



RESEARCH ARTICLE

Management and Conservation of Geomorphosites: A Case Study of Chabimura

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ABSTRACT

Chabimura, Tripura, India is renowned as an important geomorphosite because of its scientific, cultural, artistic and social/economic merits. The site is famous for important rock art depicting gods from the 15th and 16th centuries. The site is threatened by human impact that has changed the landscape. The present study intends to establish methodologies for the assessment of the value of Chabimura and its protection using geo-conservation based legal frameworks. The main aims are to understand the socio-cultural dynamics, to improve the geotourism potential and to integrate the conservation efforts with the growth of the local community. The methodology uses qualitative methodologies and the Reynard model to evaluate the tourism potential of the site. Findings show that sustainable management approaches are needed to reduce the site's vulnerability and encourage scientific tourism and support local economic growth and cultural heritage. Recommendations are addressed to community-based planning and policy integration for sustainable use of geomorphosites.

1. INTRODUCTION

Geomorphosites are one of the many types of geosites referring to all the disciplinary fields of geosciences (structural, paleontological, sedimentological, stratigraphical, mineralogical, geochemical, petrographical, hydrogeological, speleological, pedological, geomorphological sites, etc.) eosites (synonyms: geotopes, Earth science sites, geoscience sites) could be defined as parts of the geosphere that have a certain importance for the understanding of the Earth's history (Reynard 2004a).

Some authors (Panizza & Piacente 2008; Panizza 2001; Ghosh, A. Mukhopadhyay, S. (2022) have projected a definition wider. They consider as geosites any geological object – a mineral site, a

landform, a fossil, etc. – with a certain value due to human perception or exploitation. The authors distinguish four types of values: scientific, aesthetic, cultural/historical and economic. In turn, Reynard (2004b, 2005a) has proposed to consider only the geological value as “scientific value” and to add, therefore, a fifth main value which is the ecological one. He also suggested making a distinction between the values of geosites at two levels: the central (scientific) and the additional values (ecological, aesthetic, cultural and economic values).

2. STUDY AREA

Chabimura, which is located in the Amarapur subdivision, is the current study area (**Figure 1**).

Tripura's capital, Agartala, is 82 kilometers distant. On the steep mountain wall on the Gomati stream, Chabimura is well-known for its rock carvings. Shiva, Vishnu, Kartika, Durga, and other gods and goddesses are shown in enormous carvings. These pictures are from the 15th and 16th centuries AD. These pictures are curved on Devtamura's steep 90-degree rocky faces. Thick jungles cover the hill ranges. Additionally, this region is a hub for ecotourism. On the opposite side of the bank is the first panel. It is 28 meters long, 10.3 meters high, and faces south. Currently, some of the photos are lost due to the rock panels moving. The second image, of Mahishasurmardini, is curved at a height of 10 km from the riverbed and is located around 1 km from the first panel. This is one of the biggest reliefs of the Goddess in the nation, which makes it special. The local tribe venerated it as "chakrak -Ma". The picture is 10.70 meters tall and 7.70 meters wide. The face is shown as round, with

several locks of unkempt hair. With the exception of the lower, which holds the demon king's hair, she has ten weapons. Because of erosion and flowery growth, the weapons are largely indistinct. The Chabimura is distinguished by a gently rolling landscape and an abundance of greenery. The site's surroundings have hillocks and mounds on the southern side and the Baramura and Devtamura hill range on the western side. The region is located between 25 and 35 meters above mean sea level. The artificial lakes of Fatiksagar and Amarsagar are supplied by rainfall.

Elevation of Amarsagar is 98 m above msl while the northern and southern banks of Fatiksagar are about 99 m above msl. The climate is generally moderate with humid summers and average annual rainfall of 1922 to 2855 mm. The area contains a variety of sedimentary rock features of marine-mixed-fluvial origin ranging from the uppermost Oligocene (38 million years ago) to the present. These

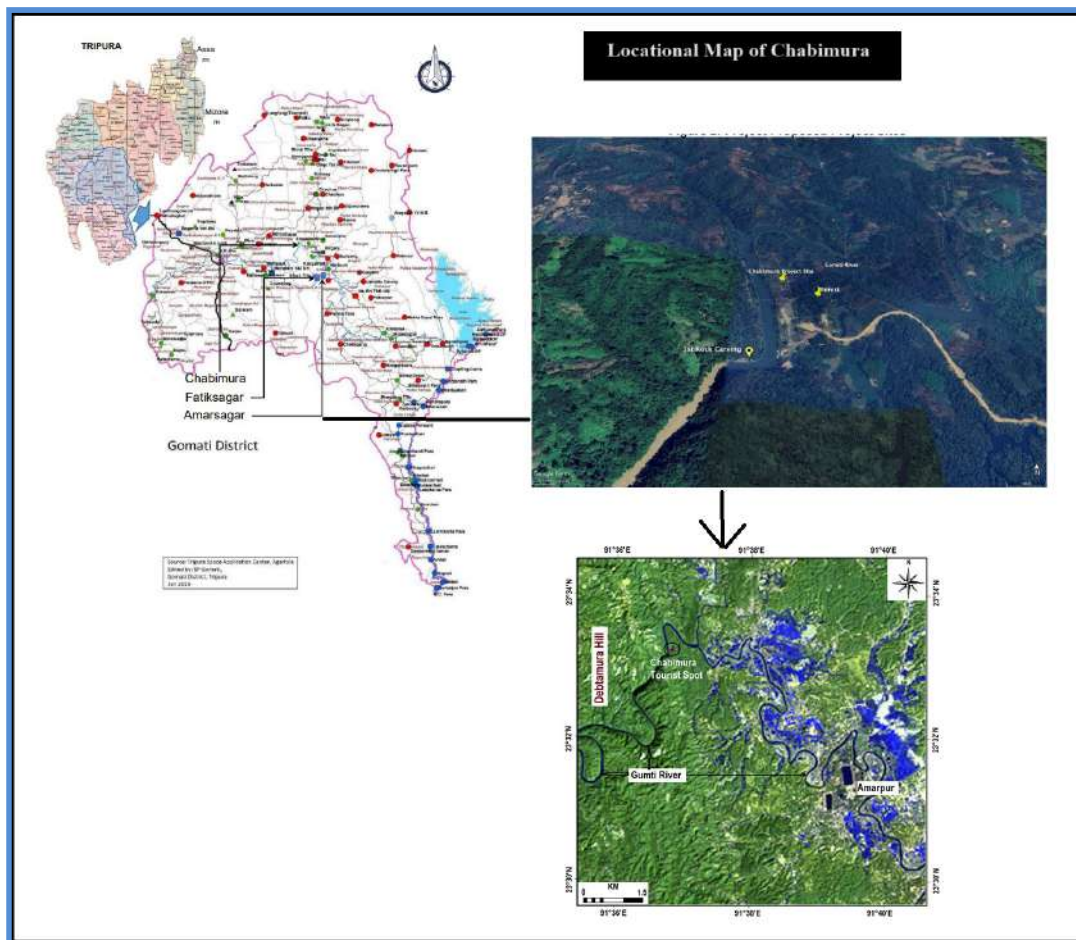


Figure 1. Study Area (Chabimura)

sediments, according to GSI, have been deposited in the Surma basin in Tertiary age (which lasted for 65 million years) under a wide range of environmental conditions controlled by local tectonic movement. The region now consists tectonically of a series of sub-parallel arcuate, elongated, doubly plunging folds arranged in a north-south direction (**Figure 2**). The area is also seismologically is fall in Zone V.

3. OBJECTIVE OF THE STUDY

- In this paper, the author has worked on largely
1. To examine and enhance innovative techniques for evaluating Chabimura's scientific, cultural, artistic, and social/economic values and to appraise a chosen research area for the growth of scientific geotourism.
 2. To safeguard it using a legal framework that takes a geomorphological heritage and geo-conservation approach.

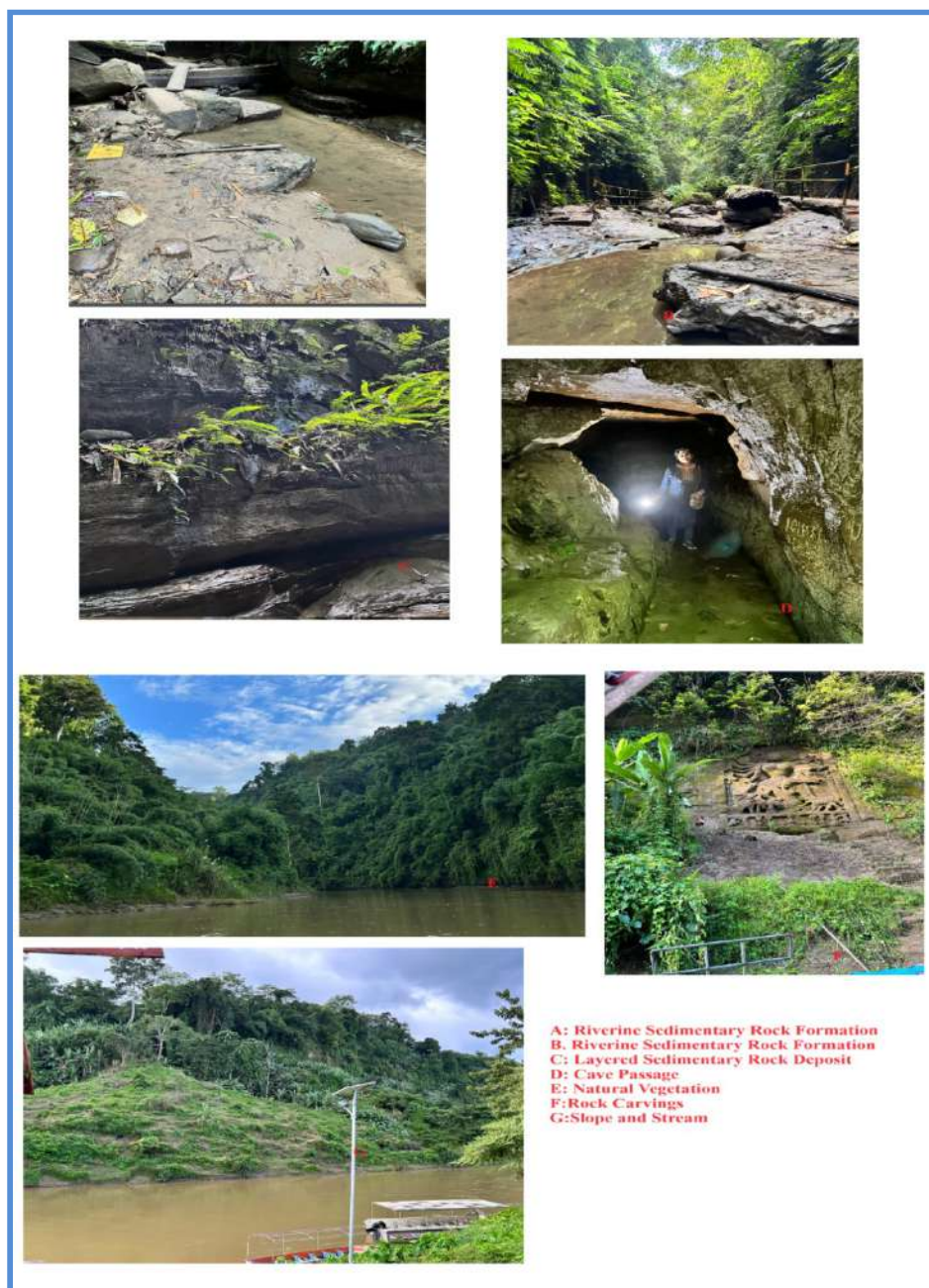


Figure 2. Physical Elements along with Rock Carvings in Chabimura

4. THE SIGNIFICANCE OF THE STUDY

The study of Chabimura and other geomorphosites of Tripura is essential as it has the potential to integrate the conservation of cultural heritage with the socio-economic development of the local community and the state as a whole. The significance of the study is elucidated in several crucial areas:

(i) Understanding socio-cultural and economic elements: The study is intended to comprehend socio-cultural features of Chabimura and its economic developmental position. It aims in particular to study the living conditions of the local inhabitants.

(ii) Geo-cultural and Geotourism Potential: The study asserts that Chabimura is a unique and valuable geomorphosite with rock carvings from the 15th and 16th centuries. It shows the possible benefits of marketing Chabimura as a responsible geotourism destination for local tribal women and youth through creating employment opportunities in boat services, homestays, guiding and handicrafts industries. Inclusive and Sustainable Development: The research reveals that the association of Janjatiya (tribal) development with protection of geomorphosites is an opportunity for inclusive and sustainable development. Tribal communities have a strong connection to their land, culture and natural environments. Utilizing this bond can be advantageous for both conservation of natural heritage and economic up-liftment of tribal inhabitants.

(iii) Filling a research gap: The study shows that Tripura offers promise for geotourism, although most of the geomorphosites are poorly documented and not well known. These places are also prone to damage caused by uncontrolled human activity due to lack of rigorous planning and precise monitoring strategy for the rise of tourism

(iv) Policy and Conservation Framework The study highlights the need for integrating the management of geomorphosites within the fold of existing frameworks such as the Tripura Tribal Areas Autonomous District Council (TTAADC), Forest Rights Act (FRA) and state tribal welfare schemes for the tribal communities to maintain their control over their land and culture and derive benefits from development.

5. METHODOLOGY:

The study mostly uses qualitative methods as its methodology. The Reynard Model (2007) plays a significant role in the comprehensive strategy for the development of sustainable tourism. The Reynard Model (2007) examines how tourism affects the growth of geomorphosites and the potential for tourism at any given location. The evaluation is divided into six parts, each part with a number of sub-criteria (**Table 1 and Figure 3**) on the basis of quantitative and qualitative criteria. Quantitative values are given in parts of 1. 0 is no value and 1 a very high value. The Reynard Model (2007) is used to assess Chabimura's tourism potential.

6. RESULTS AND DISCUSSION

(i) Potentiality as Geo-tourism spot: A preliminary survey was undertaken in January 2022 among the tourists around Chabimura. Data were collected from 100 tourists of different age on the basis of Value Criteria, on the scale of 0 to 1. Based on their responses, the value significance of each site i.e. which site is more valuable for which criteria namely, scientific, ecological, research, cultural or economic have been tabulated. Average scores of each sites was calculated based on the scores given by tourist and prepared proportion based linear scale index. The obtained value after was classified into: Very high= 1-0.8; High =0.8-0.6; Medium Low =0.6-0.4; Very Low =0.4-0.2; Extremely Low <0.2 (**Table 2**).

(ii) The vulnerability of Chabimura as geomorphosite: Geomorphosites are fragile and may need management and protection. The study of vulnerability of Chabimura deals with anthropogenic impacts on landforms and the effects of natural processes on evolution of landforms (**Figure 4**).

7. GENERALIZED FRAMEWORK AND RECOMMENDATIONS

This work suggests the following framework to guarantee sustainable development:

(i) Inclusive Integration: To guarantee that tribal communities maintain control over theirland and culture while reaping the benefits of economic growth, geomorphosite management must be

connected to the Forest Rights Act (FRA), the Tripura Tribal Areas Autonomous District Council (TTAADC), and State Tribal Welfare Schemes.

(ii) Community-Based Planning: Sustainable growth necessitates educating local people on how to be hospitable and navigate safely.

(iii) Policy encourage: To encourage tourism expansion and preserving environmental integrity, state-level initiatives should be used to provide essential infrastructure such as roads, water, and health care.

Table 1: Evaluation and Criteria Used for the Assessment

Parts and Criteria	Sub-criteria
General data	Location Type
Descriptive data	2a. Description; 2b. Morphogenesis
Scientific value	Assessment of the scientific value of the geomorphosite
Additional values	4a. Ecological value; 4b. Aesthetic value; 4c. Cultural value; 4d. Economic value
Synthesis	5a. Global value; 5b. Educational value; 5c. Threats; 5d. Management measures
References	Bibliographical references and supporting sources

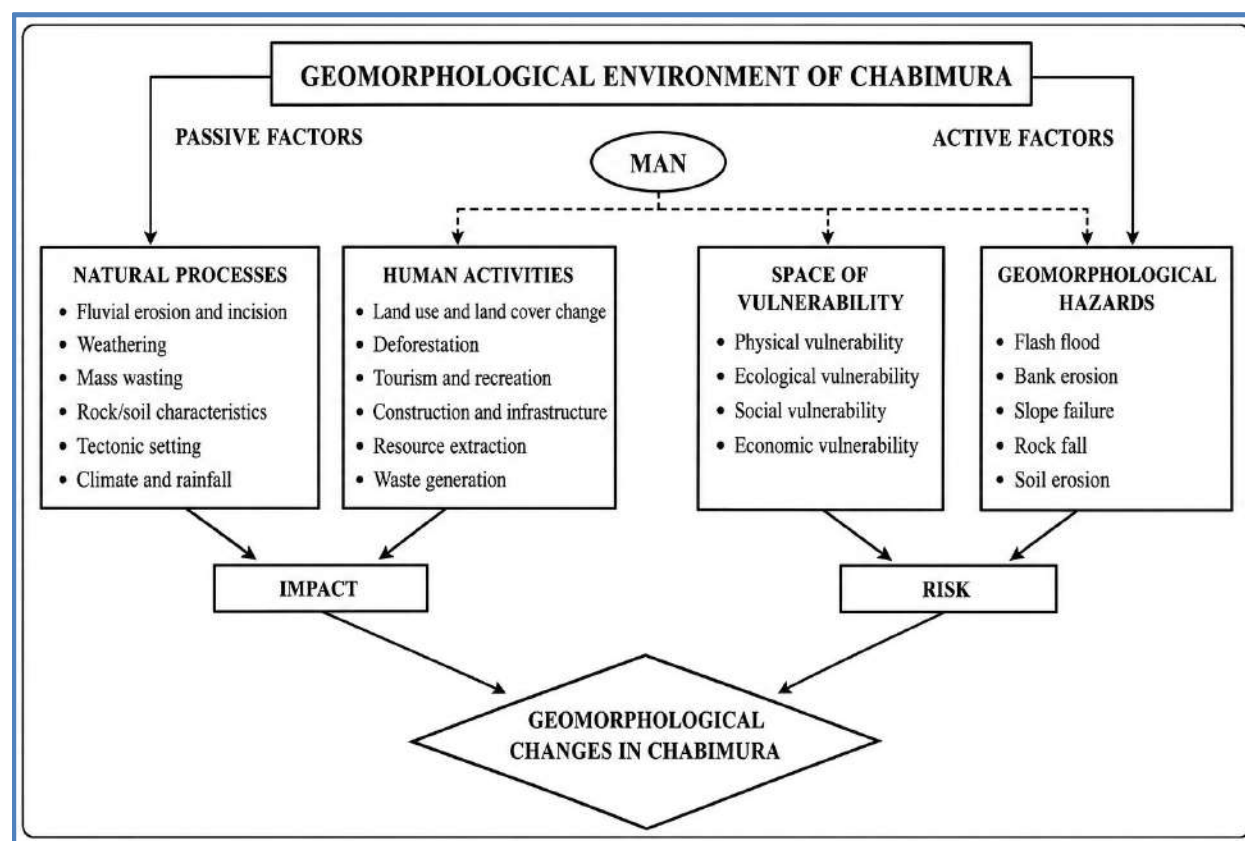
Value Criteria for Assessing Geomorphosites
Chabimura (Tripura, India)
Based on Reynard et.al 2007

Scientific Value	Ecological Value	Aesthetic Value	Cultural Value
Geological/Geomorphological significance - Rare example of canyon/cave system developed in soft sandstone (Tipam Sandstone of Surma Group) - Well developed fluvial erosion landform with unique rock sculptures - Excellent natural laboratory for studying river incision, cave formation and weathering - High integrity and naturalness of the landform - Provides important information on regional geology and geomorphic evolution	Ecological significance & knowledge of ecosystem - Rich riparian and semi-evergreen forest ecosystem - Habitat for diverse flora and fauna - Presence of rare and endemic plant species - Supports aquatic life in the Gunti River - Maintains ecological balance and water regulation - Potential for biodiversity conservation and eco-research - Important for environmental education and awareness	Understanding the natural beauty - Scenic canyon with high vertical cliffs and narrow passages - Natural rock sculptures and carvings enhance beauty - Play of light and shadow inside the caves - Harmony of river, rock and vegetation - Inspiring and serene natural atmosphere	Educational Importance - High potential for field education in geology, geomorphology and ecology - Helps in environmental interpretation and awareness - Source of local and indigenous knowledge - Useful for school, college and university learning - Accessible for educational excursions and nature study
Knowledge of Geomorphological & Geological processes & Phenomena - Illustrates fluvial erosion processes and canyon formation - Shows differential weathering and sandstone sculpting - Understanding of cave development in soft rock - Represents late Quaternary fluvial activities of the region - Potential for future research on geomorphology and sedimentology		Appreciating aesthetic values in Geosites - Unique natural rock carvings resembling human and animal figures - Pleasant trekking and boating experience - Calm river environment and green surroundings - Strong sense of place and natural wonder	Economic Value and job Opportunities - Important tourist destination in Tripura - Generates income through tourism, boating, guiding and local crafts - Creates employment for local communities - Supports sustainable local development - Potential for eco-tourism and geotourism promotion

Figure 3. Value Criteria for Assessing Geomorphosites (based on Reynard et.al 2007).

Table 2: Assessing Chabimura in terms of Value Criteria.

Value Criteria	Rating of respondents	Degree of Geotourism Relevance
Scientific Value	0.80	Very High
Ecological Value	0.80	Very High
Aesthetic Value	0.90	Very High
Cultural Value	0.50	Medium
Economic Value	0.40	Low

**Figure 4. Vulnerability of Chabimura as geomorphosite.**

8. CONCLUSION

Uncontrolled use of Chabimura is likely to increase its vulnerability risk and lead to huge losses, but it can enhance scientific tourism. The area is changing quickly under dynamic conditions. Management should be the first necessary step in protecting Chabimura.

In order to maintain tourism in such a delicate setting, conservation techniques are required for a particular study region in order to identify their heritage values with potential for geotourism.

The medium and low intensity scored regions need to be re-visited with advancement in research for promoting geotourism opportunities. In light of this research and evaluation, the author recommends that a sustainable development strategy be used to aggressively promote scientific tourism for the geomorphosites.

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CONFLICT OF INTEREST

The author asserts that there is no conflict of interest.

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