

# Impact of Climate Change on Mountaineering Activities in Haba Snow Mountain Reserve and the Development of Surrounding Communities

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## Abstract

In the context of global climate change, this study reviews and discusses the three aspects of ecology, economic development of surrounding communities, ecological balance and snow mountain activities in the Haba Snow Mountain Reserve through literature collation and research. 1) The Hengduan Mountain Plate of Haba Snow Mountain is affected by the high altitude temperate monsoon and is sensitive to climate change. There has been continuous glacier melting and snow line fluctuations. Although there is no forest line movement, the vegetation at the junction of the forest line has increased. 2) Human activities in the Haba Snow Mountain Reserve have shown an active trend, and the Biomass in various ecosystems in the region is inversely correlated. 3) Climate change will have a negative impact on landscape attraction and tourism safety in snowy mountain areas. 4) Haba Snow Mountain Reserve needs more perfect biological species statistical research and dynamic vegetation research to support the establishment of a perfect ecological protection strategy and ecological early warning in the region. 5) As the frequency of tourist activities in the Haba Protected Area increases, corresponding environmental protection signage, garbage cleaning methods, and tourist education have not been synchronizedly improved.

## Keywords

Haba Snow Mountain, Climate Change, Snow Mountain Ecology, Snow Mountain Activities

## 1. Introduction

The global climate report shows that 2023 is the hottest year on record. Human beings are facing the continuous creation of new high ecological data: the aver-

age surface temperature has increased by  $1.45^{\circ}\text{C} \pm 0.12^{\circ}\text{C}$  compared with the pre-industrial revolution, and is approaching the critical point of 2 degrees Celsius. The ocean heat has also reached the highest level in history, constantly destroying marine ecosystems, resulting in sea level rise, the disappearance of polar sea ice and the unprecedented regression of glaciers. At the same time, extreme weather is also destroying the economic development of human society [1]. This region experiences more rapid progress in global climate change, with more noticeable changes in rainfall patterns because of China's monsoon climate and complex geographical features [2]. Studies have shown that in the 70 years from 1951 to 2021, the average annual surface temperature in China increased by  $2.6^{\circ}\text{C}$  [3]. Among them, high-altitude snow areas respond more significantly to such climate crises. Remote sensing images and the results of China's second glacier inventory show that the glaciers below 4800 meters in altitude in the Qilian Mountains: The northeastern part of the Qinghai-Tibet Plateau has experienced significant losses in both area and volume, with a loss rate of 2.5% [4]. The fragile high-altitude snow-capped areas located in the Hengduan Mountains are also structurally unstable due to the melting of snow water, resulting in frequent landslides and other natural disasters [5]. Due to geological movement and glacial movement, Yulong Snow Mountain and Haba Snow Mountain together constitute the main body of the Shandong side of Hengduan. The two snow mountains are separated because of the big fracture. The fracture has become the famous Tiger Leaping Gorge, guiding the Jinsha River to flow eastward. At the same time, it has also created three famous tourist landmark landscapes: Haba Snow Mountain, Tiger Leaping Gorge and Yulong Snow Mountain. Haba Snow Mountain and Yulong Snow Mountain are both temperate glacier areas in the southeast of the Qinghai-Tibet Plateau, and the glacier area has shrunk by 64.02% in the past 60 years [6]. It is worth noting that the Hengdunshan glacier area is also a well-known tourist attraction in China. The tourist routes around the snowy mountains are mature, the services are comprehensive, and the urban transportation system is developed. At the same time, it is also a residential area for ethnic minorities. The impact of climate will not only affect agriculture, biodiversity and water sources in the region, but also the landscape defects caused by iceberg ablation have also seriously affected the local tourism economy and industry in recent years. This article will review the ecological status and the development of surrounding communities in the Haba Snow Mountain Reserve, and explore the contradiction and balance between the ecological protection urgently needed for climate change and the economic development brought about by mountaineering.

## 2. Review of the Ecological Status of Haba Snow Mountain Reserve

Haba Snow Mountain is the product of the orogeny of the Himalayas. It is located at the junction of the Qinghai-Tibet Plateau and the Yunnan-Guizhou

Plateau, which together form the eastern peak of the Yunling Mountains of the Hengduan Mountains. The administrative geography belongs to Shangri-La City, Diqing Tibetan Autonomous Prefecture, Yunnan Province (the protected area is located in the southeast), 120 kilometers away from Shangri-La Tourism City, and the highest peak is 5396 meters above sea level. Hengduan Mountain, where Haba Snow Mountain is located, is a monsoon glacier in China's warm belt, which is extremely sensitive to global temperature changes. Even small temperature fluctuations will cause a large advance and retreat in the snow line in the region [7]. The glaciers on the Qinghai-Tibet Plateau have shown an accelerating trend based on satellite observations spanning from 2020 to 2022. The Haba Snow Mountain that located in the Hengduan Mountains on the eastern side of the Qinghai-Tibet Plateau, exhibits the most pronounced downward trend. This glacier retreat is characterized by continuous and uneven loss [8]. The peak of Haba Snow Mountain, which should be covered with snow all year round, has also seen rock exposure in recent years, while dark rocks will absorb more solar heat and exacerbate the melting of snow. Icebergs are important freshwater resources, and the rapidly changing amount of snow will affect the water use of organisms and communities in the whole basin. Early observation and analysis through satellite maps have shown that the decline of most glaciers and snow lines is accompanied by the rise of forest lines, causing low-altitude vegetation to invade high-altitude meadows and destroy the ecological balance [9]. This ecological imbalance affects water sources, soil, wildlife, and thus radiating the lives of residents in the surrounding communities. Fortunately, there was no obvious movement of forest lines in the study of the southern forest line changes of the main mountains of nine Hengduan Mountain, including Haba Snow Mountain, but the vegetation coverage (FCV) data of the transition zone of the forest line of each mountain range is common. The growth trend is speculated to be related to the increase in rainfall under climate change [10]. The absence of dynamic changes in the forest line in this region cannot rule out hidden dangers. The growth cycle of the main larch and fir in Haba Snow Mountain is expected to reach the 3 meters of the forest line tree standard in 27 - 50 years. Therefore, the data study of the 20-year span may have certain limitations in presenting the change of the forest line. In addition to larch and fir, the main distribution of alpine pine and Yunnan pine in Haba Snow Mountain is also sensitive to temperature and precipitation.

At the same time, the Hengduan Mountain area where the Haba Snow Mountain is located has become one of the hot spots of biodiversity in China under the influence of topography and monsoon, and is also regarded as an active area for species evolution. As a key protected area in China, Haba Snow Mountain has a complex animal and plant system and the largest number of rare species in China. However, for a long time, there has been a lack of statistical research data on many species in this region, which makes the relevant departments lack reference in the formulation of effective protection strategies, ecological early warning, and the formulation of a list of key endangered species.

### 3. Community and Economic Development of Haba Snow Mountain Reserve

The area around the Haba Snow Mountain Reserve includes 2 townships, Hu Jumpingxia Town and Sanba Naxi Township. Hudaoxia Town has jurisdiction over 10 administrative villages, with 132 villager groups, inhabited by 9 ethnic groups, including Yi, Han, Lisu and Tibet, accounting for 82% of the total population. The Sanba Naxi people have jurisdiction over 6 administrative villages, with 75 villager groups, living in 11 ethnic groups such as Naxi, Yi and Hui, with the Naxi ethnic group accounting for 62%. As of 2011, the total population of the two regions was 39,700.

In 2022, Tiger Leap Gorge Town received a total of 720,000 tourists, generating an income of 54.73 million yuan through the tourism industry, contributing 15% to the local GDP. Haba Village in Sanba Naxi Township, is located at the foot of Haba Snow Mountain, with a land area of 3.33 square kilometers. It will receive tourists in 2022 alone. 50,000 people provide catering, accommodation, hiking, transportation, guides and many other services. Promoting and improving the tourism industry around the Haba Snow Mountain Reserve is an important economic source for the surrounding communities. Therefore, under the guidance of the policy, the intensity of human activities in the Haba Snow Mountain Reserve has also changed significantly. In the past 13 years, the intensity of human activities has increased significantly in the northeast of the reserve and the western part of the Jinsha River. At the same time, among the eight ecosystem types of meadows, grass, evergreen broad-leaved forests, evergreen coniferous forests, tree gardens, shrublands, and tree green areas, except for the increase in biomass in the meadow type, the rest of the types are due to a decreasing trend, which is positively related to the mild growth of human activities [11]. Because of the activity of human activities and the tourism industry in the Haba Reserve, at the same time, the area has also become an area with low landscape connection with the Qianhu Mountain Scenic Area, the south side of Meili Snow Mountain, and the northwest of Gaoligong Mountain Nature Reserve [12], and the landscape connection is of great significance to the reproduction of the unique primate species in Yunnan. Human activities and industrial development form an organic contradiction.

### 4. Balance between Ecological Protection and Human Activities

Against the background of rising average temperature and continuous melting of glaciers, the weakening of geological disasters and snowy mountain landscapes will reduce tourism attractiveness [13]. On July 28, 2019, the debris flow disaster in the west of Haba Snow Mountain is considered to be the result of rainfall and glacier melting [14]. In the peak season of upright tourism and snow mountain climbing, geological disasters have a negative effect on tourism confidence and the safety of snow mountain climbing activities. The value created by

the biodiversity of Haba Snow Mountain is estimated to reach 19.63 billion yuan per year, of which the value created by tourism industries such as mountaineering, accommodation and transportation is 1.88 billion yuan per year [15]. This is crucial to the development of local communities and the establishment of the well-being of ethnic minority residents, but in turn, active human activities will interfere with the fragile high-altitude ecology that is in the climate change crisis.

This research conducted interviews with the mountain guide teams in the Haba Snow Mountain Protection Area in 2024 regarding environmental and ecological protection in the scenic area (Figure 1). The interview results indicate the following:

1) A considerable amount of plastic waste can be found along the hiking routes of Haba Snow Mountain and some tourists take away plants and stones from the scenic area. However, there are no warning signs for tourist behavior throughout the entire tourist area.

2) There is no unified waste management team along the hiking routes of Haba Snow Mountain, and all garbage is collected spontaneously by guides on their way down the mountain.

3) As important tourist gathering areas, in Haba Village and the foothills of Haba Mountain, there are no relevant educational areas have been set up to inform tourists about important ecological information and behavioral guidelines. Both villagers in Haba Village and professional guides and mountain guides mentioned that they have not received formal environmental education and ecological training.

The Chinese tourism market is experiencing a recovery, with an increasing number of tourists visiting Haba Snow Mountain each year. Climbing the snow-capped mountain is becoming a popular tourist activity, climbers will directly enter high-altitude areas to experience the stunning snowy landscapes, but at the same time, they pose a threat to the fragile high-altitude snow mountain ecosystems. It is evident that while the number of tourists is increasing, the ecological education and conservation measures in the protected area have not been improved.



**Figure 1.** Interview with Haba Snow Mountain mountain guides conducted by the author.

## 5. Summary

Global warming poses a challenge to the ecology and economy of high-altitude mountainous areas. Haba Snow Mountain, as a divine peak that carries local national beliefs and maintains important ecological links, is also affected by the melting of glaciers and the large fluctuations of the snow line. Higher temperature and more rainfall make the Haba Snow Mountain snow line move and plant at the junction of the forest line. Due to the increase in density, many studies indicate that this phenomenon may cause a series of ecological chain reactions, but the lack of anti-comprehensive species investigation and forest dynamic research in the region hinders the establishment of specific ecological assessment and early warning systems. The melting of ice and snow is accompanied by the defects of the snowy mountain landscape and the frequent occurrence of geological disasters, which has an impact on the important local tourism industry. Human activities in the Haba Snow Mountain Reserve have shown an upward trend in the past decade, which brings vitality to the local community and also negatively correlates with the biological density in a variety of ecosystems. As an important snow mountain tourism area in China, Haba Snow Mountain has great economic and ecological value, but there are also subtle contradictions between the two. To achieve a balance in such contradictions, it is necessary to improve more aspects of ecological investigation and research, and also need to carry out more comprehensive tourism and environmental protection education.

## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

## References

- [1] Canton, H. (2021) World Meteorological Organization-WMO. In: *The Europa Directory of International Organizations 2021*, Routledge, 388-393.
- [2] Zhong, X., Zhang, T., Su, H., Xiao, X., Wang, S., Hu, Y., *et al.* (2021) Impacts of Landscape and Climatic Factors on Snow Cover in the Altai Mountains, China. *Advances in Climate Change Research*, **12**, 95-107. <https://doi.org/10.1016/j.accre.2021.01.005>
- [3] Sun, Y., Zhang, X., Ding, Y., Chen, D., Qin, D. and Zhai, P. (2021) Understanding Human Influence on Climate Change in China. *National Science Review*, **9**, nwab113. <https://doi.org/10.1093/nsr/nwab113>
- [4] Cai, X., Li, Z. and Xu, C. (2022) Glacier Wastage and Its Vulnerability in the Qilian Mountains. *Journal of Geographical Sciences*, **32**, 117-140. <https://doi.org/10.1007/s11442-022-1939-z>
- [5] Zou, Y., Sun, P., Ma, Z., Lv, Y. and Zhang, Q. (2022) Snow Cover in the Three Stable Snow Cover Areas of China and Spatio-Temporal Patterns of the Future. *Remote Sensing*, **14**, Article No. 3098. <https://doi.org/10.3390/rs14133098>
- [6] Wang, S., Che, Y., Pang, H., Du, J. and Zhang, Z. (2020) Accelerated Changes of Glaciers in the Yulong Snow Mountain, Southeast Qinghai-Tibetan Plateau. *Re-*

- gional Environmental Change*, **20**, Article No. 38.  
<https://doi.org/10.1007/s10113-020-01624-7>
- [7] Wang, S., Che, Y., *et al.* (2021) Spatiotemporal Dynamic Characteristics of Typical Temperate Glaciers in China. *Scientific Reports*, **11**, Article No. 657.  
<https://doi.org/10.1038/s41598-020-80418-7>
  - [8] Zhao, F., Long, D., Li, X., Huang, Q. and Han, P. (2022) Rapid Glacier Mass Loss in the Southeastern Tibetan Plateau since the Year 2000 from Satellite Observations. *Remote Sensing of Environment*, **270**, Article ID: 112853.  
<https://doi.org/10.1016/j.rse.2021.112853>
  - [9] Baker, B.B. and Moseley, R.K. (2007) Advancing Treeline and Retreating Glaciers: Implications for Conservation in Yunnan, P.R. China. *Arctic, Antarctic, and Alpine Research*, **39**, 200-209.  
[https://doi.org/10.1657/1523-0430\(2007\)39\[200:atargi\]2.0.co;2](https://doi.org/10.1657/1523-0430(2007)39[200:atargi]2.0.co;2)
  - [10] Zou, F., Tu, C., Liu, D., Yang, C., Wang, W. and Zhang, Z. (2022) Alpine Treeline Dynamics and the Special Exposure Effect in the Hengduan Mountains. *Frontiers in Plant Science*, **13**, Article ID: 861231. <https://doi.org/10.3389/fpls.2022.861231>
  - [11] Ma, X.M. and Luo, Z.Q. (2015) Quantitative Study on the Spatiotemporal Variation of Human Activity Intensity in the Haba Snow Mountain Reserve. *Anhui Agricultural Science*, **43**, 205-208.
  - [12] Li, H., Guo, W., Liu, Y., Zhang, Q., Xu, Q., Wang, S., *et al.* (2022) The Delineation and Ecological Connectivity of the Three Parallel Rivers Natural World Heritage Site. *Biology*, **12**, Article No. 3. <https://doi.org/10.3390/biology12010003>
  - [13] Wang, S., He, Y. and Song, X. (2010) Impacts of Climate Warming on Alpine Glacier Tourism and Adaptive Measures: A Case Study of Baishui Glacier No. 1 in Yulong Snow Mountain, Southwestern China. *Journal of Earth Science*, **21**, 166-178.  
<https://doi.org/10.1007/s12583-010-0015-2>
  - [14] Zhao, X., Zhang, H., Zhao, Z.F., *et al.* (2020) Study on the Causes of the Mixed Rainfall-Glacier Debris Flow in Haipalugou, Northwest Yunnan on July 28, 2019. *Journal of Engineering Geology*, **28**, 1372-1382.
  - [15] Tao, J., Zang, R.G., Yang, G.W., *et al.* (2012) Economic Valuation of Biodiversity in the Haba Snow Mountain Nature Reserve, Yunnan. *Western Forestry Science*, **41**, 9-17.