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Tourism climate information based on human thermal perception in Taiwan and Eastern China

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ABSTRACT

Human thermal perceptions are closely related to success in the tourism sector. However, a single climatic parameter or thermal index based on empirical equations cannot fully assess the thermal conditions at tourist destinations. While examining Taiwan and Eastern China, this study attempts to determine tourist thermal perceptions based on physiologically equivalent temperature (PET) and thermal comfort classifications (TPCs) for temperate and (sub)tropical regions. Seasonal distribution maps of PET indicate that Taiwan and Eastern China are perceived as comfortable during spring and autumn for those residing in temperate regions, while only the southern region during spring and the northern region during summer are perceived as comfortable for those residing in (sub)tropical regions. Furthermore, the annual thermal comfort distribution (ATCD) is determined to identify comfortable months for 20 tourist destinations. The PET frequencies, which are calculated using hourly climate data, describe climate variability and change. This climate information will prove useful to tourism authorities, travel agencies, resorts and tourists.

1. Introduction

Weather and climate are critical to tourists and the success of tourist destinations. Bigano, Hamilton, and Tol (2005) indicated that climate is a significant factor for tourists when choosing a travel destination. Notably, climate during different seasons affects tour schedules of travel agencies and tourists. For resorts and scenic destinations, good weather can increase the number of tourists, whereas adverse weather conditions can increase operating costs (e.g., energy usage by air-conditioners in hotels during hot months). Furthermore, climate changes also significantly influence nature-based tourism (Scott, Jones, & Konepek, 2007). A number of studies have determined that British, German, and Dutch tourists have decreased the number of times they visit warm countries due to rising temperatures (Berrittella, Bigano, Roson, & Tol, 2006; Bigano et al., 2005; Hamilton, 2004; Lise & Tol, 2002).

Tourism climate can be represented by thermal, physical (rain or snow), and aesthetic conditions (visibility, sunshine and cloud cover) (de Freitas, 2005). Since most physical and aesthetic factors are subjective, the thermal factor is frequently analyzed as it has an important role in tourism. When tourists are exposed to an outdoor thermal condition that causes thermal stress, i.e., extremely high or low temperatures, tourist health can be adversely affected. Conversely, when tourists experience thermal conditions that are close to their thermal comfort zones, the number of tourists visiting resorts and scenic destinations can increase (Lin, 2009).

When discussing the thermal characteristics of tourism climate, one must choose a suitable thermal index to assess outdoor thermal environments. The simplest approach is to assess a thermal environment using a single climate factor such as air temperature, relative humidity, or number of sunshine hours. Notably, drought, heat waves, and sea surface temperatures have also been utilized to assess thermal environments (Perry, 2005).

An advanced scheme integrates factors using an empirical equation for evaluating thermal environments (e.g., the wind-chill index (Steadman, 1971), discomfort index (Thom, 1959), apparent temperature (Steadman, 1979), tourism climate index (TCI) (Mieczkowski, 1985). However, these indices only address some of the relevant meteorological parameters and do not include thermal physiology or heat balance of the human body. Thus, these indices cannot be considered state-of-the-art indices. Although these indices may prove effective in very specific situations, they have significant disadvantages (Höppe, 1999; Matzarakis, Mayer, & Iziomon, 1999). Therefore, climate-tourism-information-scheme (CTIS) addresses most of meteorological parameters and includes heat balance of the human body (Lin & Matzarakis, 2008, Zaninovic & Matzarakis, 2009). De Freitas, Scott, & McBoyle (2008) developed

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the climate index for tourism (CIT) that includes the heat balance of the human body, but also integrates thermal, aesthetic, and physical facets of weather. Moreover, the construction and interpretation of CIT is based on empirically tested criteria, as opposed to arbitrarily selected variables and thresholds. For evaluation simplicity, Robinson (2001) defined heat waves using air temperature and relative humidity. However, the thermal index for tourist destinations is based on thermal comfort, not thermal stress periods (e.g. heat waves). Therefore, microclimate parameters, such as wind speed and solar radiation, markedly impact the energy balance of the human body.

People from different regions with different thermal experiences may have different thermal perceptions when exposed to the same thermal condition; this is called thermal adaptation. Since tourists are typically from different regions and have different climatic experiences, Lin and Matzarakis (2008), in investigating how climate affects tourism to Sun Moon Lake, Taiwan, determined annual thermal perceptions of tourists from different regions using the thermal perceptions and thermal comfort zone of tourists from Taiwan and Europe as assessment criteria.

Taiwan and Eastern China are near the sea and, therefore, have considerable potential for domestic and international tourism. Furthermore, direct flights between Taiwan and China are now common, allowing those from mainland China to visit Taiwan, and vice versa. Notably, the number of tourists from both countries has increased significantly. This study, which focuses on Taiwan and Eastern China, generates tourism climate information based on the thermal requirements of tourists. The primary steps in this study are as follows.

1. Select an appropriate thermal index and incorporate tourist thermal perception into the thermal index while considering the characteristics of thermal adaptation of tourists from different climatic regions and countries.
2. Determine the tourist temporal–spatial distribution of thermal perception using climate data, and then define the thermal comfort period and tourism potential for Taiwan and Eastern China.
3. Discuss detailed variations in thermal perceptions using a daily scale. This study then presents suitable and practical tourism climate information in an easily understood framework for tourists to promote the development of the tourism industry in Taiwan and Eastern China.

2. Methods

2.1. Study area

The study area is located at 21.9–38.2°N latitude and 113.6–122.7°E longitude, encompassing Taiwan and Eastern China (Shandong, Jiangsu, Zhejiang, Anhui, Fujian, and Jiangxi provinces, and Shanghai City). Fig. 1 shows the study region, which is home to eight capital cities and 12 tourist destinations. Fig. 2 shows study area topography. The mountainous area in Eastern China (elevations >500 m) encompasses the center of Shandong Province, areas southwest and southeast of Anhui Province, the area south of Jiangxi, and most of the Zhejiang and Fujian provinces. The highest elevation in the study area is Jade Mountain (Yushan, 3952 m) in Taiwan's Central Mountain Range (CMR). The climate of Eastern China can be classified as warm and temperate (regions north of the

Fig. 1. Study area and main tourist locations.

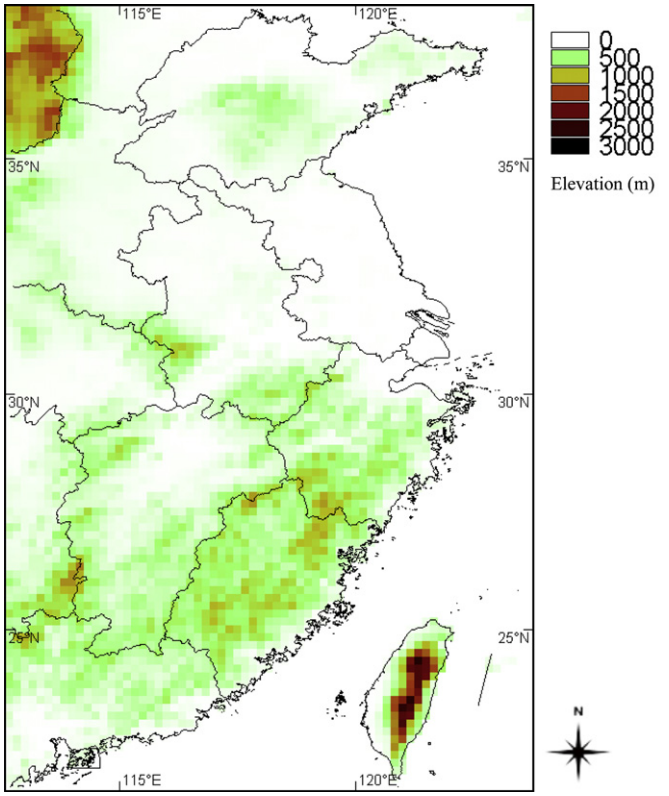

Fig. 2. Topography of the study area.