

Geotourism and Sustainable Development Perspectives of the Khao Phra Wihan National Park on the Southern Edge of the Khorat Plateau, Thailand

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Abstract: *Khao Phra Wihan National Park is located in Southern Edge of the Khorat Plateau and is the border between Thailand and Cambodia. This area is under the influence of the Khmer culture including their architectures and arts. Based on the surveying and characterization of the geosites, this area comprises many sandstone landforms such as the cliff, the cascade, and the reservoir, interweaving with other natural sites. Pha Mo E Dang cliff is the highlight of this park. There are sculptures and engravings. In addition, there are panoramic views of the Prasart Khao Phra Wihan and Cambodian plain from the top of the cliff, which is the outstanding point of the southern edge of the Khorat Plateau. The evaluation of geosites can lead to a good international relationship and will support the co-management of geoheritage resource. This is the first step to announce geotourism in this area. This is a powerful tool for a sustainable development in economies, social science, anthropology, and earth science in both the local and state.*

Keywords: *Geotourism, Sustainable Development, Khao Phra Wihan National Park, Khorat Plateau, Thailand*

1. Introduction

Khao Phra Wihan National Park is a protected natural area in Sisaket Province, the southern part of Northeastern Thailand. The park lies 98 km in the southern flank of Sisaket city center, at the end of Thai highway 221. There are numerous ruins of the 11th century Khmer Empire, which were built to honour the Hindu god Shiva in 1,100 years ago. Prasat Khao Phra Wihan is situated at the Cambodian Plain, but Khao Phra Wihan National Park headquarter is located in the slope of the Dandrek escarpment. In the past, Thai government established Natural Park which includes Prasat Khao Phra Wihan. However, it is not a part of this natural park; it is located in Cambodian plain and is the world heritage site. Due to this castle being the famous world heritage, Thai people always visit the Khao Phra Wihan National Park to look at the Castle.

Geotourism is being developed at a very rapid rate around the world and will become an important touristic activity in Thailand. Geotourism is often referred to as a form of nature-based tourism that focuses primarily on the geosystem (Gray, 2011; Newsome and Dowling, 2010). An early definition of geotourism as strictly 'geological tourism' was published by Hose (1995, 2000) and has subsequently been refined as a form of tourism that specifically focuses on geology and landscape. Geotourism announcement in this area is the first step promoted the new travel trend of Thailand. It effectively develops a good international relationship and supports the co-management and conservation of geoheritage resources between Thailand and Cambodia. Geotourism can be a powerful tool for sustainable development but, if not managed effectively, can constitute a direct threat to geoheritage resources (Newsome *et al.*, 2012). This study described the appearance, geological background and origin of the geosites, as well as the existing provisions for tourism.

2. Materials and Methodology

Materials for this research include topographic and geologic maps, photographs, and literatures related to the topic and the study area. Meanwhile, the methodology of the study is modified from Nazaruddin (2015), comprised the inventory, characterization, assessment, and geotourism planning. The inventory consists of identification and mapping of selected geological sites. The characterization of geological sites is carried out by observing and describing the landform group occurrence in detail. After that, we will describe geosite attraction distribution in the national park. In addition, the assessment is conducted on the basis of determination of geoheritage values and levels of significance. Finally, the geoscientific interpretation is the important data for geotourism and for planning the travel route of the Khao Phra Wihan National Park.

3. General Geology

Khao Phra Wihan National Park is located in the Southern Edge of the Khorat Plateau, where uplifted from an extensive plain composed of remnants of the Cimmerian microcontinent, and terranes such as the Shan–Thai Terrane, either late in the Pleistocene or early in the Holocene Epoch (Bunopas and Vella, 1992). It is covered by Jurassic to Cretaceous sedimentary rocks of the Khorat Group; Phra Wihan, Sao Khua, and Phu Phan Formations that comprised sandstone and siltstone and has many joint systems in the area (Figure1).

The Phra Wihan Formation comprises well-sorted, rounded, fine-coarse grained, pale yellow sandstone, thin bedded siltstone, mudstone and conglomerate. It was deposited in braided streams and occasional meandering rivers in slightly humid conditions (Meesook, 2000) and have Late Triassic to Early Jurassic age (Hahn, 1982). The Sao Khua Formation consists of cycles of reddish brown sandy mudstone with interbedded siltstone, fine to medium grained sandstone and conglomerate. This formation has river bank environment deposition in semi-arid paleoclimate (Meesook, 2000). Kon’no and Asama (1973) found plant remains of *Sphenopteris goeppati*, dated Late Jurassic to Early Cretaceous. In addition, the Phu Phan Formation mainly consists of medium to coarse grained light gray sandstone, subordinated with siltstone, shale, conglomerate with calcareous lens, and reddish brown sandstone. Some sandstones grade into thick beds of conglomerate with large planar and trough cross-bedding. The Phu Phan Formation was deposited in braided streams and occasional meandering rivers in a rather hot and humid to semi-arid paleoclimate (Meesook, 2000) in Early Cretaceous (Racey *et al.*, 1994, 1996).

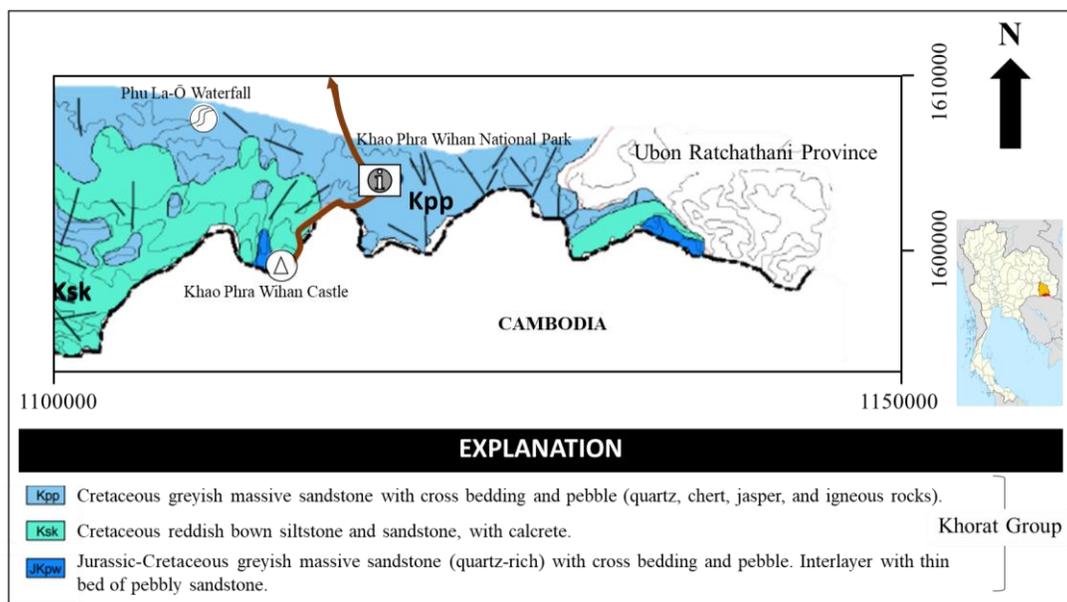


Fig. 1: Geologic map of selected study case in Si Saket Province, Thailand (modified from Department of Mineral Resources, Thailand, 2007).

4. Inventory and Characterization

The inventory of potential geosite resources in the study area includes the identification and mapping of the selected geological sites which are based on the previous listings of the famous attraction in the Khao Phra Wihan National Park. Both rock type and their occurrence are never demonstrated in any scientific description. Identification of the sites of geoheritage significance also needs considering some criteria such as unique occurrence, rarity, and representativeness of some geological features (Predrag and Mirela 2010). The travel route map in the Khao Phra Wihan National Park was created in this study (Figure 2). The geodiversity of the Khao Phra Wihan National Park, consist of cliff, cascade, and reservoir. Meanwhile, the national parks have many other attractions, which are a part of the outstanding point for interested tourist especially the historical and nature attractions.

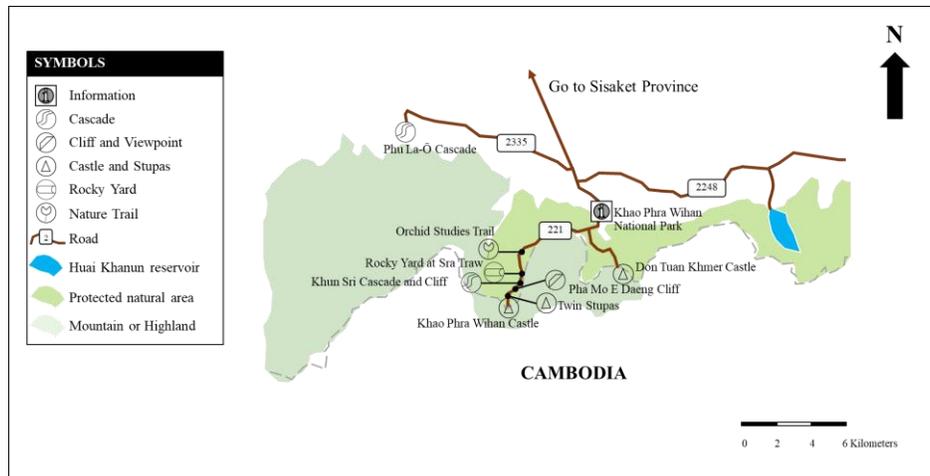


Fig. 2: Accessibility of the geosites in the Phra Wihan National Park

Pha Mo E Daeng Cliff rears over 500 meters above the Cambodian plain (Figure3a). Cliff is the steep slope of earth materials, usually a rock face, which is nearly vertical and may be overhanging. Structural cliffs may be formed as the result of fault displacement or the resistance of a cap rock to uniform down cutting. The case of this sandstone cliffs, is formed in strongly cemented sandstones, especially on the sides of the deeply incised valleys and around the edges of plateau (Figure3b). In 1987, a Border Protection Ranger Unit discovered two groups of bas-relief images and engravings (Figure4). The figures are now a highlight of the park. The park atop Pha Mo E Dang is the viewpoint area to panorama viewscape of Prasat Preah Vihear and Cambodian plain (Figure5).



Fig.3: a) Pha Mo E Daeng Cliff and b) steep cliff in the edges of plateau.



Fig.4: the sculpture and engravings in the sandstone cliff



Fig.5: the panorama viewscape of Prasat Preah Vihear and Cambodian plain

Sra Traw is an ancient Khmer reservoir, which reserved the water from Huai Traw stream for agriculture in the past. At present, this area has been developed to be a clean and pleasant recreational area. Khun Sri Cascade is the small-sized waterfall that exposes the sandstone feature of the national park. On the other hand, Khun Sri Cave is the sandstone cliff in the area. It is not a cave in a geological term, which is formed in limestone topography. Phu La-Or Cascade is the medium-sized waterfall which is most beautiful from September to February. It is located inside Phnom Dongrak Wildlife Sanctuary and has a nature trail to observe local plants and views. The difference in rock type and fault movement are the conditions that give rise to cascade. The morphology of the North eastern part of Thailand, a high plateau surrounded by a steep scarp slope, creates cascades and rapids on most of its major rivers.

Huai Khanun reservoir is an artificial (man-made) lake. It exposes some geological features which have potential geoheritage values. The area is composed dominantly of sandstone. Its original purpose is as a catchment area of Huai Khanun stream flow (reservoir) for agriculture. However, because of the beauty of its surroundings, its functions can be further developed into a tourist destination that offers not only the beauty of this reservoir but also a quiet and comfortable environment. There are historical sites in this park such as stupas and castle. The Twin Stupas are two red sandstone structures of the Khmer Civilization. In addition, the Don Tuan Khmer castle is located on border ridge and is built by sandstone and laterite.

5. Assessment

The assessment of this potential geoheritage resources used the qualitative approach that focuses on some geodiversity values, mainly scientific and educational values and additional values such as aesthetic, recreational, cultural, economic, and functional values (Gray 2004; Gray 2005; Komoo 2003). In addition, levels of significance should also be assigned for the ranking of geoheritage resources, such as international, national, statewide, regional, and local (Brocx and Semeniuk 2007). Table 1 presents the qualitative assessment of the study area on the basis of geoheritage values and levels of significance.

TABLE I: The Qualitative Assessment of the Study Area

Scientific and educational value	Various Sandstone	Sandstone Landforms such as cliff and cascade	
Aesthetic value	Attractive landscape of cliff	Attractive landscape of cascade	Attractive landscape with the manmade lake surrounded by hilly area
Recreational value	Rock climbing and hiking	Swimming	Lake cruise with the boat
Cultural and historical value	Settlement of Khmer	Khmer architecture	bas-relief images and engravings
Economic value	Local community can generate income by selling		
Functional value	Cambodian plain panorama view		
Level of significance	National		

6. Discussion for Sustainable Development Perspectives

Geoheritage evaluation can serve as a tool for the conservation and development of the study area. In this study, the strength, weakness, opportunity, and threat (SWOT) analysis was used to evaluate the study area in terms of their SWOT. This analysis is effective method, which can be used for plan management that take into consideration many factors. This method is used to maximize the potential of the strengths and opportunities while minimizing the impact of the weaknesses and threats. One of the positive sides of the area is its potential for research and public education, not only on geological interest but also on indigenous flora and fauna, archaeological and historical objects. In addition, this scenic area has high aesthetic value which makes the area more attractive. Table 2 lists the SWOT analysis of the study area for conservation and development.

TABLE II: SWOT Analysis to Evaluate of the Study Area for Conservation and Development

No.	SWOT	Remark
1	Strength	Good management and protection from National Park Good potential for recreational activities such as hiking, swimming etc. High aesthetic value such as viewscape, nature, and Khmer civilization High cultural value of aboriginal people Some sites have historical, economic, and functional values Good accessibility
2	Weakness	Lack of promotion of the area Armed conflict area between Thailand and Cambodia
3	Opportunity	Study area is suitable for research and educational activities Need information panels to serve visitors Promotion can increase the attractiveness of this area and bring possibility of development of local community Cooperation between local authority, university, and community
4	Threat	Encroachment on the public land

Although the Khao Phra Wihan National Park is far from the Sisaket city center, there is a good accessibility for the travellers. It is developed as an outdoor recreation ground. Facilities include a small hall, viewing point, outdoor court and accommodation. There are the Nature Trail lines around Sra Traw and near the Phu La-Or cascade. They run through various kinds of flora. Meanwhile, Huai Khanun reservoir is one of the famous nature attractions of this park. The geosites are accessible without restriction, using a dense network of paths. However,

the park does not have any signs on the description and interpretation of the landforms and the origin of rock formations.

The promoting of geotourism will help tourists understand the geological processes and realize the important of the conservation. Although the geoscientific data is still lacking, it is essential for geosite conservation. National parks are legal forms of geo- and nature- site protection, intended to sustain harmonious cultural landscapes of significant aesthetic value. Within the protected area, the most impressive cliff, Pha Mo E Dang, and other previously named sites are listed as nature monuments. In addition, it is the new tourism announcement of Thailand, which affects good local and nation economies. The geotourism can be a powerful tool for sustainable development but, if not effectively managed, can constitute a direct threat to geoheritage resources.

7. Conclusion

Khao Phra Wihan National Park is located in the Southern Edge of the Khorat Plateau and is dominated by sandstone and siltstone. It is the border between Thailand and Cambodia and Khmer civilization area. This area has many landform features such as Pha Mo E Dang cliff, Khun Sri and Phu La Or cascades, Sra Traw and Huai Khanun reservoirs. Cliff and cascade are a geological process due to the difference resistance in sedimentary rock layer. Steep cliff like Pha Mo E Dang is common on the edge of plateau. Meanwhile a reservoir is created by people for agriculture and consumption in both the past and present. These geosites interweave with nature and culture, which is the good index of assessment and evaluation. The first impression of this park is Pha Mo E Dang cliff. There are the bas-relief images and engravings and panorama views of the Prasart Khao Phra Wihan and Cambodian plain. The promoting of geotourism will help people understand the geological processes and realize the important of the geoconservation. In addition, the first step to geotourism announcement is a powerful tool for sustainable development in economy and good international relations as support in co-management in geoheritage and other heritage resources.

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9. References

- [1] Meesook, "Cretaceous environment of northeastern Thailand", *Cretaceous environment of Asia*, H. Okada and N.J. Mateer, Ed. 2000, 207-223.
- [2] Racey, J.G.S. Goodall, M.A. Love, S. Polachan and P.D. Jones, "New age data for the Mesozoic Khorat Group of Northeastern Thailand". In *Proc. the International Symposium on Stratigraphic Correlation of Southeast Asia*, 1994, pp. 245-252.
- [3] Racey, M.A. Love, A.C. Canham, J.G.S. Goodall, S. Polachan, P.D. Jones, (December, 1996). Stratigraphy and reservoir potential of the Mesozoic Khorat Group, NE Thailand, Part I: Stratigraphy and sedimentary evolution. *Journal of Petroleum Geology [Online]*. Pp. 321-338. Available: www.researchgate.net/publication/229641734_Stratigraphy_and_reservoir_potential_of_the_Mesozoic_Khorat_Group_NE_Thailand
- [4] D. Newsome and R.K. Dowling, *Geotourism: The tourism of geology and landscape*. Oxford, UK: Goodfellow Publishers, 2010.

- [5] D. Newsome, R. Dowling and Y.F. Leung. (April-July, 2012). The nature and management of geotourism: A case study of two established iconic geotourism destinations. *Tourism Management Perspectives [Online]*. 2(3). pp. 19–27. Available: www.sciencedirect.com/science/article/pii/S2211973611000122
- [6] D. Predrag and D. Mirela. (November, 2010). Inventory of geoheritage sites – the base of geotourism development in Montenegro. *Geographica Pannonica [Online]*. 14(4). pp. 126–132. Available: www.dgt.pmf.uns.ac.rs/pannonica/papers/volume14_4_3.pdf
- [7] D.A. Nazaruddin. (December 2015). Systematic Studies of Geoheritage in Jeli District, Kelantan, Malaysia. *Geoheritage [Online]*. 9. pp. 19–33. Available: <https://link.springer.com/article/10.1007/s12371-015-0173-9>
- [8] Department of Mineral Resources Thailand, “Geologic map of Si Saket Province”, 2007.
- [9] E. Kon’no and K. Asama, “Mesozoic plants from Khorat, Thailand: Geology and Palaeontology of Southeast Asia”, *Tokyo University Press*, vol. 12, pp. 149-172, 1973.
- [10] L. Hahn, “Stratigraphy and marine ingressions of the Mesozoic Khorat Group in Northeastern Thailand”, *Geologische Jahrbuch, Reihe B*, vol. 43, pp. 7-35, 1982.
- [11] M. Gray, “Other nature: Geodiversity and geosystem services”, *Environmental Conservation*, vol. 38, pp. 271–274, 2011.
- [12] S. Bunopas and P. Vella, “Geotectonics and Geologic Evolution of Thailand”, present at the National Conference on Geologic Resources of Thailand, November 17–24, 1992, pp. 224.
- [13] T.A. Hose, “European geotourism— Geological interpretation and geoconservation promotion for tourists”. In *Geological heritage: Its conservation and management*, InD. Barretino, W.P. Wimbledon, and E. Gallego, Ed. 2000, (pp. 127–146).
- [14] T.A. Hose, “Selling the story of Britain's stone”, *Environmental Interpretation*, vol. 10, pp. 16–17, 1995.