

Lonar Lake: environmental impact and heritage preservation

The scientific community has widely recognized that global environmental change is an indisputable reality, with anthropogenic activities being a significant contributor. Impacts of climate change are documented in numerous assessment reports of the Intergovernmental Panel on Climate Change (IPCC). The evidence of increasing concentrations of greenhouse gases in the atmosphere and observed warming is unquestionable. Further, emissions of greenhouse gases will exacerbate the effects of climate change and impact all aspects of the climate system. To mitigate the effects of climate change, there is a need for significant and sustained reductions in greenhouse gas emissions. The environmental impact of climate change is both global and regional in nature. While global temperature increases, sea-level rise, and extreme weather events are examples of global issues requiring a global approach, air pollution and water contamination are examples of regional issues that require attention from individual countries.

The recent assessment reports by the IPCC have played a significant role in determining the maximum allowable carbon dioxide emissions to limit the global average temperature rise to within 2 degrees above pre-industrial levels. These reports have meticulously outlined various climate change risk scenarios associated with different degrees of warming. However, the data also reveals that over a billion people, mostly in Asia, live in low-lying coastal areas, making them highly vulnerable to the dangers of sea-level rise. Of particular concern, India is one of the ten nations with the largest populations living in these vulnerable coastal zones.

It is of utmost importance to acknowledge the growing threat of rising sea levels, which poses a serious risk to almost one-fifth of the world's 720 cultural and mixed heritage sites currently listed as UNESCO World Heritage sites. This is a matter of great concern that requires immediate attention, especially if the temperature rises by 3 degrees above pre-industrial levels. It is worth noting that regional climate change issues such as flooding can also cause significant damage to heritage sites, as exemplified by the case of the Sundarbans, the world's largest mangrove forest in the Ganges delta region of India and Bangladesh. The rapid deterioration of this forest has resulted in coastal retreats, which is alarming given that it protects the coastal areas

from tsunamis and cyclones. Moreover, the increased occurrence of storms in the Bay of Bengal, tidal flooding, and changes in water quality, among other climate change-related factors, are also affecting this region. Therefore, it is important to establish an integrated coastal and ocean management system to mitigate these risks and conduct coastal vulnerability assessments.

According to recent reports, Lonar Lake, which holds the honourable title of being a 'National Geo-Heritage Monument', is currently experiencing severe environmental and ecological damage. This geological marvel is located in the Buldhana district of Maharashtra, India, and is nothing short of a natural wonder. Lonar Lake came into existence during the Pleistocene Epoch, a period that spanned from roughly 2,588,000 to 11,700 years ago. It was formed due to a hypervelocity impact that is unique in the sense that it is the only known such crater in basaltic rock in the entire planet. The lake itself is saline and alkaline, and it is located within a basalt impact structure. The circular depression surrounding the lake is, on average, 1.2 kilometres in diameter and lies approximately 140 metres below the crater's edge. Meanwhile, the crater ring encompasses an area of roughly 1.8 kilometres in diameter. Experts concur that the lake is approximately 52,000 years old, although there is a standard deviation of 6,000 years.

The basin is encircled by a series of diminutive hills, with a circumference of approximately 8 kilometres at the hilltop and 4.8 kilometres at the lake's periphery. The slopes of these hills are adorned with deciduous trees, including teak, Samidha (Palash/Flame-of-the-Forest), Indian Screwtree, and Pale Indigo plants. Additionally, shrubs like babul (thorny acacia) and ziziphus (jajube) can be observed at the crater's edge. The lake water contains numerous salts (sodas), which accumulate when the lake recedes during the dry season. Moreover, two small streams, namely Purna and Penganga, converge into the lake. Notably, near the southern edge of the lake, a well of sweet water can be found.

Situated in India's basaltic formation known as the 'Great Deccan Traps', this unique lake lies within a crater. This specific crater is the only known extraterrestrial impact crater within the basaltic formation. Initially thought to have volcanic origins, debate surrounded the classification of the crater as either a geobleme, caused by terrestrial

pressure or volcanic activity, or an astrobleme, resulting from the impact of extraterrestrial rock or projectile. However, current research confirms that the crater is, in fact, an impact crater caused by a hyper-velocity impact of an asteroid or comet. The presence of plagioclase, either in the converted form of maskelynite or with planar deformation features, serves as evidence to confirm the impact origin of the crater. Maskelynite is formed when plagioclase undergoes intense heat and pressure, vitrifying the plagioclase. Such transformations are only possible through shock metamorphism caused by hyper-velocity impact. Further evidence of the impact origin of the crater is seen through the presence of shatter cones, impact deformation of basalt layers that make up the crater's edge, and non-volcanic ejecta, which cover the region surrounding the crater. The meteorite impact occurred in an easterly direction, at an angle of 35 to 40 degrees, and resulted in the meteorite crashing into the earth at a speed of 90,000 kmph, weighing an estimated 2 million tonnes.

The lake, situated amidst the forest, exhibits distinct chemical attributes that indicate a clear distinction between two regions – one characterized by alkaline properties, while the other remains neutral. These regions are home to a variety of unique plant and animal species that differ in terms of colour, size and behaviour. Additionally, the lake harbours an exceptional class of microorganisms that consume methane and exhibit magnetic characteristics, which have piqued the interest of the scientific community. The surrounding area boasts a diverse range of flora and fauna, with towering trees offering shade and protection to various bird species and small mammals.

The tranquil lake serves as a sanctuary for a diverse array of avian species, ranging from waterfowl such as ducks, shovelers, stilts, grebes and herons, to other fascinating birds like parakeets, hoopoes, robins, blue jays, magpies, tailor birds, woodpeckers and peafowl. These birds have made their homes in the idyllic lake basin, thriving in this peaceful environment. In addition to the avian population, the lake is also home to various reptiles, including monitor

lizards and snakes, as well as a number of mammals, such as langurs, bats and gazelles. It is truly a marvel to witness the harmonious coexistence of these different species within the lake's ecosystem.

It is concerning to note that Lonar Lake is currently facing a significant threat of ecological damage. Recent investigations by the Centre for Citizen Science in Pune have revealed that the lake's perimeter has shifted inward by 100 metres within three years. This group has been studying the lake since 2003 in collaboration with researchers from the India Meteorological Department, the National Centre for Radio Astrophysics, and the Inter-University Centre for Astronomy and Astrophysics. It is alarming to note that the shrinking of the lake's surface has occurred without any noticeable change in the region's rainfall levels. The reasons behind this worrying event have been attributed to various factors, including the drying up of local percolation dams, the closure of streams that feed the lake, and borewells situated in the vicinity of the lake.

Furthermore, the water quality of Lonar Lake has also undergone severe degradation. The lake's salinity and pH levels have been steadily declining due to rampant sewage dumping, while the use of pesticides and fertilizers in farmland near the lake serves as another source of pollution. The subsequent increase in levels of nitrogen and phosphorus has triggered the growth of invasive algae species, which is a matter of great concern. The algae hinder the flow of oxygen, which is essential for the survival of native microorganisms. These findings warrant immediate attention and action to ensure the preservation of Lonar Lake and its ecosystem.

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