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Special Article

Sustainable Tourism At Lonar Lake In Maharashtra: *A Geopark Approach*

Archana Mishra[1] and Rekha Maitra[2]

Abstract

The Lonar area, in the state of Maharashtra, India, is an underappreciated geo-heritage site with distinctive wildlife and biodiversity, a rich cultural legacy, and well-known geological characteristics. UNESCO, since 2015, recognized the 'Global Geoparks' initiative which promotes sustainable development via community participation. It has been applied successfully in 48 countries and it has been an instrument of local development, education, conservation, and sustainable tourism in such geo-site areas. Geoparks preserve unique geological heritage, and biodiversity and boost the local economy by encouraging sustainable livelihoods, geo-tourism, and heritage discouraging harmful behaviours that cause damage to the unique geological character and heritage of the region. Their bottom-up strategy, which involves local people and combines sustainable development and conservation, is gaining popularity. In India, there is no such geopark yet and Lonar could be a potential area where not only geo-tourism could flourish but a Geo Park strategy could boost tourism revenue, jobs, and opportunities for the local community. This paper examines the strengths and opportunities in the Lonar region from a geo-tourism point of view and reinforces a sustainable tourism approach by adopting UNESCO fostered Geo Park approach to Tourism Development in the Lonar Region.

Keywords: *Geo Park, tourism, Sustainability, biodiversity, conservation, ecotourism, local community, smart tourism.*

[1] Assistant Professor, Jai Hind College (Autonomous), Mumbai
Email: archana.mishra@jaihindcollege.edu.in

[2] PGT-Tourism, GD Goenka School, East Delhi
Email: rekhavmaitra@gmail.com

Introduction

Lonar Lake is a unique and fascinating geological site located in Maharashtra, India. The lake's creation by a meteor impact about 52,000 years ago has historical and unique scientific significance. The antiquity of this landscape is referred to in the ancient Puranas (350 and 750 CE and the Ain -i -Akbari by Abul Fazal (1600 CE). Lonar geo site is seen as a co-occurrence of historical legacy and spiritual heritage with twenty-seven temples, three monuments, seven temple tanks, and three inscriptions found within the Crater (Ramsar Information sheet, 2020).

Scientists claim that the lake is situated in the only crater on Earth created by a high-velocity impact on basaltic rock, namely a meteor strike that occurred at an estimated speed of 90,000 km/h. The lake now occupies 77.69 hectares within the Lonar Protected Area, which is 3.66 square kilometers. (Marpakwar, 2023). By the thermoluminescence analysis, the age of the lake is estimated as being 52000 years old with a 6000-year correction on either side, whereas the Argon dating system revealed a crater formed around 570000 years ago. (Dey, 2019).

Maharashtra Government has categorized Lonar as an 'A' Grade Tourist Place, which receives funding from either international sources or the Government. The Committee for the Development of Tourism began in 1999 and 2011. Lonar receives steady science enthusiasts, wildlife lovers, and spiritual and ecotourists around the year. The connectivity to Lonar is through Aurangabad by cab or bus, which is a three-hour drive, it has better connectivity by rail, air, and roads. The lake's impact on local communities and their cultural practices needs to be explored as it has the potential and scope for building economic opportunities. Lonar Lake has been studied by the Smithsonian Institution, the United States Geographic Survey in America, the Geological Society of India, and India's Physical Research Laboratory. But from the Geo Park or Geo-tourism perspective, it has been less explored.

The methodology of the paper consists of identification, screening, eligibility, and inclusion of articles related to the research topic and a review of the literature in two parts- first, pertaining to the geological site Lonar and its features, its ecological uniqueness, and tourism potential and the challenges being faced, currently and secondly a review of the concepts and successful sustainable strategies such as the UNESCO concept of a ‘Geopark’ and geo-tourism in such areas of geological heritage. A qualitative analysis was undertaken to explore the application of the Geo Park strategy at Lonar and opportunities interlinking Geo Park strategy along with other kinds of tourism possibilities that could lead to better economic opportunities for local community, lead to better conservation of geological and cultural heritage in the Lonar region.

Literature Review

A literature review on Lonar shows papers discussing Lonar as a geo site and a large majority of writings focus on its geomorphology. Adam C. Maloof et al. (2009) provided a geological study map of Lonar and highlighted the Lonar Crater as a well-preserved Basalt trap of the Deccan peninsula, making it a rare analogue for impact structures compared to the planets and the moon. In the study, it is discussed how the primary feeder stream to the lake enters the crater at the northeastern head of Dhar Canyon, providing Lonar with drinkable water even during the dry months, and how Dhar Canyon empties into Lonar Lake via a delta, where banana growing is presently practised. Below the main Dhara (stream), another perennial water source emerges as a spring some 65 m below it. According to the paper, Temple Ramgaya is located on the east side of the crater floor. This portion of the crater is home to a small permanent spring, and during dry years, the lake lacks a stream exit, causing a thick layer of salt to accumulate on the lake bed.

The paper refers to Little Lonar, suggested by Fredriksson et al. (1973) and Fudali et al. (1980), a second impact crater associated with the meteorite that created the Lonar Crater, as an elliptical depression, and the Lonar Crater rim as an area that sees chickpea farming. Fudali et al. (1980) discuss how the ejecta blanket's high porosity reduces surface runoff while also preserving the ejecta through light ground shrub cover. The condition has shielded the crater rim and cavity from more recent buildings, but not the full ejecta blanket, according to the report.

Lonar crater's dense forests have been spoken about as comprising custard apple, eucalyptus, lemongrass, bamboo, teak, and medicinal plants with rich alkaline angiosperms bio-diversity (Malu et al., 2000 cited by Tambekar et al. (2012). The study mentioned that the medicinal value of various fruits and vegetables in the Lonar region is known, but the antibacterial potential of medicinal flora is poorly or not studied (Tambekar et al, 2012).

D. H. Tambekar et al. (2010) spoke of Lonar as one of the well-preserved impact structures on the earth as a meteoritic impact crater in basalt rock. The paper talks about the uniqueness of craters in hard igneous basalt rocks, and its uniqueness evokes interest and value among researchers and continues to be a popular site for many. It points out the physicochemical qualities of Lonar Lake water. The alkalinity and salinity of the lake water are decreasing, thereby proposing that it be protected and preserved.

Ranawat and George (2019) pointed out the potential geo-heritage and geo-tourism sites in India which includes Lonar and that India has yet to get any of its sites on the list. Singh and Meenakshi (2018) say that the biodiversity in the region comes from the saline lake, marshy areas all around the lake, and fresh water at the periphery, natural and artificial but the usage of toxic chemicals from fertilizers, insecticides and a pesticide have polluted the lake water.

On suggested strategies for such geo sites as Lonar, a review of papers highlighted themes such as Geopark and geo-tourism that could turn around local development and provide conservation and sustainability. Previous research studies validate that geo-sites form an exciting study as they occur due to natural phenomena, i.e., a drop of a meteorite or any such naturally formed topography. For the upkeep and maintenance of geo-tourism activities, revenue generation is done through nature trails, hiking, academic meets, and excursions. Geo-tourism is referred to as UNESCO's 'geo-parks.' Following the Convention on Biological Diversity (CBD, 1993), which emphasized the preservation of biodiversity and the long-term use of its components and biological resources, the notion of geodiversity temporarily came into being in 1993. The relevance of geodiversity to geo-tourism, leisure activities, and geoparks has been explored. (Gray, 2008).

A geopark (a concept introduced by UNESCO in 2001) has been defined as a cohesive area endowed with extensive international archaeological heritage used to promote long-term local community development (Dowling, 2013). Within UNESCO Global Geoparks, which are distinct, coherent geographic regions, the management of sites and landscapes of worldwide geological significance is guided by a holistic approach to conservation, education, and sustainable development.

The study conducted by Herrera-Franco et al. (2020) analyzed through a bibliometric analysis the research trends in geo-tourism, using the Scopus database. The researchers found a steady growth of publications on geo-tourism since its emergence in the 1990s. The paper mentions the decade-long UNESCO initiative of Global Geoparks as a successful form of sustainable tourism. The study identified the countries that lead in geo-tourism research such as Spain, China, and the United States. The authors also observed an increasing focus on sustainable tourism practices, as well as the integration of technology in geo-tourism research. The study also noted that numerous research gaps need to be addressed in the field, particularly the need to develop a standardized definition of geo-tourism and the lack of studies on the impacts of geo-tourism on local communities. Geo-tourism rooted in geology-based tourism that caters to the niche tourists seeking knowledge about the geology and geomorphology of a site beyond the level of mere aesthetic appreciation is one of the first definitions of geo-tourism. (Hose, 1995).

The paper by Dowling and Newsome (2018) provides an overview of geo-tourism, a rapidly growing niche within the tourism industry that focuses on a destination's natural and cultural heritage. The article defines geo-tourism and outlines its key characteristics citing geo-tourism development examples from various countries, including a focus on sustainability, education, and preservation of local cultures and environments.

Ólafsdóttir R and Tverijonaite E (2018) have examined Geo-tourism as a growing field that encompasses geo-heritage management, new models for assessing geo-sites,

and other methodological approaches. Daria Chylińska in "The Role of the Picturesque in Geo-tourism and Iconic Geo-tourist Landscapes," (2018) explores the importance of the 'picturesqueness' in geo-tourism. Chylińska argues that they play a significant role in attracting tourists to geological sites and these landscapes have the power to evoke emotional responses in visitors, which can enhance their experience and make it more memorable. Chylińska identifies several iconic geo-tourism landscapes, such as Yosemite National Park, the Grand Canyon, and Uluru-Kata Tjuta National Park, that exemplify the importance of the picturesque in geo-tourism. She concludes that a deeper understanding of the picturesque and its significance can aid in the successful promotion.

Dowling (2013) analyzed that while eco-tourism and biodiversity have received greater attention from scholars for over thirty years, geo-tourism and associated concepts like geo-heritage, geodiversity, conservation, and tours are relatively new. Its primary focus is on the geology and landscapes of a region in order to promote the development of sustainable tourism. The strict position of geo-tourism has broadened to include geodiversity, geo-heritage and geo-activities. Dowling explained geo-tourism as a partnership among the Government, local people and private sectors, local businesses, outdoor companies, tour agencies, restaurants, and accommodations. (Dowling, 2009)

Hose (2012) gave the historical and theoretical aspects of geo-tourism and approaches to its sustainable management and spoke of three vital interrelated aspects (the '3G's') of modern geo-tourism, that is, geo-conservation, geo-history and geo-interpretation. A differentiation of 'geological' from 'geographical' versions of geo-tourism emerged wherein geological definition treated geo-tourism as a type of tourism, an 'approach to tourism is somewhat akin to sustainable tourism with geo-tourism aiming to bring tourism development opportunities while ensuring the conservation and geo-heritage attributes (Newsome, Dowling, & Leung, 2012).

Hose et al. (2011) have spoken about how Geo-tourism in the United Kingdom was seen as a means to promote, preserve and then conserve geo-sites and geo-morpho sites. According to Hose (2006), it is a type of niche or special interest tourism, similar to other travel categories including eco-tourism, "sustainable tourism," "alternative tourism," "educational travel," "environmental," "nature-based," and "heritage" tourism, but with potential to develop. Hose (2000, 2008, 2012) further discussed geo-tourism as a vehicle to foster geo-conservation, geological heritage and geological diversity underpinned by the concept of sustainability.

Farsani et al. (2011) discussed the significance of geo-parks while developing geo-tourism to generate new opportunities, economic activities and additional sources of income in rural regions and on the role of geo-parks in improving the local economy, encouraging the production of local products, local handicrafts involved in geo-tourism and geo-products and using innovative strategies such as niche marketing, geo-tours,

geo-products, geo-museums, geo-sports, geo-restaurants and geo-bakeries instrumentalizing local communities knowledge of the area.

Djurović P. and Mijović D, (2006) defined Geo-heritage sites as geodiversity, which could be hydrological, pedological, geological and geo-archaeological with cultural and empirical significance. Newsome and Dowling (2010) spoke of geo-tourism as focusing on geology and landscape rather than eco-tourism on natural areas, geo-tourism natural or artificial environments. It was stated that geo-tourism promotes travel to geological sites, preserves geological diversity, and fosters learning about earth sciences through self-guided tours, viewpoints, geological trails, guided tours, geo-activities, and support of geo-site centers. Planning and administration, qualified staff, lodging and services, access, and transportation would all be included. Due to local economic, social and conservation benefits, community involvement has increased, and geo-tourism development could augment residents' income generation, jobs and skill development (Farsani et al, 2011). Environmentally innovative forms of tourism that foster environmental and social responsibility should be given greater importance (Pásková, 2012).

The research study by Maitra, R., et al (2023) highlights the importance of sustainable tourism and its various factors in considering tourism resources such as natural, artificial, renewable, and non-renewable resources while developing a sustainable tourism plan.

This paper contributes by analyzing various touristic and heritage aspects of the Lonar Lake ecosystem and calls for a conservation strategy that adopts a UNESCO ‘Geopark’ approach to protect the unique geological and ecological site, while also supporting the local administrative vision to boost the local economy interlinking with other forms of tourism in the region.

Findings and Discussion

Lonar is a geo site intersected by archaeological, cultural, and spiritual heritage with 27 temples, three monuments, seven temple tanks and three inscriptions inside the Crater (Ramsar Information sheet, 2020). Maharashtra Government has categorized Lonar as an 'A' Grade Tourist Place, a place of national or international importance, and receives funding from either international sources or the Government. The Committee for the Development of Tourism began in 1999 and in 2011. It sees steady science enthusiasts, wildlife lovers, and spiritual and ecotourists around the year. The connectivity to Lonar is through Aurangabad as a significant node, and through the cab or bus, it is a three-hour drive, though Aurangabad has better connectivity by rail, air and roads. Jalna is the nearest railhead for Lonar. (90 km away)

The oldest reference to Lonar dates back to the mythology-where it is spoken as the site where an incarnation of Vishnu defeated the demon-giant *Lonasur* (also called Lavansura) by emerging off the lid and leading to his subterranean cave. The

lake is mentioned in ancient and medieval literature like the Skanda Purana, and Padma Purana and has a reference as Panchapsar (five streams that feed the lake), the famous text titled 'Raghuvansh' by Kalidasa, The Ain-e-Akbari, a text by Abul Fazal speaks about the Lonar lake a place of sanctity in the biography of Akbar. The text lists it as a place for performing good works for the deliverance of ancestors. The lake has been spoken of in the text as containing minerals for manufacturing glass and soap and was used to produce saltpeter to yield revenues. (Dixit, 2012)

Surrounded by the peaks of the surrounding hills, the basin is the meeting location of the Penganga and Purna streams and is mentioned in the Latin texts of Padma Purana and Skanda Purana. It is also the preferred tourist destination for most adventure seekers. In addition to being one of the most popular tourist destinations, the wooden statue at the Hanuman temple near the lake allegedly has magnetic properties, drawing thousands of pilgrims there every year. The majority of the fourteen temples that round the Lonar Crater Lake are in ruins.

The mythological antecedents and references to Lonar Lake and its geological uniqueness, wildlife, and temples make it culturally rich as a place of worship. The Great Temple at Lonar, Buldhana District, imaged in the Allardyce Collection (1860) is one of the finest temples in the area, whose exterior walls are covered in sculpture and are seen on the old photographs of the British Library by Robert Gill. Trainman, the official site (provides train-related intelligence), states that Lonar Lake is the "Bowl of Mysteries" as the lake has been enigmatic to researchers, astronomers, geologists, ecologists, and even NASA.

Ajanta, the Ellora caves, and the Daulatabad fort are close to Lonar and are heritage-wise attractions. Daulatabad Fort, founded by Yadavas and named Devgiri, is a unique fort in Maharashtra, which has structures belonging to the 11th to 16th centuries AD. There are various prominent structures, including stepped wells, Chand Minar, Hammam, Chini Mahal, Rang Mahal, and Bharat Mata temple. Ellora Caves comprises famous rock shrines representing a mix of three different religions – Buddhism, Jainism, and Hinduism. The Buddhist group consists of primary 12 caves, 17 Hindu group caves, and Jain group 5 caves. Ellora Caves tour is 30 km from Central Aurangabad in the northwest direction. The historical heritage of the Ajanta caves exhibits a mix of awe-winning structures, luxurious carvings, and the richness of ancient Indian culture. The architecture reflects Buddhist influence. Every cave has exquisite wall paintings that form the middle of the tourist attractions. Pitalkhora Cave, about 40 km from Ellora, stands as a reserved part of the forests, and this cave exhibits a revolutionary architecture of cave engineering. Shirdi, a famous pilgrimage site dedicated to Shree Sai Baba, is a prominent tourist attraction about 250 km from Lonar.

Lonar is a geological, archaeological, and cultural tourist site and a notified National Geo-heritage monument. Lonar wetland comprises the villages of Lonar, Lonai, Patel Nagar, and Sabunpura, while the agricultural fields are seen on the Eastern,

Western, and Northern sides. Lonar Crater (declared by the Smithsonian Institute of Washington DC and the Geological Survey of India) is among the largest crater lakes in Asia and the third-largest natural saltwater lake. The crater exists as a natural lake, and the water is saline due to the outflow that leads to mineral concentration as the lake water evaporates. (Ramsar sites Information, 2020). The Lonar crater, located at 19°58′N, 76°31′E, is among the most well-studied and conserved craters in India.

The Argon dating technology indicated a crater created around 570000 years ago, whereas the thermoluminescence study estimates the age of the lake to be 52000 years old with a 6000-year adjustment on each side. (Dey, 2019). The crater on which the lake is located has a diameter of 1.8 km, making it one of the most notable impact craters. The lake's mean diameter is around 3900 feet or 1.2 km. It has an ejecta blanket-covered impact crater that has been well-reserved, as well as slopes, a crater lake, a crater basin, sweet water springs, Little Lonar, and Amber Lake, which never dries out. The experts described a few advantageous features that the springs are perennial, the higher groundwater level in the basin. Owing to high concentrations of sodium chloride, carbonate, fluoride, and bicarbonate, it has high alkalinity.

The two streams flow straight into the lake, making them similar to the lake's water sources. There is a sweet water well near the lake's southernmost point. (Chandran et al, 2022). Lonar has been mentioned as the third-largest natural saltwater lake in the world. (The first one is Bosmatvi Lake in Ghana) (Trainman, 2020) Lake offers various benefits in the form of salts and minerals of therapeutic value. Restoration projects can be undertaken to improve water quality and preserve the lake's unique features. It can serve as a valuable research site for scientists studying the area's geology and ecology.

A recent study by IIT Bombay drew up the similarities between the minerals in the lake soil and the minerals found in the moon rock which was brought back during the Apollo mission. (Fernandes, 2019). In 2021, NASA Earth Observatory captured images of a 50,000-year-old Lake with experts pointing out that the color was due to the salinity and presence of algae.

There are just three known meteorite impact craters in India: Lonar in the Deccan Volcanic Province, Ramgarh in the Vindhyan Supergroup, and Dhala in the Bundelkhand Craton. Other possible meteorite impact craters in India include Luna in the Rann of Kuchchh, Shiva in the western offshore basin, Kaveri in the southern granulite terrain, and Simlipal in the Singbhum Craton. (Chandran et al, 2022) The presence of basaltic target rocks at Lonar adds to its significance because it may be compared to meteorite impact craters formed on other planetary bodies with basaltic target rocks, such as Mars. (Newsome et al., 2010; Fredriksson et al., 1973)

The primary source of water in the crater is rainwater. Because the lake's evaporation exceeds its intake during the dry season, the lake gets groundwater inflow, lowering its level. Because the pH of the water is higher than 10.5 it is not recommended for

drinking, farming, or industrial use. Nonetheless, geologists have described its hydrological services—such as sediment retention, nutrient recycling, local temperature management, and organic matter accumulation—as priceless.

As explained by Maharashtra Tourism Twitter, Mr Gajanan Kharat, the salinity in the lake has increased due to falling water levels and has become warmer, resulting in the growth of algae, which turns reddish in warmer temperatures and hence the colour of the lake turns pink. (Physorg, 2020). The Hindu (2020) saw the pink colour comes from a pigment produced by Haloarchaea or halophilic archaea.

The distinct sodic environment of Lonar is home to a diverse array of microorganisms, including planktons, cyanobacteria, and anaerobes. Lonar's unique sodic ecosystem supports a unique blend of micro-organisms, ranging from anaerobes to cyanobacteria and planktons. The area has lush greenery and is surrounded by basalt rock and maskelynite. In addition, the wetland is home to 30 tree species, 10 shrub species, 13 climber species, 8 herb species, and 6 grass species. Faunal diversity includes 12 species of mammals, 160 species of birds, 46 species of reptiles, seven species of amphibians, and 14 species of molluscs. (Ramsar Information Sheet, 2020). The wetland forms an essential site for the migratory bird species of the Central Asian Flyway in winter. (Ramsar Information Sheet, 2020).

Species are native to the Indian subcontinent and are known for medicinal properties—the Indian lilac has a significant presence here. The 2000 designation of Lonar Wetland as a Wildlife Sanctuary placed it under the control of the Melghat Tiger Project, Additional Chief Conservator of Forests, Amravati.

The crater and its surroundings distinguish themselves from the rest of the dry arid region by containing a rich biodiversity in the neighbourhood, which is surrounded by a forest cover, providing habitat for a diverse range of plant and animal species. (Chandran et al, 2022). Leopards, monkeys, wild boars, and migratory birds may be found in the forest around the crater and lake site, which is a designated wildlife sanctuary and a component of the Melghat tiger reserve. There are several sanctuaries close to Lonar, such as the Dyanganga wildlife sanctuary near Buldhana, Around Lonar, there are other sanctuaries like the Dyanganga wildlife sanctuary in Buldhana, Katepurna in Washim and other wildlife sanctuaries in Akola, Painganga and Tipeshwar. Maharashtra has a total of six national parks and thirty-six wildlife sanctuaries. The wildlife tourists trickle in steadily over the whole year. Migratory birds also flock to the lake during the winter months, making it an ideal place for bird watchers and wildlife enthusiasts.

The use of chemical fertilizers and pesticides has been causing pollution of the lake. Construction and expansion of residential areas have seen deforestation illegally carried out. Polluting of streams by littering by devotees by disposing of coconut shells, petals, and torn plastic bags. Biodiversity is threatened owing to the sewage dump in the lake. There is a lack of effective solid waste disposal or enough public facilities.

Waterlogging is affecting flora and fauna, encroachment, hunting, and firewood collection are activities damaging the geo-site and the environment. Development plans by the Government are there but do not give high benefits in terms of employment opportunities or adding to tourism and conservation efforts taken are limited.

The second Ramsar site in Maharashtra has been designated as Lonar Crater, the first being Madhameshwar, Thane Creek. The Ramsar Convention, which was originally established in 1971 in Ramsar, Iran, aims to stop the global loss of wetlands. The term "Ramsar sites" implies that they are wetlands of international importance under the convention. (2020, Chatterjee).In Maharashtra, there are two such Ramsar sites -Nandur Madhameshwar and Lonar. There are 46 Wetland sites in India (Ramsar, 2021). The benefits of being a Ramsar site include the ability for the locals to engage in sustainable forestry, fishing, agriculture, and tourism by utilizing renewable resources.

The Ramsar Convention aims to conserve the wetlands and the biological diversity globally and sustain human life through ecosystem maintenance to foster eco-tourism services that benefit the people. It fosters cooperative partnerships and contributions from non-government and community-based organizations in the strategic development of these wetlands. Various wetlands have benefited from several small and medium businesses linked to tourism, hospitality, bird watching, and fishing, having developed in various such regions and protecting the indigenous heritage. (As seen in the Danube Valley and Australian Wetlands).

While legal protection is there, re-vegetation has been partially implemented, while habitat manipulation/enhancement is limited in the Lonar region. Catchment management initiatives are partially implemented, rare species regulation, management measures, and Threatened species management programs have been partially implemented, management of waste status is partially implemented, water management limited, the communication, education, participation, and awareness activities have been partially implemented (Ramsar information Sheet, 2020). The process of sensitizing the local community regarding the conservation of the ecosystem needs continuous efforts from the authorities.

On the offerings side, a survey of the existing tour packages for Lonar, as seen on the companies' websites such as Yatra.com, Thomas Cook, Tour Travel, Unnayan Tours, and Thrillophilia, either some packages are only standalone for Lonar visits or others for Lonar crater visits are packaged with nearby heritage sites such as Ajanta and Ellora. The packages covered a guided sightseeing experience consisting of a geo-site visit, history, and heritage-related talk, pilgrimage or cultural fairs, or a visit to adjoining heritage sites or wildlife parks, either by bus or private car travel. Some packages included night stargazing packages. Geo tourism-based activities educational or contrails, or branding around knowledge-based or local heritage or local products were not seen in the packages in any elaborate way being offered. Information on Lonar

is either seen on the Buldhana administrative website or on websites where Lonar is listed as a national geo-heritage site or on the Ramsar website. A dedicated website for the geo-site was not seen and neither was any management body with multiple stakeholders' representation.

Buldhana district's (under which Lonar comes) demographic profile indicates that the total population in the district is over 25 lakhs and a gender divide exists in terms of count of the population, male literacy rates are 91% and female literacy rates are higher than the national average and at 76% indicating that education-based activities or innovative strategies if applied for boosting small or medium businesses it could bring greater employment to the employment in the region. (Table 1). The average literacy rate is 81.85 % for rural and 89.08 % for urban areas in the Buldhana district which implies that knowledge-intensive activities, conservation-related events, or marketing or ICT integration brought literate human resources could augment the efforts.

Table 1. Number of households, Population, Male-Female Population, and Literacy rates in Buldhana.

	Particulars	**Number**
	Total Number of Household	560089
	Total Population of District	2586258
	Total Male Population	1337560
	Total Female Population	1248698
	% of Urban Population to the total population	0.2122
	Literacy Rate	83.4
	Male Literacy Rate	90.54
	Female Literacy Rate	75.84

Source: Demographic Information as per Census 2011. Retrieved from https://buldhana.nic.in/en/demography/

Geo-tourism which entails education-related activities, management, conservation, eco-tourism, tour guiding, wildlife or biodiversity management or event management, ICT integration, networking, digital marketing, research, curation, lifestyle or tourism-related enterprises and services along with governance could bring job opportunities, better prospects and local development in the region while preserving the unique geological heritage. Tourism infrastructure boost, marketing and geo activities along

with areas rich heritage and ecological richness have the potential to bring greater jobs and tourist influx, Recently, the Nagpur bench of the Bombay High Court directed the Maharashtra government to establish Lonar Crater Lake Development Authority to conserve the Lonar crater lake.

Geopark Approach and promoting geo-tourism in Lonar

A UNESCO Global Geopark must display the geological history of international significance, but its main objective is to explore, develop, and celebrate the linkages between the region's natural, cultural, and intangible heritages and its geological heritage. The designation of UNESCO Global Geoparks is granted for a duration of four years, following which each one undergoes a comprehensive re-examination as part of a revalidation process to assess its quality and functionality. All pertinent local and regional stakeholders and authorities in the region are involved in the bottom-up process that creates UNESCO Global Geoparks (e.g. landowners, community groups, tourist operators, indigenous people, and local organizations). Strong political and public support for the formation of strong local multiple partnerships, a strong commitment to the process, and the development of a comprehensive plan that will achieve all community goals while showcasing and protecting the region's geological history are required from the local communities.

For becoming a UNESCO Geopark, the geological heritage is expected to hold international value, to be assessed by the experts on which Lonar could qualify as it is a rare impact structure and has recognition internationally under the Ramsar Convention. All parties involved in UNESCO Global Geoparks must come to an agreement on a management strategy that takes into account the social and economic needs of the local population while protecting their cultural identity and the natural surroundings. This strategy has to be all-inclusive, including the UNESCO Global Geopark's collaborations, infrastructure, finances, governance, development, and communication. Global Geoparks support peace-building efforts by fostering greater understanding between disparate groups and hence, networking is a critical requirement.

UNESCO Global Geoparks mainly promote local, sustainable economic development through geo-tourism. A UNESCO Global Geopark must be well-known in order to encourage geo-tourism in the area. It must be possible for residents and guests of the UNESCO Global Geopark to get relevant information. It is important that the region's geological and other sites are connected by a thorough map, booklets, and a dedicated website to facilitate the dissemination of knowledge. A UNESCO Global Geopark also needs an established business identity. The visibility of a UNESCO Global Geopark is essential to promoting geo-tourism in the region. Both locals and visitors to the UNESCO Global Geopark must be able to locate pertinent information. In order to disseminate knowledge, the area's geological and other sites are connected by a

comprehensive map, pamphlets, and a special website. An official business identity is also necessary for a UNESCO Global Geopark.

In addition to working with the local community within the UNESCO Global Geopark, a UNESCO Global Geopark also collaborates with other UNESCO Global Geoparks via the Global Geoparks Network (GGN) and regional networks for UNESCO Global Geoparks. This allows the geoparks to share knowledge and enhance the quality of the UNESCO Global Geopark label collectively.

Through geo-tourism, UNESCO Global Geoparks primarily supports local, sustainable economic development and Lonar could benefit hugely from this approach. The Geological Survey of India has identified twenty-six sites across countries to develop geoparks, The application of the Schumpeterian approach, innovation, diversification, clusters, creating macro and micro linkages at a local level, with creative industries, focusing on authenticity, quality in services, marketing, technology integration and bringing community participation foremost can be the source point for employment generation in a culturally diverse country and can lead to economic development and more employment (Mishra, 2021).

Conclusion

The Lonar crater and its surrounding areas can be further promoted as a Geo Park tourism destination for geo-tourism, ecotourism, cultural tourism, religious and heritage tourism, educative, medicinal, and adventure and wildlife tourism incorporating smart tourism technologies too. India has only one crater, as listed by UNESCO. Therefore, the ancillary facilities of Lonar Lake must match international standards. Lonar Crater can be marketed for cultural and crater tourism due to its unmatched uniqueness of being the only crater listed in the Geological Survey of India. Lonar's geological, archaeological, and historical significance coupled with heritage and tourism spots–temples and religious attractions–create a lot of potential in the region for linking Geo Park based geo-tourism with other forms of tourism in the region that can bring a unique destination branding that could be further enabled by smart tourism tools and boost local economy and protect the site.

References

Alamy. 2023. Photograph of the Great Temple at Lonar, Buldana District, Maharashtra from the Allardyce Collection,1860. The Picture Art Collection. Available at: https://www.alamy.com.

Chatterjee. 2020. Lonar Lake in Buldhana district was declared a Ramsar site, second for Maharashtra within a year. Hindustan Times.

Chandran, S R, James, S, Aswathi, J, Padmakumar, D, Kumar RBB, Chavan, A, Bhore V, Kajale, K, Bhandari, S, Sajinkumar, KS. 2022. Lonar Impact Crater, India: The Best-Preserved Terrestrial Hypervelocity Impact Crater in a Basaltic Terrain as a Potential Global Geopark. Geoheritage. 14(4):130. doi: 10.1007/s12371-022-00767-9.

Census of India. 2011. Buldana (Buldhana) District - Population 2011-2023. Available at: https://www.census2011.co.in/census/district/338-buldana.html#:~:text=Buldana%20Literacy%20Rate,and%2064.07%20in%20Buldana%20District

Chylińska, Dagmara. 2018. The Role of the Picturesque in Geotourism and Iconic Geotourist Landscapes. Geoheritage. 11. 10.1007/s12371-018-0308-x.

Dixit, Sachin. 2012. Ain-i-Akbari on Lonar. Available at: https://lonar.org/ain-i-akbari-on-lonar

Djurović, P., Mijović, D. 2006. Geoheritage of Serbia: Representative of its total geodiversity. Zbornik radova LIV, 4-18. (in Serbian)

Dowling, R.K. 2009. Geotourism's contribution to local and regional development. In: de Carvalho C, Rodrigues J (eds) Geotourism and local development. Camar municipal de Idanha-a-Nova, Portugal.

Dowling, R.K. 2013. Global Geo-tourism – An Emerging Form of Sustainable Tourism. Czech Journal of Tourism, 2(2), 59-79. DOI: 10.2478/cjot-2013-0004.

Dowling, R., & Newsome, D. 2018. Geo-tourism: definition, characteristics, and international perspectives. Handbook of geo-tourism, 1-22.

Egyankosh. 2023. Participatory Irrigation Management and Wetland Conservation. Available at https://egyankosh.ac.in/bitstream/123456789/12886/1/Unit%2016.pdf

Farsani, N. T., Coelho, C., & Costa, C. 2011. Geo-tourism and geoparks as novel strategies for socio-economic development in rural areas. International Journal of Tourism Research, 13(1), 68-81.

Fernandes, Snehal. 2023. Hindustan Times. Mineral contents of Buldhana's Lonar lake similar to moon rocks: IIT-Bombay study.

Fudali, R.F., Milton, D.J., Fredriksson, K., and Dube, A. 1980. Morphology of Lonar Crater. India: Comparisons and implications: The Moon and the Planets, v. 23, DOI: 10.1007/BF00897591

Fredriksson, K., Brenner, P., Dube, A., Milton, D., Mooring, C., and Nelen, J. 1979. Petrology, mineralogy, and distribution of Lonar (India) and lunar impact breccias and glasses: Smithsonian Contributions to the Earth Sciences, Volume. 22.

Gill, Robert. 1860. Photograph of the Great Temple at Lonar, Buldhana District, Maharashtra. Available at: https://3.bp.blogspot.com/_pCG_c3Rq788/TIyC0sT6JGI/AAAAAAAAI0I/VvAGdRzNzXU/s1600/Detail+of+carvings+on+a+temple+wall,+Lonar+Maharastra+-+1865.jpg

Government of Maharashtra. 2023. Buldhana Administration. Demographic Information as per Census 2011. Available at: https://buldhana.nic.in/en/demography

Gray M. 2008. Geodiversity: developing the paradigm. Proceedings of the Geologists' Association 119: 287–298.

Herrera-Franco, G., Montalván-Burbano, N., Carrión-Mero, P., Apolo-Masache, B., & Jaya-Montalvo, M. 2020. Research trends in geo-tourism: A bibliometric analysis using the Scopus database. Geosciences, 10(10), 379.

Hose, T. A. 2000. European Geo-tourism – Geological Interpretation and Geo-conservation Promotion for Tourists. In Barretino, D., Wimbledon, W. P., & Gallego, E. (Eds.), Geological Heritage: Its Conservation and Management (pp. 127-146) Madrid: Instituto Tecnologico Geominerode Espana (Cross ref)

Hose, T. A. 2008. Towards a History of Geo-tourism: Definitions, Antecedents and the Future. Geological Society of London Special Publication

Hose, T.A. 2012. 3G's for Modern Geotourism. Geoheritage 4, 7–24. Available at: https://doi.org/10.1007/s12371-011-0052-y

Hose. T. A. 1995. Selling the Story of Britain's Stone. Environmental Interpretation. Vol. 10, No. 2, 1995, pp. 16-17.

Jojic Glavonjic, Tamara & Milijašević, Dragana & Panić, Milena. 2010. Geo-heritage protection of Serbia: Present situation and perspectives. 10.2298/IJGI1001017J.

Maitra, R., Tripathi, R., Kumar, A., & Shukla, D. 2023. Assessing the Relationship between Social Media and Sustainable Tourism: A Review. Nepalese Journal of Hospitality and Tourism Management, 4(1), 73-84.

Maloof, Adam & Stewart, Sarah & Weiss, Benjamin & Soule, Samuel & Swanson-Hysell, Nicholas & Louzada, Karin & Garrick-Bethell, Ian & Poussart, Pascale. 2010. Geology of Lonar Crater, India. Geological Society of America Bulletin. 122. 10.1130/B26474.1.

Malu RA, Dhabhade DS and Kodarkar MS. 2000. Diversity of Lonar Lake. J. Aquat Bio., 15:16-18. Mansouri S. 1999. Inhibition of Staphylococcus aureus mediated by Iranian plants. Pharmaceutical Biol., 37:375-377.

Malu, Ram. 2002. Lonar Crater saline lake, an ecological wonder in India. International Society for Salt Lake Research. Archived from the original on Oct 6th, 201. (CrossRef)

Malu, Ram. 2002. Lonar Crater saline Lake is an ecological wonder in India. *International Society for Salt Lake Research*. Archived from the original on Oct 6th, 2014. (CrossRef)

Marpakwar, C. 2023. Somewhere in the Middle of Nowhere. Time has stood still here for Millennia. Goethe institute. Available at: https://www.goethe.de/prj/sti/en/lan/23006679.html

MDPI. 2022. Sustainability. An Open Access Journal from MDPI. Available at: https://www.mdpi.com/journal/sustainability

Mishra, Archana. 2021. Diversity, Tourism, and Employment Generation: A Strategic Perspective on India. PRAGATI: *Journal of Indian Economy* Vol. 8(2), Jul-Dec 2021, pp. 1-28 DOI: 10.17492/jpi.pragati.v8i2.822101

Nandy, N. C., and Deo, V. B. 1961. Origin of the Lonar Lake and its Salinity, TISCO. Vol. 8.

Newsome, D. & Dowling, R.K. 2010. Geo tourism: the tourism of geology and landscape. Oxford: Goodfellow Publishers http://dx.doi.org/10.23912/978-1-906884-09-3-21

Ólafsdóttir R, Tverijonaite E. Geo-tourism: A Systematic Literature Review. Geosciences. 2018; 8(7):234. Available at: https://doi.org/10.3390/geosciences8070234

Pásková, M. 2012. Environmentalistika cestovního ruchu (Tourism Environmentalism). *Czech Journal of Tourism*, 1(2), 77-113.

Ramsar Sites Information Service. 2020. Ramsar Information Sheet. India. Lonar Lake. Available at: Available at: https://rsis.ramsar.org/RISapp/files/RISrep/IN2441RIS_2011_en.pdf

Ranawat, Punyakrit & George, Soni. 2019. Potential Geo-heritage & Geo-tourism Sites in India. International Journal of Scientific and Research Publications (IJSRP).

Singh, M. R. and Meenakshi Singh. 2018. Comparative Limnological and Physico-Chemical Studies of Lonar Crater Lake, India. Journal of Global Bioscience. ISSN 2320-1355 Volume 7, Number 8.

Tambekar DH, Pawar AL, Dudhane MN. 2010. Lonar Lake water: past and present. Nat Environ Pollut Technol 9(2):217–221.

Tambekar, D. H., Jaitalkar, D. S. and M. V. Kavitkar. 2012. Studies On Antimicrobial Potential of Medicinal Plants from Lonar Lake, Science Research Reporter 2(3): 268-273.

The Hindu. 2020. Lonar Lake in Maharashtra's Buldhana district turned pink due to 'Haloarchaea' microbes: probe. Available at: https://www.thehindu.com/news/national/lonar-lake-turned-pink-due-to-haloarchaea-microbes-probe/article32161619.ece

Trainman. 2019. Mystery of Lonar Crater. Blog. Available at: https://blog.trainman.in/blog/mystery-of-lonar-crater/

Torabi Farsani, Neda & Coelho, Celeste & Costa, Carlos. 2011. Geo-tourism and Geoparks as Novel Strategies for Socio-economic Development in Rural Areas. International Journal of Tourism Research.

Torabi Farsani, Neda & Coelho, Celeste & Costa, Carlos. 2013. Rural Geo-tourism: A new tourism Product. Acta Geografica.

UNESCO. 2010. Guidelines and Criteria for National Geoparks seeking UNESCO's assistance to join the Global Geoparks Network, Paris.

UNESCO. 2023. UNESCO Global Geoparks. Available at: https://www.unesco.org/en/iggp/geoparks/about

United Nations. 2023. Convention on Biological Diversity and its protocols. Available at: https://www.un.org/ldcportal/content/convention-biological-diversity-and-its-protocols