wollastonite, Vermiculite, Ochre, Perlite, Bentonite, Asbestos, Cadmium, Felspar, Soapstone, Kaolin, Sillimanite, Limestone, Diatomite, Pyrophyllite, Fluorite, Vanadium, Dunite, Ilmenite, Gallium and Zircon

Garnet group

It is a group of complex silicate minerals and has similar chemical compositions. There are three groups of garnet - Aluminum-garnet group, Chromium-garnet group, and Iron-garnet group. The minerals in Aluminium-garnet group are Almandine, Grossularite, Pyrope, and Spessartine. The mineral in Iron-garnet group is Andradite. The mineral in Chromium-garnet group is Uvarovite. Garnet group minerals occur in different rock types. It is a hard substance. It is resistant to chemical exposure. Used as an Semi-precious stone and also in Abrasives, Sand blasting, Water filtration materials and Water jet cutting. Garnets are available in Andhra Pradesh, Chhattisgarh, Jharkhand, Kerala, Orissa, Rajasthan and Tamil Nadu. It is also found in beach sands of Kerala, Orissa and Tamil Nadu states. In 2007-08, India produced 8,73,000 tonnes.

Wollastonite

It is a meta-silicate of Calcium. It is mostly white in color and occurs as bladed or needle like crystals. As on 2010, India had 16 million tonnes of resource. Most of the deposits are available in Rajasthan (Dungarpur, Pali, Sirohi and Udaipur districts). Minor amount of deposits are found in Gujarat and Tamil Nadu. It is mainly used in Ceramic industries and Metallurgical applications. It is also used as a filler in Wall tiles, Paint, Rubber and Plastic. India is one of the largest reserves. In 2010, India produced 1,45,000 tons. It is mined by opencast method. It is also used as a substitute for short-fibre asbestos in brake-linings. Central Building Research Institute has found that Wollastonite can be used as substitute for chrysotile asbestos in cement products.

Sillimanite group

It is a group of metamorphic minerals - Sillimanite, Kyanite and Andalusite. These are polymorphs of Alumino-Silicate. These are formed under high-pressure and high-temperature conditions. The three minerals are calcined to form Mullite. Mainly used as refractory materials. As on 2010, India had 66 million tonnes of Sillimanite, 100 million tonnes of Kyanite and 18 million tonnes of Andalusite as resource. Most of the resources are found in Tamil Nadu, Orissa, Uttar Pradesh, Andhra Pradesh, Kerala and Assam. Minor amount of resources are found in Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Meghalaya, Rajasthan and West Bengal. Granular Sillimanite is available in beach sands of South India. Sillimanite refractory bricks are used in Steel, Glass and Petrochemical industries. In 2004, India produced 14,500 tonnes of Sillimanite and 6200 tonnes of Kyanite.

Ilmenite

It is a compound of Iron and Titanium. It will be iron-black or Steel-gray in color. It is non-toxic material and used in biomedical substances. Institute of Minerals and Materials Technology has developed an Environment friendly technology for processing Ilmenite. It is also used in production of Titanium dioxide pigment. It is available in Kerala, Tamil Nadu and Orissa. Mining is done at locations Chavara, Chatrapur, Aluva and Manavalakurichi by Indian Rare Earths limited. As on 2013, India has 21% of the world's reserves and constitutes 6% of the world's production.

Pyrophyllite

It is a hydrous Alumino-silicate. It is chemically inert, has high melting point and low electrical conductivity. It is used in Refractories, Foundry dressings, Pesticides, Ceramics and Rubber. It is available as Hydrothermal deposits. Physical and Optical properties of Pyrophyllite is similar to Talc. It is also used in Electrical insulators, Sanitary-ware and in Glass industry. As on 2010, India had 56 million tonnes of resource. Most of the resources are found in Madhya pradesh (Chhatarpur, Tikamgarh and Shivpuri districts). Remaining resources are found in Orissa, Uttar pradesh, Andhra Pradesh, Maharashtra and Rajasthan. In 2010, India produced 1.5 million tonnes.

Minor minerals

Minor minerals available are Building stone, Brick earth, Quartzite, Marble, Granite, Gravel, Clay and Sand. These are mainly used in Building constructions. Impact of mining these minerals was significant over a period of time even the area was small. Impacts were Increasing water scarcity, Damage to River beds and adverse effects on bio-diversity. So from 2012 onwards, mining of these minerals are to be done after clearance from Ministry of Environment and Forests (India).

Marble

Marble is a metamorphosed limestone formed by re-crystallization. It is available in different colours and textures. Marble deposits are available in many states of India. It has been used in India for a long time. It was used in construction of Temples, Tombs and Palaces. Now it is also used for flooring in homes and offices. It is preferred for flooring because of its durability and water resistance. Marbles which are economically important are available in Rajasthan, Gujarat, Haryana, Andhra Pradesh and Madhya Pradesh. As on 2010, there was 1931 million tonnes of resource, including all grades of marble. Based on the chemical composition, types of Marble available are Calcite, Dolomitic, Siliceous Limestone, Serpentine and Travertine marbles. Other than construction, it is used in Paint and Agricultural lime.

Nuclear

India's proven Nuclear reserves include Uranium, Thorium.

Uranium

In Nalgonda District, the Rajiv Gandhi Tiger Reserve (the only tiger project in Andhra Pradesh) has been forced to surrender over 3,000 sq. kilometres to uranium mining, following a directive from the Central Ministry of Environment and Forests.

In 2007, India was able to extract 229 tonnes of U_3O_8 from its soil. On 19 July 2011, Indian officials announced that the Tumalapalli mine in Andhra Pradesh state of India could provide more than 170,000 tonnes of uranium, making it as the world's largest uranium mine. Production of the ore is slated to begin in 2012.

The Department of Atomic Energy (DAE) recently discovered that the upcoming mine in Tumalapalli has close to 49,000 tonne of uranium reserves. This could just be a shot in the arm for India's nuclear power aspirations as it is three times the original estimate of the area's deposits.

Thorium

The IAEA's 2005 report estimates India's reasonably assured reserves of thorium at 319,000 tonnes, but mentions recent reports of India's reserves at 650,000 tonnes. A government of India estimate, shared in the country's Parliament in August 2011, puts the recoverable reserve at 846,477 tonnes. The Indian Minister of State V. Narayanasamy stated that as of May 2013, the country's thorium reserves were 11.93 million tonnes (monazite, having 9-10% ThO_2), with a significant majority (8.59 Mt; 72%) found in the three eastern coastal states of Andhra Pradesh (3.72 Mt; 31%), Tamil Nadu (2.46 Mt; 21%) and Odisha (2.41 Mt; 20%). Both the IAEA and OECD appear to conclude that India may possess the largest share of world's thorium deposits.

Antipodes

The only land area antipodal to India is Easter Island, which is antipodal to the western corner of Rajasthan. The triangular island closely reflects the triangle between the cities of Mokal, Kuchchri, and Habur. Habur corresponds to Hanga Roa, and Mokal to the eastern cape.

Riverside cities in india

City	River	State
Agra	Yamuna	Uttar Pradesh
Ahmedabad	Sabarmati	Gujarat
Allahabad	Ganges	Uttar Pradesh
Ayodhya	Saryu	Uttar Pradesh
Badrinath	Alaknanda	Uttarakhand
Banki	Mahanadi	Odisha
Brahmapur	Rushikulya	Odisha
Chhatrapur	Rushikulya	Odisha
Bhagalpur	Ganges	Bihar
Kolkata	hugli	West Bengal
Cuttack	Mahanadi	Odisha
New Delhi	Yamuna	Delhi
Dibrugarh	Brahmaputra	Assam
Ferozpur	Sutlej	Punjab
Guwahati	Brahmaputra	Assam
Haridwar	Ganges	Uttarakhand
Hyderabad	Musi	Telangana
Jabalpur	Narmada	Madhya Pradesh
Kanpur	Ganges	Uttar Pradesh
Kota	Chambal	Rajasthan
Jaunpur	Gomti	Uttar Pradesh
Patna	Ganges	Bihar
Rajahmundry	Godavari	Andhra Pradesh

Srinagar	Jhelum	Jammu & Kashmir
Surat	Tapi	Gujarat
Tiruchirapalli	Kaveri	Tamil Nadu
Varanasi	Ganges	Uttar Pradesh
Vijayawada	Krishna	Andhra Pradesh
Vadodara	Vishwamitri	Gujarat
Mathura	Yamuna	Uttar Pradesh
Mirzapur	Ganga	Uttar Pradesh
Auraiya	Yamuna	Uttar Pradesh
Etawah	Yamuna	Uttar Pradesh
Bangalore	Vrishabhavathi	Karnataka
Farrukhabad	Ganges	Uttar Pradesh
Fatehgarh	Ganges	Uttar Pradesh
Kannauj	Ganges	Uttar Pradesh
Mangalore	Netravati, Gurupura	Karnataka
Shimoga	Tunga River	Karnataka
Bhadravathi	Bhadra	Karnataka
Hospet	Tungabhadra	Karnataka
Karwar	Kali	Karnataka
Bagalkot	Ghataprabha	Karnataka
Honnavar	Sharavathi	Karnataka
Gwalior	Chambal	Madhya Pradesh
Gorakhpur	Rapti	Uttar Pradesh
Lucknow	Gomti	Uttar Pradesh
Kanpur Cantonment	Ganges	Uttar Pradesh
Shuklaganj	Ganges	Uttar Pradesh
Chakeri	Ganges	Uttar Pradesh
Malegaon	Girna River	Maharashtra
Sambalpur	Mahanadi	Odisha
Rourkela	Brahmani	Odisha
Pune	Mula, Mutha	Maharashtra
Daman	Daman Ganga River	Daman
Madurai	Vaigai	Tamil Nadu
Thiruchirapalli	Kaveri	Tamil Nadu
Chennai	Cooum, Adyar	Tamil Nadu
Coimbatore	Noyyal	Tamil Nadu
Erode	Kaveri	Tamil Nadu
Tirunelveli	Thamirabarani	Tamil Nadu
Bharuch	Narmada	Gujarat
Karjat	Ulhas	Maharashtra
Nashik	Godavari	Maharashtra
Mahad	Savitri	Maharashtra
Nanded	Godavari	Maharashtra
Kolhapur	Panchaganga	Maharashtra
Nellore	Pennar	Andhra Pradesh

Nizamabad	Godavari	Telangana
Sangli	Krishna	Maharashtra
Karad	Krishna, Koyna	Maharashtra
Hajipur	Ganges	Bihar
Ujjain	Shipra	Madhya Pradesh

Indian national highways

NH No.	OSM Rel.	States	Length	Route
1	3194791	Jammu and Kashmir	535 km (332 mi)	(NH1A) Uri, Baramula, (NH1D) Srinagar, Kargil, Leh
2	3194847	Assam, Nagaland, Manipur, Mizoram	1,214 km (754 mi)	(NH37) NH15 near Dibrugarh, Sibsagar, (NH61) Jhanji, Amguri, Mokokchung, Wohka, (NH39) Kohima, (NH150) Imphal, Churachandpur, (NH54) Seling, Serchhip, Lawngtla, Tuipang
102	3207333	Manipur	107 km (66 mi)	(NH39) NH2 near Imphal, Moreh
202	3207789	Nagaland, Manipur	460 km (290 mi)	(NH155) NH2 near Mokokchung, Tuensang, Sampurre, Meluri, (NH150) Jessami, Ukhrul, NH2 near Imphal
302	3208481	Mizoram	10 km (6.2 mi)	(NH54A) NH2 near Therait, Lunglei
502	3208496	Mizoram	23 km (14 mi)	(NH54B) NH2 near Venus Saddle, Saiha
3	3195225	Uttar Pradesh, Rajasthan, Madhya Pradesh, Maharashtra	1,190 km (740 mi)	Agra, Dholpur, Morena, Gwalior, Shivpuri, Guna, Biaora, Maksi, Dewas, Indore, Julwania, Dhule, Nashik, Thane, Mumbai
103	3208959	Himachal Pradesh	58 km (36 mi)	(NH88) NH3 near Hamirpur, Bhota, Ghumarwain, NH154 near Ghaghas
303	3209917	Himachal Pradesh	60 km (37 mi)	(NH20A) NH154 near Nagrota, (NH88) Daulatur, Ranital, Jawalamukhi, NH3 near Nadaun
133		Jharkhand	200 km (120 mi)	Pirpainti, Godda, Deoghar
503	3209984	Himachal Pradesh	70 km (43 mi)	(NH88) NH154 near Mataur, Kangra, (NH20A) Ranital, Dera Gopipur, NH3 near Mubarakpur
703	3210116	Punjab	144 km (89 mi)	(NH71) NH44 near Jaland, Nakodar, Mahatpur, Moga, Badhni, NH7 near Barnala
4	3210218	Andaman & Nicobar	230 km (140 mi)	(NH223) Mayabandar, Port Blair, Chiriyatapu
5	3195290	Punjab, Chandigarh, Haryana, Himachal Pradesh	637 km (396 mi)	(NH95) Firozepur, Moga, Jagraon, Ludhiana, (NH21) Kharar, (NH22) Chandigarh, Kalka, Solan, Shimla, Theog, Narkanda, Rampur, Chini, Shipkila

105	3210467	Himachal Pradesh, Punjab, Haryana	67 km (42 mi)	(NH21A) NH5 near Pinjore, Baddi, Nalagarh, NH205 near Swarghat
205	3210477	Himachal Pradesh, Punjab	183 km (114 mi)	(NH21) Kharar Ropar, Swarghat, (NH88) Nauni, Darlaghat, NH5 near Shimla
6	3257907	Gujarat, Maharashtra, Chhattisgarh, Odisha, Jharkhand, West Bengal	1,873 km (1,164 mi)	Surat, Dhule, Jalgaon, Bhusaval, Akola, Amravati, Nagpur, Bhandara, Durg, Raipur, Mahasamund, Sambalpur, Kolkata
106	3258906	Meghalaya	82 km (51 mi)	(NH44E) Shillong, Nongstoin
206	3258935	Meghalaya	126 km (78 mi)	(NH40) Jowai, Dauki, Mylliem
306	3258947	Assam, Mizoram		(NH54) Kolasib, Silchar
7	3195344	Punjab, Chandigarh, Haryana, Himachal Pradesh, Uttarakhand	770 km (480 mi)	(NH10) Fazilka, (NH15) Abohar, Malaut, (NH64) Bathinda, Barnala, Sangrur, Patiala, Rajpura, (NH73) Panchkula, Raipur Rani, (NH72) Narayangarh, Dhanana, Ponta-Sahib, Dehradun, (NH58) Rishikesh, Devprayag, Rudraprayag, Karnaprayag, Chamoli, Badrinath, Mana
107	3210938	Uttarakhand	74 km (46 mi)	(NH109) Rudraprayag, Guptkashi Phata, Gaurikund
307	3210976	Uttarakhand, Uttar Pradesh	46 km (29 mi)	(NH72A) Dehradun, Mohand, Biharigarh, Chhutmalpur
507	3211487	Uttarakhand	109 km (68 mi)	(NH123) Harbatpur, Vikasnagar, Kalsi, Barkot
707	3211535	Himachal Pradesh, Uttarakhand	151 km (94 mi)	(NH72B) Paonta Sahib, Rajban, Shillai, Minas, Minus-Tiuni, Hatkoti
907	3211948	Himachal Pradesh, Uttarakhand, Haryana	60 km (37 mi)	(NH73A) Paonta Sahib, Darpur, Ledi, Mustafabad, Jagadhri, Yamuna Nagar
8	3211965	Assam, Tripura	371 km (231 mi)	(NH44) Karimganj, Patharkandi, Churaibari, Ambasa, Teliamura, Agartala, Udaipur, Sabrum Indo
108	3213212	Tripura, Mizoram		(NH44A) Namu, Mamit, Lengpui, Sairang, Aizawl
9	3196981	Punjab, Haryana, Delhi, Uttar Pradesh, Uttarakhand	811 km (504 mi)	(NH10) Malaut, Dabwali, Sirsa, Fatehabad, Hisar, Hansi, Rohtak, Bahadurgarh, (NH24) Delhi, Ghaziabad, Moradabad, (NH87) Rampur, Bilaspur, (NH74) Rudrapur, (NH125) Sitarganj Khatima, Tanakpur, Pithoragarh
109	3213787	Uttarakhand	284 km (176 mi)	(NH87) Rudrapur, Haldwani, Nainital, Bhowali, Almora, Ranikhet, Dwarahat, Chaukhutiya, Gairsaing, Aobadri, Karnaprayag
309	3214038	Uttarakhand, Uttar Pradesh	287 km (178 mi)	(NH74) Rudrapur, (NH121) Kashipur, Ramnagar, Dhumakot, Thalisain, Tripalisan, (NH119) Bubakhal, Pauri, Srinagar
509	3214363	Uttar Pradesh	239 km	(NH93) Moradabad, Chandausi, Babrala,

			(149 mi)	Aligarh, Agra
709	3214590	Haryana	68 km (42 mi)	(NH71A) Rohtak, Gohana, Panipat
10	3214598	Sikkim, West Bengal	174 km (108 mi)	(NH31) Siliguri, (NH31A) Sivok, Kalimpong, Gangtok, (NH310) border
110	3214645	West Bengal	76 km (47 mi)	(NH55) Siliguri, Karsiyang, Darjeeling
11	3187168	Rajasthan	495 km (308 mi)	(NH15) Jaisalmer, Pokaran, (NH11) Bikaner, Sri Dungargarh, Ratangarh, Fatehpur
325	3836269	Rajasthan	135 km (84 mi)	NH25 near Balotra, Siwana, Jalore, Ahore, Takhatgarh, NH14 near Sanderao
12	3214746	West Bengal	612 km (380 mi)	(NH34) Dalkola, Raiganj, Gajol, Maldah, Farakka, Morgram, Baharampur, Krishananagar, Ranaghat, Barasat, (NH117) Kolkata, Kakdwip, Bok-Khali
112	3214989	West Bengal	59 km (37 mi)	(NH35) Barasat, Gaighata, Bangaon, border
13	3215052	Arunachal Pradesh, Assam	1,150 km (710 mi)	(NH229) Tawang, Jang, Sela Lake, Baisakhi, Senge, Mohan Camp, Dirang, Dangsing, Bomdila, Tenga Valley, Kimi, Palizi, Seppa, Sagalee, Midpu, Hoz, Yazali, Ziro town, Daporijo, Bam, Along, Biru, Pangin, Pasighat (NH-52)
14	3216171	West Bengal	306 km (190 mi)	(NH60) Morgram, Rampur Hat, Siuri, Raniganj, (NH60A) Bankura, Garhbeta, Salbani, Kharagpur
114	3216499	West Bengal	109 km (68 mi)	(NH2B Ext) Mallarpur, Mayureswar, Prantik, (NH2B) Bolpur, Bhedia, Guskhara, Talit, Barddhaman
314	3216523	West Bengal	87 km (54 mi)	(NH60A) Bankura, Puruliya
15	3216908	Assam, Arunachal Pradesh	664 km (413 mi)	(NH52) Baihata-Charali, Mangaldai, Dhekiajui, Tezpur, Banderdeva, North Lakhimpur, (NH52B) Kulajan, (NH37) Dibrugarh, Tinsukia, (NH52) Rupai, Mahadevpur, Wakro
115	3217348	Assam	64 km (40 mi)	(NH37) Dum Duma, Saikhoaghat, Kundil Bazar, Roing
215	3217522	Assam		(NH52B) Mahadevpur, Namchik, Changlang, Khonsa, Kanubari, Dibrugarh
315	3217452	Assam	111 km (69 mi)	(NH153) Makum, Ledo, Lekhapani, border
415	3217523	Assam, Arunachal Pradesh	59 km (37 mi)	(NH52A) Ghopur, Itanagar, Daimukh, Banderdeva
515	3217636	Assam, Arunachal Pradesh	111 km (69 mi)	(NH52) Kulajan, Jonai, Pasighat
715	3217671	Assam	197 km (122 mi)	(NH37A) Tejpur, (NH37) Kaliabor, Jakhalabandha, Bokakhat, Jorhat, Jhanji

16	3198047	West Bengal, Odisha, Andhra Pradesh, Tamil Nadu	1,659 km (1,031 mi)	(NH6) Kolkata, (NH60) Kharagpur, (NH16) Baleshwar, Cuttack, Bhubaneshwar, Vishakhapatnam, Vijayawada, Nellore, Chennai
116	3218639	West Bengal	52 km (32 mi)	(NH41) Kolaghat, Haldia Port
216	3218647	Andhra Pradesh	397 km (247 mi)	(NH214) Kathipudi, Kakinada, (NH214A) Machilipatnam, Ongole
316	3281634	Odisha		(NH203) NH16 near Bhubaneshwar, Puri-Konark, (NH203A) Puri-Satpada
516	3282556	Odisha	8.3 km (5.2 mi)	(NH217) NH16 near Narendrapur-Gopalpur
716	3219078	Andhra Pradesh, Tamil Nadu	147 km (91 mi)	(NH205) Chennai, Tiruttani, Renigunta
17	3219773	West Bengal, Assam	477 km (296 mi)	(NH31) NH10 near Sivok, Bagrakot, (NH31C) Chalsa, Nagarkata, (NH31) Goyerkata, Bispara, Falakata, Sonarpur, Koch-Bihar, Tufanganj, Golakganj, Bilasipara, (NH31B) North Salmara, (NH37) Goalpara, Boko, NH27 near Guwahati
117	3219792	Assam	14 km (8.7 mi)	(NH31) NH17 near North Salmara, NH27 near Bijni
217	3219799	Assam, Meghalaya	307 km (191 mi)	(NH51) NH17 near Paikan, Tura, (NH62) Dalu, Baghmara, Rongjeng Damra, NH17 near Dudhnai
317	3220294	West Bengal	67 km (42 mi)	(NH31C) NH17 near Birpara, Madari Hat, Rajabaht Khawa, NH27 near Salsabari
517		West Bengal		NH17 near Goyerkata, NH27 near Dhupgari
717	3259562	West Bengal	41 km (25 mi)	NH17 near Chalsa, NH27 near Mainaguri
18	3220404	Jharkhand, West Bengal, Odisha	359 km (223 mi)	(NH32) NH19 near Govindpur, Dhanbad, Puruliya, Balarampur, (NH33) Chandil, Ghatshila, (NH6) Baharagora, (NH5) junction with NH49, Baripada, Betnoti, NH16 near Baleshwar
118	3291021	Jharkhand	5 km (3.1 mi)	NH18 near Asanbani, Jamshedpur
19	3198928	Delhi, Haryana, Uttar Pradesh, Bihar, Jharkhand, West Bengal	1,435 km (892 mi)	(NH2) Delhi, Mathura, Agra, Kanpur, Allahabad, Varanasi, Mohania, Aurangabad, Dobhi, Barhi, Bagadar, Gobindpur, Asansol, Palsit, Kolkata
119	3220719	Bihar	75 km (47 mi)	(NH2C) NH19 near Dehri, Jadunathpur border
319	3220892	Bihar	117 km (73 mi)	(NH30) NH19 near Mohania, Dinara, Charpokhari, NH922 near Ara
519	3220940	Uttar Pradesh	28 km (17 mi)	(NH2A) NH19 near Sikandara, NH27 near Bhognipur

719	3220992	Uttar Pradesh, Madhya Pradesh	124 km (77 mi)	(NH92) NH19 near Etawah, Bhind, NH44 near Gwalior
919	3221023	Haryana, Madhya Pradesh	74 km (46 mi)	(NH71B) NH19 near Palwal, Sohna, Dharuhera, NH352 near Rewari
20	3222093	Bihar, Jharkhand, Odisha	658 km (409 mi)	(NH31) NH31 near Bakhtiyarpur, Bihar Sharif, Nawada, Rajauli, Kodarma, (NH33) Barhi, Hazaribag, (NH75) Ranchi, Khunti, Murhu, Chakradharpur, Chaibasa, Jaintgarh, Parsora, (NH215) Kendujhargarh, NH16 near Panikholi
120	3222301	Bihar	92 km (57 mi)	(NH82) NH20 near Bihar Sharif, Nalanda, Rajgir, Hisua, NH22 near Gaya
320	3222553	Jharkhand	86 km (53 mi)	(NH23) NH20 near Ramgarh, Gola, NH18 near Chas
520	3222572	Odisha	105 km (65 mi)	(NH125) Parsora, NH143 near Rajamundra
21	3189802	Rajasthan, Uttar Pradesh	262 km (163 mi)	(NH11) Jaipur, Dausa, Bharatpur, Agra
22	3222675	Bihar, Jharkhand	416 km (258 mi)	(NH77) border near Sonbarsa, Sitamarhi, Muzaffarpur, (NH19) Hajipur, (NH83) Patna, Punpun, Gaya, Bodh Gaya, (NH99) Dobhi, Hunterganj, Chatra, NH39 near Chandwa
122	3222808	Bihar	101 km (63 mi)	(NH28) NH22 near Muzaffarpur, Dholi, Mushrigharari, NH31 near Barauni
322	3222817	Bihar	58 km (36 mi)	(NH103) NH22 near Hazipur, NH122 near Mushrigharari
522	3223144	Jharkhand	119 km (74 mi)	(NH100) NH22 near Chatra, Hazaribagh, NH19 near Bagodar
722	3223177	Bihar	74 km (46 mi)	(NH102) NH22 near Muzaffarpur, Rewaghat, NH31 near Chhapra
922	3223201	Uttar Pradesh, Bihar	140 km (87 mi)	(NH30) NH22 near Patna, (NH84) Ara, Bhojpur, Buxar
23	3189804	Rajasthan	222 km (138 mi)	(NH11A) Kothum, (NH11B) Lalsot, Karauli, Bari, Dhaulpur
24	3223253	Uttar Pradesh	293 km (182 mi)	(NH29) Sonauli (border), Pharenda, Gorakhpur, (NH97) Ghazipur, Zamania, NH19 near Saiyad Raja
25	3189720	Rajasthan	353 km (219 mi)	(NH112) Barmer, Kawas, Madhasar, Dhudhwa, Bagundi, Tilwara, Balotra, Pachpadra, Kalyanpur, Jodhpur, Kaparda, Bilara, Jaitaran, (NH14) Bar, Beawar
125	3189827	Rajasthan	168 km (104 mi)	(NH114) Jodhpur, Balesar, Dechu, Pokaran
26	3223309	Odisha, Andhra Pradesh	526 km (327 mi)	(NH201) NH53 near Bargarh, Barapali, Balangir, Bhawanipatna, (NH43) Boriguma, Koraput, Salur, Vizianagaram, NH16 near Natavalsa
27	3188931	Gujarat, Rajasthan,	3,507 km	(NH112) Porbandar, (NH8A) Bamanbore,

		Madhya Pradesh, Uttar Pradesh, Bihar, West Bengal, Assam (Part of Meghalaya)	(2,179 mi)	Morvi, (NH15) Samakhiali, (NH14) Radhanpur, Palanpur, (NH76) Pindwara, Udaipur, Mangarwar, Chittaurgarh, Kota, Baran, Shivpuri, Ganj, (NH25) Jhansi, (NH128) Kanpur, Lucknow, (NH28) Faizabad, Gorakhpur, Gopalganj, Pipra, Kothi, (NH57) Muzaffarpur, Darbhanga, Forbesganj, Araria, (NH31) Purnia, Dalkola, Islampur, (NH31D) Shiliguri, Jalaiguri, (NH31) Mainaguri, Dhupgar, Falakata, (NH31D) Sonapur, (NH31C) Salsaguri, (NH31) Bongaigaon, Bijni, Patacharkuchi, Nalbari, (NH37) Guwahati, Dishpur, (NH36) Nagaon, (NH54) Dobaka, Lumding, Haflong, Silchar
127	3224406	Assam	42 km (26 mi)	(NH37) NH27 near Nagaon, Samaguri, NH715 near Jakhalabandha
127A	3281526	Assam	38 km (24 mi)	(NH152) Pathsala, border
227	3224496	Bihar	214 km (133 mi)	(NH104) NH27 near Chakia, Narhar, Pakri Bridge, Madhuban, Shivhar, Sitamarhi, Harlakhi, Umgaon, Jaynagar, Laukaha, Laukahi, NH27 near Narahia
327	3224653	West Bengal	32 km (20 mi)	(NH31C) NH27 near Bagdogra, Naksal Bari, Galgalia
527	3224706	Bihar	14 km (8.7 mi)	(NH57A) NH27 near Forbesganj, Jogbani
527B	3224711	Bihar	54 km (34 mi)	(NH105) NH27 near Darbhanga, Aunsi, NH227 near Jaynagar
527D	3224720	Bihar	69 km (43 mi)	(NH28A) NH27 near Piprakothi, Sagauli, Raxaul, border
727	3224736	Uttar Pradesh, Bihar	169 km (105 mi)	(NH28B) NH27 near Kushinagar, Chhitanuni bridge, Bagaha, Lauriya, Bettiah, NH527D near Chhapwa
927	3224750	Uttar Pradesh	152 km (94 mi)	(NH28C) NH27 near Barabanki, Baharaich, Nepalganj , border
28	3225118	Uttar Pradesh	305 km (190 mi)	(NH233) border, Naugarh, Sidarth Nagar, Bansi, Basti Tanda, (SH73) Azamgarh, NH31 near Varanasi
28A		Bihar	68 km (42 mi)	(NH28) Pipra, Motihari, Raxaul
28B		Bihar, Uttar Pradesh	150 km (93 mi)	Chapwa, Kushinagar
128	3225139	Uttar Pradesh	164 km (102 mi)	(NH232) NH28 near Tanda Ambedkar Nagar, Sultanpur, Amethi, NH30 near Rae Bareli
29	3225538	Assam, Nagaland	320 km (200 mi)	(NH36) NH27 near Dabaka , Amlakhi, (NH39) Dimapur, (NH150) Kohima Chizam, NH202 near Jessami

129	3225875	Assam, Nagaland	105 km (65 mi)	(NH39) NH29 near Dimapur, Bokajan, Golaghat, NH715 near Numaligarh
30	3225905	Uttarakhand, Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Telangana, Andhra Pradesh	2,010 km (1,250 mi)	(NH74) NH9 near Sitarganj, Pilibhit, (NH24) Bareilly, Shahjahanpur, Sitapur, (NH24B) Lucknow, (NH231) Raebareli, (NH96) Pratapgarh, (NH27) Allahabad, Mangawan, (NH7) Rewa, Katni, (NH12A) Jabalpur, Mandla, Chilpi, (NH200) Simga, (NH43) Raipur, Dhamtari, Keskal, (NH221) Jagdalpur, Konta, Nellipaka, Bhadrachalam, Paloncha, Kottagudam, Tiravuru, Mailavaram, NH65 near Kondapalle
130	3226218	Chhattisgarh	291 km (181 mi)	(NH200) NH30 near Simga, (NH111) Bilaspur, Kathgora, NH43 near Ambikapur
330	3226243	Uttar Pradesh	103 km (64 mi)	(NH96) NH30 near Allahabad, Pratapgarh, Sultanpur, NH27 near Faizabad
530	3226393	Uttar Pradesh	66 km (41 mi)	(NH24) NH30 near Bareily, NH9 near Rampur
230	3266623	Uttar Pradesh	17 km (11 mi)	(NH24A) NH30 near Bakshi-ka-Talab, Chenhat, junction with NH27 / NH731 / NH30 / NH27, NH30 near Bakshi-ka-Talab
31	3226439	Uttar Pradesh, Bihar, West Bengal	968 km (601 mi)	(NH232A) NH27 near Unnao, (NH232) Lalganj, (NH231) Raebareli, Salon, Pratapgarh, Machhlishahr, (NH56) Jaunpur, (NH29) Varanasi, (NH19) Ghazipur, Ballia, Chhapra, (NH30) Hajipur, (NH31) Bakhtiyarpur, Mokama, Begusarai, Khagari, Bihpur, Kora, Katihar, Harishchanderpur, NH12 near Pandua
131	3259618	Bihar	132 km (82 mi)	(NH106) NH31 near Bihpur, Kishanganj, Madhepura, Birpur, border
231	3226776	Bihar	196 km (122 mi)	(NH107) NH31 near Maheshkund, Sonbarsa Raj, Simri Bakhtiyarpur, Saharsa, Madhepura, Sarsi, (NH31) Purnia, NH31 near Kora
331	3227144	Bihar	65 km (40 mi)	(NH101) NH31 near Chhapra, Baniapur, NH27 near Muhumadpur
431	3227188	Bihar	70 km (43 mi)	(NH30A) NH31 near Phatuha, Chandi, Harnaut, NH31 near Barh
531	3227193	Bihar	93 km (58 mi)	(NH85) NH31 near Chhapra, Siwan, NH27 near Gopalganj
731	3227200	Uttar Pradesh	221 km (137 mi)	(NH56) NH31 near Jaunpur, Sultanpur, NH27 near Lucknow
32	3227344	Tamil Nadu, Puducherry	314 km (195 mi)	(NH45) NH48 near Chennai, Chengalpattu, (NH66) Tindivanam, (NH45A) Puducherry, Cuddalore, Chidambaram, Karaikal, NH83 near Nagapattinam
132	3227797	Tamil Nadu	37 km	(NH45) NH32 near Tindivanam, NH38 near

			(23 mi)	Viluppuram
332	3227811	Tamil Nadu, Puducherry	38 km (24 mi)	(NH45A) NH32 near Puducherry, NH38 near Viluppuram
33	3228059	Bihar, West Bengal	443 km (275 mi)	(NH110) NH139 near Arwal, Jahanabad, Bandhuganj, Ekangarsarai, (NH82) Biharsharif, (NH80) Mokama, Luckeesarai, Munger, Bhagalpur, Kahalgaon, Sahibganj, Rajmahal, Barharwa, NH12 near Farakka
34	3228564	Uttarakhand, Uttar Pradesh , Madhya Pradesh	1,426 km (886 mi)	(NH108) Gangotri Dham, Bhatwari, Uttarkashi, (NH94) Dharasu, nearTerhi]], Ampata, (NH58) Rishikesh, (NH74) Haridwar, (NH119) Najibabad, Bijnore, (NH58) Meerut, (NH91) Ghaziabad, Bulandshahr, Aligarh, Etah, Kannauj, (NH86) Kanpur, Hamirpur, Mahoba, Chattarpur, (NH12A) Hirapur, Damoh, (NH7) Jabalpur, NH44 near Lakhnadon
134	3228717	Uttarakhand	94 km (58 mi)	(NH94) NH34 near Dharasu, Kuthnaur, Yamnotri
334	3228724	Uttarakhand, Uttar Pradesh	207 km (129 mi)	(NH58) NH34 near Haridwar, Roorkee, Muzaffarnagar, (NH235) Meerut, Hapur, NH34 near Bulandshar
534	3228946	Uttarakhand, Uttar Pradesh	151 km (94 mi)	(NH119) NH34 near Najibabad, Kotdwar, Satpauli, Bubakhal
734	3228969	Uttar Pradesh, Uttarakhand	108 km (67 mi)	(NH74) NH34 near Najibabad, Nagina, NH309 near Kashipur
934	3229083	Madhya Pradesh	156 km (97 mi)	(NH86) NH34 near Hirapur, Banda, (NH26A) Sagar, Jeruwakhera, Khurai, Bina
234	3229153	Uttar Pradesh	156 km (97 mi)	(NH91A) NH34 near Kannauj, Bela, (NH92) Etawah, Kishni, NH34 near Bhongaon
35	3229508	Uttar Pradesh	346 km (215 mi)	(NH76) NH34 near KaBrai, Banda, Karwi, Mau, Allahabad, (NH7) Mirzapur, NH19 near Varanasi
135	3229736	Madhya Pradesh, Uttar Pradesh	130 km (81 mi)	(NH7) NH35 near Mirzapur, Lalganj, Drummondganj, Mauganj, NH30 near Mangawan
335	3229784	Madhya Pradesh, Uttar Pradesh	110 km (68 mi)	(NH232) NH35 near Banda, Fathepur, NH31 near Lalganj
36	3229793	Tamil Nadu	334 km (208 mi)	(NH45C) NH132 near Vikravandi, Panruti, Neyveli, Sethiathope, Kumbakonam, (NH226) Thanjavur, Gandarvakottai, (NH210) Pudukottai, (NH226) Thirumayam, Kilasevalpatti, Tirupattur, Madagupatti, Sivagangai, NH87 near Manamadurai
136	3230497	Tamil Nadu	68 km (42 mi)	(NH226) NH36 near Thanjavur, Thiruvaiyaru, Kunnam, Perali, NH38 near Perambalur
336	3230541	Tamil Nadu	52 km	(NH210) NH36 near Pudukkottai, Kiranur,

			(32 mi)	NH83 near Tiruchirappalli
536	3230701	Tamil Nadu	109 km (68 mi)	(NH210) NH36 near Thirumayam, Devakottai, Tiruvadanai, NH87 near Ramanathapuram
37	3230787	Assam, Manipur	313 km (194 mi)	(NH53) NH2 near Imphal, Jiribam, Jirighat, Lakhipur, Silchar, (NH44) Badarpur, Karimganj, border
38	3231116	Tamil Nadu	604 km (375 mi)	(NH234) NH75 near Vellore, Polur, Tiruvannamalai, (NH45) Viluppuram, Ulundurpettai, Perambalur, (NH45B) Tiruchirappalli, Melur, Madurai, Aruppukkottai, NH138 near Tuticorin Port
138	3231953	Tamil Nadu	54 km (34 mi)	(NH7A) NH38 near Tuticorin Port, NH44 near Palayamkottai
39	3233217	Madhya Pradesh, Uttar Pradesh, Jharkhand	869 km (540 mi)	(NH75) NH44 near Jhansi, Chhatarpur, Khajuraho, Panna, Satna, Rewa, Sidhi, Dudhinagar, Garhwa, Daltenganj, Latehar, Chandwa, NH20 near Ranchi
139	3234465	Bihar, Jharkhand	236 km (147 mi)	(NH98) NH39 near Rajhara, Chhatarpur, Hariharganj, Aurangabad, Daudnagar, Arwal, Naubatpur, NH31 near Patna
339	3290989	Madhya Pradesh, Uttar Pradesh	34 km (21 mi)	NH39 near Nowgong, NH34 near Srinagar
539	3234483	Madhya Pradesh	173 km (107 mi)	(NH12A) NH39 near Jhansi, Pirthipur, Tikamgarh, NH934 near Shahgarh
40	3234491	Andhra Pradesh	420 km (260 mi)	(NH18) NH44 near Kurnool, Nandyal, Cuddapah, Pileru, Putalapattu, Chittoor, NH48 near Ranipettai
140	3234929	Andhra Pradesh	0 km (0 mi)	NH40 near Putalpattu, NH71 near Tirupati
41	3234951	Gujarat	290 km (180 mi)	(NH8A) NH41 near Samakhiyali, Gandhidham, Mandvi, Naliya, Narayan Sarovar
141	3234961	Gujarat	31 km (19 mi)	(NH8A) NH41 near Gandhidham, Kandla Port
42	3234973	Karnataka, Andhra Pradesh, Tamil Nadu	337 km (209 mi)	(NH205) NH44 near Anantapur, Kadiri, (NH219) Madanapalli, Kuppam, NH44 near Krishnagiri
43	3235103	Madhya Pradesh, Chhattisgarh, Jharkhand	806 km (501 mi)	(NH78) NH30 near Katni, Umaria, Shahdol, Nagar, Ambikapur, Pathalgaon, Jashpurnagar, Chhattisgarh, (NH23) Gumla, (NH33) Ranchi, NH18 near Chandil
143	3235599	Jharkhand, Odisha	247 km (153 mi)	(NH23) NH43 near Gumla, Palkot, Kolebira, Thethaitanagar, Jharkhand, Panposh, Rajamundra, NH49 near Barakot
44	3189954	Jammu and Kashmir, Himachal Pradesh, Punjab, Haryana, Delhi, Uttar Pradesh, Madhya	3,745 km (2,327 mi)	(NH1A) Srinagar, Jammu, Pathankot, (NH1) Jalandar, Ludhiana, Ambala, Karnal, Panipat, (NH2) Delhi, Faridabad, Mathura, (NH3) Agra, (NH75) Gwalior, (NH26) Jhansi, (NH7)

		Pradesh, Maharashtra, Telangana, Andhra Pradesh, Karnataka, Tamil Nadu		Lakhnadon, Nagpur, Adilabad, Hyderabad, Kurnool, Bengaluru, Salem, Madurai, Kanyakumari
244	3239209	Jammu and Kashmir	246 km (153 mi)	(NH1B) NH44 near Khanabal, Symthanpass, Kishtwar, Doda, NH44 near Batote
144	3239340	Jammu and Kashmir	15 km (9.3 mi)	(NH1C) NH44 near Domel, Katra
344	3239360	Punjab, Haryana, Uttarakhand	173 km (107 mi)	(NH72) NH44 near Ambala, (NH73) Dhanana, Saha, Yamunanagar, Saharanpur, NH334 near Roorkee
544	3239550	Kerala, Tamil Nadu	332 km (206 mi)	(NH47) NH44 near Salem, Coimbatore, Palakkad, Thrissur, NH66 near Ernakulum
744	3239789	Kerala, Tamil Nadu	232 km (144 mi)	(NH208) NH44 near Tirumangalum, Srivilliputtur, Rajapalaiyam, Tenkasi, Puliyur, Punalur, Kottarakara, NH66 near Kollam
944	3240283	Tamil Nadu	23 km (14 mi)	(NH47B) NH44 near Kavalkinaru, Aralvaymozhi, NH66 near Nagercoil
45	3248199	Madhya Pradesh	280 km (170 mi)	(NH12) NH46 near Obaidullaganj, Bareli, Tendukheda, NH30 near Jabalpur
46	3248209	Madhya Pradesh	604 km (375 mi)	(NH3) NH44 near Gwalior, Shivpuri, Guna, (NH12) Biora, Bhopal, (NH69) Obeddullaganj, Hoshangabad, NH47 near Betul
146	3248220	Madhya Pradesh	188 km (117 mi)	(NH86) NH46 near Bhopal, Vidisha, NH44 near Sagar
47	3248235	Gujarat, Madhya Pradesh, Maharashtra	1,080 km (670 mi)	(NH8A) NH27 near Bamanbore, Limbdi, (NH59) Ahmedabad, Godhra, Dahod, (NH59A) Indore, (NH69) Betul, Saoner, NH44 near Nagpur
147	3248297	Gujarat	50 km (31 mi)	(NH8C) NH47 near Sakhej, Gandhinagar, NH48 near Chilloda
48	3188469	Delhi, Haryana, Rajasthan, Gujarat, Maharashtra, Karnataka, Tamil Nadu	2,807 km (1,744 mi)	(NH8) Delhi, Bawal, Kotpuli, Jaipur, (NH79A) Kishangarh, (NH79) Nasirabad, (NH76) Chittorgarh, (NH8) Udaipur, Ahmedabad, Vadodara, Ankleshwar, (NH3) Mumbai, (NH4) Thane, Pune, Satara, Kolhapur, Belgam, Chitradurga, (NH7) Bengaluru, (NH46) Krishnagiri, (NH4) Vellore, Chennai
148	3189844	Rajasthan	105 km (65 mi)	(NH11A) NH48 near Manoharpur, Dausa, NH23 near Lalsot
248	3240893	Rajasthan	53 km (33 mi)	(NH11C) NH8 through Jaipur from km220 to km 273.50
348	3240902	Maharashtra	28 km (17 mi)	(NH4B) NH48 near Palspe, Jawaharlal Nehru Port
448	3240909	Rajasthan	57 km (35 mi)	(NH8) NH48 near Kishangarh, (NH79) Ajmer, NH48 near Nasirabad
548	3240924	Maharashtra	5 km	NH66 near Kalamboi, NH348 at km 16.687

			(3.1 mi)	
648	3240937	Karnataka, Tamil Nadu	143 km (89 mi)	(NH207) NH48 near Nelamangla, Dodaballapur, Devanahalli (NH44) , Sarajpur, Bagalur, NH48 near Hosur
748	3240977	Karnataka, Goa	160 km (99 mi)	(NH4A) NH48 near Belgaum, Anmod, Ponda, NH66 near Panaji
948	3241154	Karnataka, Tamil Nadu	317 km (197 mi)	(NH209) NH48 near Bengaluru, Kanakapura, Malvalli, Kollagal, Chamarajnagar, NH544 near Coimbatore
49	3241993	Chhattishgarh, Odisha, Jharkhand, West Bengal	706 km (439 mi)	(NH200) NH130 near Bilaspur, Pamgarh, Raigarh, Kanaktora, Jharsuguda, Kuchinda, Pravasuni, (NH6) Deogarh, Barakot, Palalaharba, KenduJhargarh, Bangriposchi, Baharagora, NH16 near Kharagpur
149	3287546	Odisha		(NH23) NH49 near Palalaharha, Talcher, NH55 near Nuahata
50	3242033	Karnataka	544 km (338 mi)	(NH218) NH65 near Homanabad, Gulbarga, Jevargi, (NH13) Bijapur, Hospet, NH48 near Lakshraisagara
150	3461026	Karnataka	137 km (85 mi)	NH50 near Gulbarga, Yadagiri, NH167 near Devasuguru
150A	3790917	Karnataka	618 km (384 mi)	[[N50 near Jewargi, Siruguppa, Bellary, Hiriyur, Chikkanayakanahalli, Nagamangala, Srirangapatna, Mysore, Nanjangud, NH-948 near Chamarajnagar
150E	3790976	Karnataka, Maharashtra	105 km (65 mi)	NH-50 near Gulbarga, Chowdapur, Afzalpur, NH-52 near Solapur
51	3242613	Gujarat	522 km (324 mi)	(NH8E) Dwarka, Bhogat, Porbandar, Navibander, Shil, Mangrol, Somnath, Kodinar, Una, Mahuva, Talaja, Bhavnagar
151	3242849	Gujarat	99 km (62 mi)	(NH8D) NH51 near Gadu, [[Vanthali Junagadh, NH27 near Jetpur
52	3188321	Punjab, Haryana, Rajasthan, Madhya Pradesh, Maharashtra, Karnataka	2,317 km (1,440 mi)	(NH71) Sangrur, (NH65) Narwana, Hisar, (NH11) Fatehpur, (NH12) Jaipur, tonk]], Kota, Aklera, Rajgarh, (NH3) Biora, Dewas, Indore, Sendhwa, (NH211) Dhule, Aurangabad, Beed, Osmanabad, (NH13) Solapur, (NH218) Bijapur, (NH63) Hubli, Ankola
152	3244074	Haryana	155 km (96 mi)	(NH65) NH52 near Narwana, Kaithal, (NH22) Ambala, NH7 near Panchkula
352	3244097	Haryana	218 km (135 mi)	(NH71) NH52 near Narwana, Jind, Rohtak, Jhajjar, Rewari, NH48 near Bawal
552	3189847	Rajasthan	75 km (47 mi)	(NH116) NH52 near Tonk, Uniara, Sawai Madhopur
752	3189852	Rajasthan	92 km (57 mi)	(NH90) Aklera], Baran
53	3245213	Gujarat, Maharashtra,	1,781 km	(NH6) Hajira, Surat, Uchchhal, Dhule, Jalgaon,

		Chhattisgarh, Odisha	(1,107 mi)	Akola, Amravati, Nagpur, Bhandara, Deori, Rajnandgaon, Durg, Raipur, Arang, Saraipali, Bargarh, Sambalpur, (NH200) Deograh, Dubri, Chandhikhol, (NH5A) Haridaspur, Paradip Port
153	3246845	Chhattisgarh	39 km (24 mi)	(NH216) NH53 near Saraipali, NH49 near Sarangarh
353	3246854	Chhattisgarh, Odisha	146 km (91 mi)	(NH217) NH53 near Ghorai, Mahasamund, Bagbahra, Nauparha, NH59 near Khariar
54	3209621	Punjab	340 km (210 mi)	(NH15) Panthankot, Gurdaspur, Amritsar, Zira, Faridkot, (NH64) Bathinda, Bikaner, Sikar, near NH8 Jaipur
154	3209668	Punjab, Himachal Pradesh	279 km (173 mi)	(NH20) NH54 near Pathankot, Nurpur, Palampur, Jogindarnagar, (NH21) Mandi, Sundar Nagar, Ghaghas, Bilaspur, NH205 near Nauni
55	3247298	Odisha	264 km (164 mi)	(NH42) NH53 near Sambalpur, Redhakhol, Angul, Nuahata, Dhenkanal, NH16 near Cuttack
56	3247318	Rajasthan, Madhya Pradesh, Gujarat	290 km (180 mi)	(NH79) NH27 near Chittaurgarh, (NH113) Nimbahera, Pratapgarh, Banswara, Jhalod, Umbi, NH47 near Dahod
156	3247350	Rajasthan, Madhya Pradesh	10 km (6.2 mi)	(NH79) NH56 near Nimbahera, Border to MP
57	3247355	Odisha	297 km (185 mi)	(NH224) NH26 near Balangir, Sonapur, Bauda, Dashapalla, Nayagarh, NH16 near Khordha
58	3189779	Rajasthan	620 km (390 mi)	(NH65) Fatehpur,Ladnun]], (NH89) Nagaur, Merta, (NH8) Ajmer, Bayawar, Devgarh, Udaipur
59	3247434	Odisha	352 km (219 mi)	(NH217) NH353 near Khariar, Titlagrah, Lankagarh, Baligurha, Surada, Asika, NH16 near Brahmapur
60	3247531	Maharashtra	395 km (245 mi)	(NH3) NH53 near Dhule, (NH50) Nashik, Sangammer, Ale, NH48 near Pune
160	3248693	Maharashtra	149 km (93 mi)	(NH3) NH60 near Nasik, NH48 near Thane
61	3248429	Maharashtra, Telangana	652 km (405 mi)	(NH222) NH160 near Bhiwandi, Kalyan, Murbad, Ale, Ahmadnagar, Tisgaon, Pathardi, Yeli, Kharwandi, Padalshingi, Majalgaon, Parbhani, Nanded, Bhokar, NH44 near Nirmal
62	3188295	Punjan, Rajasthan	748 km (465 mi)	(NH15) Abohar, Ganganagar, Suratgarh, Lunkaransar, (NH89) Bikaner, (NH65) Nagaur, Jodhpur, (NH14) Pali, Sirohi, Pindwara
162	3189874	Rajasthan	89 km (55 mi)	(NH14) Pali, Bar
63	3249230	Telangana, Maharashtra, Chhattisgarh, Odisha	560 km (350 mi)	(NH16) Nizamabad, Metpalli, Mancheral, Chinnur, Kotapad, NH26 near Boriguma

163	3249370	Telangana, Chhattisgarh	344 km (214 mi)	(NH202) NH63 near Bhopalpatnam, Venkatapuram, Warangal, NH44 near Hyderabad
64	3250238	Gujarat	332 km (206 mi)	(NH8) NH48 near Ahmedabad, (NH228) Anand, Dandi
65	3250367	Maharashtra, Karnataka, Telangana, Andhra Pradesh	926 km (575 mi)	(NH9) NH48 near Pune, Indapur, Solapur, Umarga, Homnabad, Hyderabad, Suryapet, Vijayawada, Vuyyuru, Pamarru, NH216 near Machilipatnam
165	3251439	Andhra Pradesh	107 km (66 mi)	(NH214) NH65 near Pamarru, Mandavalli, Pallevada, Digamarru, NH216 near Narsapur
66	3251490	Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu	1,593 km (990 mi)	(NH17) NH48 near Panvel, Indapur, Mahad, Rajapur, Kudal, Panaji, Margao, Karwar, Honavar, Udupi, Mangalore, Kasaragod, Kannur, Kozhikode, Ponnani, Guruvayoor, Edappalli, (NH47) Ernakulam, Alappuzha, Kollam, Thiruvananthapuram, NH44 near Kanyakumari
166	3251991	Maharashtra	149 km (93 mi)	(NH204) Ratnagiri, Tink, Pali, NH48 near Kolhapur
366	3252270	Goa	10 km (6.2 mi)	(NH17A) NH66 near Cortalim, Vasco, Marmagao Port
566	3252296	Goa	12.2 km (7.6 mi)	(NH17B) NH748 near Ponda, Verna, NH366 near Vasco
766	3252308	Kerala, Karnataka	268 km (167 mi)	(NH212) NH66 near Kozikode, Kalpetta, Gundlulpet, Mysore, NH948 near Kollegal
966	3252912	Kerala	122 km (76 mi)	(NH213) NH66 near Ferokh, NH544 near Palakkad
966A	3252940	Kerala	15 km (9.3 mi)	(NH47C) NH544 near Kalamassery, NH66 Vallarpadam, Ernakulam
966B	3464512	Kerala	8 km (5.0 mi)	(NH47A) NH66]], Wellington Island near Kochi, Ernakulam
67	3253003	Karnataka, Andhra Pradesh	300 km (190 mi)	(NH63) NH48 near Hubli, Gadag, Koppal, Hosepet, Bellary, NH44 near Gooty
167	3461042	Karnataka, Telangana	264 km (164 mi)	NH67 near Bellary, Raichur, Makhtal, NH44 near Badepalli
367	3791072	Karnataka	157 km (98 mi)	NH67 near Bhanapur, Kukunur, Yelburga, Gajendragad, Badami, Guledagudda, Bagalkot,NH52 near Gadankeri
68	3188307	Rajasthan, Gujarat	429 km (267 mi)	(NH15) Jaisalmer, Barmer, Sanchor, Tharad, Bhabhar, Radhanpur
69	3253743	Karnataka, Andhra Pradesh	625 km (388 mi)	(NH206) NH66 near Honnavar, Shimoga, (NH234) Banavar, Hulyar, Sira, Madhugiri, Chintamani, (NH4) Mulbagal, Palmaner, NH40 near Chittor
169	3254973	Karnataka	215 km (134 mi)	(NH13) NH69 near Shimoga, Tirthahalli, Koppa, Karkal, NH66 near Mangalore

169A	3791187	Karnataka	87 km (54 mi)	NH-169 near Thirthahalli, Agumbe, Hebri, NH-66 near Udupi
369	3255290	Karnataka	105 km (65 mi)	(NH13) NH69 near Shimoga, Channagiri, Holalkere, NH48 near Chitradurga
71	3255313	Andhra Pradesh	108 km (67 mi)	(NH205) NH42 near Madanpalli, Pileru-Tirupati, NH716 near Renigunta
73	3255381	Karnataka	316 km (196 mi)	(NH234) NH66 near Mangaluru, (NH206) Banavara, Arsikere, NH48 near Tumkur
173	3791221	Karnataka	72 km (45 mi)	NH73 near Mudigere, Chikmagalur, NH69 near Kadur
75	3255606	Karnataka, Tamil Nadu	533 km (331 mi)	(NH48) NH73 near Bantval, Hassan, (NH4) Nelamangala, Bengaluru, Kolar, (NH234) Mulbagal, Venkatagirikota, Pernampet, Gudiyattam, Katpadi, NH48 near Vellore
275	3791268	Karnataka	367 km (228 mi)	NH-75 near Bantwal, Puttur, Sullia, Madikeri, Kushalanagar, Bylakuppe, Hunsur, Mysore, Srirangapatna, Mandya, Ramanagaram, NH75 near Bangalore
77	3255919	Tamil Nadu	177 km (110 mi)	(NH66) NH48 near Krishnagiri, Uttangarai, Tiruvannamalai, Gingee, NH32 near Tindivanam
79	3256003	Tamil Nadu	137 km (85 mi)	(NH68) NH44 near Salem, Attur, NH38 near Ulundurpettai
81	3256061	Tamil Nadu	340 km (210 mi)	(NH67) NH544 near Coimbatore, Palladam, Karur, (NH227) Tiruchirappalli, Lalgudi, Gangaikondacholapuram, Kattumannarkoil, NH32 near Chidambaram
181	3256768	Karnataka, Tamil Nadu	211 km (131 mi)	(NH67) NH81 near Coimbatore, Mettupalayam, Udagamandalam), Gudalur, NH766 near Gundulpet
83	3256907	Tamil Nadu	394 km (245 mi)	(NH209) NH544 near Coimbatore, Pollachi, (NH45) Dindigul (NH67) Tiruchchirappalli, Thanjavur, NH32 near Nagapattinam
183	3257198	Kerala, Tamil Nadu	322 km (200 mi)	(NH45) NH83 near Dindigul, (NH220) Theni, Uttamapalayam, Cumbum, Kumily, Peermedu, Mundakkayam, Kanjirappali, Kodungoor, Kottayam, Changanassery, Adoor, NH744 near Kottarakara
85	3257242	Kerala, Tamil Nadu	413 km (257 mi)	(NH49) NH66 near Kochi, Ernakulam, Moovttupuzha, Adimali, Munnar, Devikulam, Bodi, Theni, Madurai, (NH230) Tiruppuvanam, Sivaganga, Tondi port
86		Madhya Pradesh	0 km (0 mi)	Bhopal, Sehore, Dewas
87	3257823	Tamil Nadu	154 km (96 mi)	(NH49) NH38 near Tiruppuvanam, Manamadurai, Ramanathapuram, Rameswaram, Dhanushkodi

Port of india

Name	Cargo Handled (FY2013-14)		Vessel Traffic (FY2012-13)		Container Traffic	
	million tonnes	% Increase (over previous FY)		% Increase (over previous FY)	'000 TEUs	% Increase (over previous FY)
Kandla	87.00	-7.06% ↓	2,734	0.74% ↑	29	-75.42% ↓
Paradip	68.00	20.25% ↑	1,279	-4.96% ↓	9	-30.77% ↓
JNPT	62.37	-3.32% ↓	2,588	-11.25% ↓	4,161	-2.30% ↓
Mumbai	59.19	1.98% ↑	1,949	-5.25% ↓	41	-14.58% ↓
Visakhapatnam	58.50	-0.91% ↓	2,066	-16.36% ↓	263	6.48% ↑
Chennai	51.11	-4.30% ↓	1,928	-5.63% ↓	1,468	-4.68% ↓
Kolkata	41.39	3.65% ↑	3,155	-0.91% ↓	563	-6.17% ↓
Mangalore	39.37	6.29% ↑	1,096	-5.11% ↓	50	4.17% ↑
Tuticorin	28.64	1.35% ↑	1,292	-13.40% ↓	508	6.72% ↑
Ennore (corporate)	27.34	-52.85% ↓	475	23.38% ↑	--	--
Kochi	20.89	5.25% ↑	1,367	-1.09% ↓	351	4.78% ↑
Mormugao	11.74	-33.65% ↓	473	39.75% ↑	22	10.00% ↑
All Indian Ports	555.50	1.78% ↑	20,402	-6.95% ↓	7,465	-3.10% ↓

Word ocean

#	Ocean	Location	Area (km2) (%)	Volume (km3) (%)	Avg. depth (m)	Coastline (km)
1	Pacific Ocean	Separates Asia and Oceania from the Americas	7008168723000000 000168,723,000 46.6	70086698800000000 00669,880,000 50.1	7003397000000 0000003,970	70051356630000 00000135,663
2	Atlantic Ocean	Separates the Americas from	7007851330000000 00085,133,000 23.5	70083104109000000 00310,410,900 23.3	7003364600000 0000003,646	70051118660000 00000111,866

		Europe and Africa				
3	Indian Ocean	Washes upon southern Asia and separates Africa and Australia	700770560000000000070,560,000 19.5	7008264000000000000264,000,000 19.8	70033741000000000003,741	700466526000000000066,526
4	Southern Ocean	Sometimes considered an extension of the Pacific, Atlantic and Indian Oceans, which encircles Antarctica	700721960000000000021,960,000 6.1	70077180000000000071,800,000 5.4	70033270000000000003,270	700417968000000000017,968
5	Arctic Ocean	Sometimes considered a sea or estuary of the Atlant	700715558000000000015,558,000 4.3	70071875000000000018,750,000 1.4	70031205000000000001,205	700445389000000000045,389

		ic, which covers much of the Arctic and washes upon northern North America and Eurasia				
Total – World Ocean			7008361900000000000361,900,000 100	7009133500000000001,335,000,000 100	70033688000000000003,688	7005377412000000000377,412

Dam of the world

Rank	Name	Country	Year completed	Structure height [m]	Structure volume [106 m3]	Reservoir volume [109 m3]	Installed capacity [MW]	Type
1	Tarbela Dam	Pakistan	1976	143	153	13.7	3,478	TE/ER
2	Fort Peck Dam	United States	1940	76.4	96	23	185	TE
3	Atatürk Dam	Turkey	1990	166	84.5	48.7	2,400	TE/ER
4	Houtribdijk	Netherlands	1968	13	78	0	NA	TE/ER
5	Oahe Dam	United States	1963	75	70.3	29	786	TE/ER
6	Gardiner Dam	Canada	1967	64	65.4	9.4	186	TE
7	Mangla Dam	Pakistan	1967	147	65.4	7.25	1,000	TE or TE/ER
8	Oroville Dam	United States	1968	230	59.6	4.36	819	TE/ER
9	San Luis Dam (BF Sisk Dam)	United States	1967	93	59.6	2.52	424	TE

10	Nurek Dam	Tajikistan	1980	300	54	10.5	3,200	TE
11	Samara Dam	Russia	1955	52	54	57.3	2,315	TE or ER
12	Garrison Dam	United States	1954	64	50.8	29	NA	TE
13	Cochiti Dam	United States	1975	76.5	50.2	0.73	NA	TE
14	Aswan Dam	Egypt	1970	111	44.3	169	2,100	TE/ER
15	W. A. C. Bennett Dam	Canada	1968	186	43.7	7.4	2,876	TE
16	San Roque Dam	Philippines	2003	200/210	40	0.835	345	TE or ER
17	Fort Randall Dam	United States	1953	50.3	38.2	6.7	320	TE/ER
18	Afsluitdijk	Netherlands	1932	13	36.5	5.5	NA	TE/ER
19	Kölnbrein Dam	Austria	1979	200	35.2	1.58	1,028.5	TE
20	Guri Dam	Venezuela	1978	162	29.8	135	10,235	PG/ER
21	Three Gorges Dam	China	2008	181	27.4	39.3	22,500	PG

List of largest tailings dams

Rank	Name	Country	Year completed	Structure height [m]	Structure volume [106 m3]	Reservoir volume [109 m3]	Installed capacity [MW]	Type
1	Syncrude Tailings Dam Mildred MLSB	Canada	1995	88	540/720	0.35	NA	TE
2	Syncrude Tailings Dam Mildred SWSS	Canada	2010	40-50	119	0.25	NA	TE
3	ASARCO Mission Mine Tailings Dam	United States	1973	30	40.1	0	NA	ER