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# Holiday Climate Index-Based Evaluation of Tourism Potential in the Fiji Islands Under Future Climate Conditions

Yuvindi Amasha[1,2] | Panchali U. Fonseka[2] | Lisandi Bhagya[1,2] | Maheesha Alahakoon[1,2] | Randika K. Makumbura[3] | Komali Kantamaneni[4,5] | Upaka Rathnayake[3]

[1]Department of Spatial Sciences, Faculty of Built Environment and Spatial Sciences, General Sir John Kotelawala Defence University, Sooriyawewa, Sri Lanka | [2]Space Applications and Technology Division, Arthur C Clarke Institute for Modern Technologies, Moratuwa, Sri Lanka | [3]Faculty of Engineering and Design, Atlantic Technological University, F91 YW50, Sligo, Ireland | [4]United Nations-SPIDER-UK Regional Support Office, University of Lancashire, Preston, UK | [5]School of Engineering and Computing, University of Lancashire, Preston, UK

**Correspondence:** Upaka Rathnayake (upaka.rathnayake@atu.ie)

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## ABSTRACT

Coastal areas are among the most popular tourist destinations globally but are increasingly vulnerable to the impacts of climate change. Previous studies have assessed climatic suitability for tourism by quantifying ideal and unacceptable conditions based on beach user behavior and survey responses. Tourism contributes ~17% to the Fiji Islands' GDP, highlighting its strong economic dependence on the sector, particularly coastal tourism. However, there is limited research assessing the impacts of climate change on tourism climatic comfort. To address this gap, the present study evaluates the holiday climate index (HCI) for urban and beach destinations across the Fiji Islands. The analysis incorporates both historical years (2014–2024) and projected climatic scenarios (2025–2050) and (2071–2100) under representative concentration pathways (RCPs) (RCP 4.5 and RCP 8.5). Bias-corrected outputs from global circulation models (GCMs) downscaled through regional climate models (RCMs) were used to derive monthly temperature, humidity, cloud cover, precipitation, and wind speed. HCI scores were computed for both winter and summer seasons for urban and beach tourism. Results indicate that most coastal and urban locations in the Fiji Islands currently experience favorable climatic conditions for tourism, with winter HCI scores ranging from 78 to 92 ("Very Good" to "Excellent") and summer scores ranging from 70 to 85 ("Good" to "Very Good"). Under future climate scenarios, average HCI scores are projected to decline by 3%–8% across several regions during 2025–2050, particularly during the summer season. However, projections indicate variability in future climatic suitability, with some regions showing reduced suitability during 2025–2050, while some improvements in HCI scores are projected in 2071–2100, particularly under RCP 8.5. These findings provide a scientific basis for climate-informed tourism planning in the Fiji Islands and highlight the importance of incorporating climate projections into long-term tourism strategies.

## 1 | Introduction

Around the world, tourism plays a significant socioeconomic role in both developed and developing countries [1, 2]. It is a major driver of economic growth, employment, and foreign exchange earnings in many nations. Given the global economic importance of tourism, the sector is increasingly vulnerable to climate change [3–6]. Rising global temperatures, shifting precipitation patterns, sea-level rise, and the increased frequency of extreme weather events pose significant challenges to tourism destinations worldwide [3, 5–7]. These climatic changes not only affect the environmental appeal of destinations but also influence tourist comfort, safety, and seasonal travel behavior [3, 4]. Due to its indirect impact on the ecosystem and social factors that fuel climate change, tourism has been recognized as a significant climate-sensitive sector [3, 6].

Research on the relationship between climate change and travel demand suggests that changes in tourist flows and declines in certain destinations are expected, as tourists respond to climatic conditions [8–10]. However, the extent of these changes depends on tourist perceptions, adaptability, and behavioral preferences [3, 10, 11]. Considering these dynamics, understanding and measuring the influence of climate on tourism through standardized climate indices becomes increasingly essential [12].

Climate indices are numerical indicators commonly used to detect conditions and trends within the climate system [12, 13]. In the context of tourism, these indices are also applied to evaluate the current and projected climatic suitability of destinations. The concept of assessing climatic suitability for tourism was first presented by Mieczkowski [14], who developed the tourism climate index (TCI), which integrates key climatic variables such as temperature, wind speed, humidity, cloud cover, and precipitation. However, the TCI has been criticized for its oversimplification and limited ability to represent activity-specific and seasonal tourism preferences [12, 15–18].

To address these limitations of the TCI, Scott et al. [19] and Rutty et al. [10] expanded the framework into a more refined model known as the holiday climate index (HCI), which integrates tourism preferences in both coastal and urban settings [20]. The HCI is designed to reflect activity-specific tourism conditions by incorporating seasonal variations, thereby improving the relevance of climate data [21]. As a result, it provides a more behaviorally responsive assessment of climate suitability (as quantified using HCI scores) compared to the TCI [17, 22]. In this study, climatic suitability is defined and quantified using the HCI, ensuring consistency between the conceptual framework and the applied metric. HCI is constrained by its computational complexity and dependence on accurate, context-specific input data [10, 19]. Previous studies have shown that HCI results can vary across regions, even within similar climatic zones, highlighting the importance of location-specific assessments [21].

The integration of HCI with representative concentration pathways (RCPs), such as RCP 4.5 and RCP 8.5, enables the assessment of future climate–tourism relationships under different emission scenarios [10, 19, 23]. These RCPs are developed by the Intergovernmental Panel on Climate Change (IPCC), represent different greenhouse gas concentration trajectories, where RCP 4.5 represents a stabilization pathway and RCP 8.5 represents a high-emission scenario [6, 23]. This approach enables the evaluation of how climate suitability for tourism may evolve under future conditions. Previous studies indicate that coastal tourism destinations are particularly vulnerable to climate variability and change [24–26].

This vulnerability is especially pronounced in small island developing states (SIDS), where tourism plays a central economic role and environmental exposure is high. [3, 27]. The Fiji Islands, located in the South Pacific, are highly dependent on tourism as a key contributor to national income and employment. Existing studies in Fiji have primarily examined climate variability, extreme weather events, and their impacts on coastal systems and tourism [28–33]. However, there is limited research that quantitatively evaluates climatic suitability for tourism using indices such as the HCI, particularly under future climate scenarios [26, 34–36].

Therefore, this study aims to address this research gap by applying the HCI to evaluate the current and future climatic suitability of selected urban and coastal tourism destinations in the Fiji Islands under changing climate scenarios. The analysis incorporates historical climate data and future projections under RCP 4.5 and RCP 8.5 scenarios to assess spatial and seasonal variations in tourism suitability. The findings of this study provide insights into potential climate-related risks and opportunities for tourism development and support climate-informed planning and decision-making in the Fiji Islands.

## 2 | Study Area, Data, and Methods

### 2.1 | Study Area

The South Pacific nation of the Fiji Islands is made up of an archipelago of over 300 islands and 500 islets [37], of which ~100 are permanently inhabited (Figure 1). It is well-known for its rocky terrain, beaches with palm trees, and coral reefs with coastal lagoons [38]. The Fiji Islands is located in the southwestern Pacific Ocean, ~1770 km (1100 miles) northeast of New Zealand and 2900 km (1800 miles) east of Australia [37] as shown in Figure 1. It is part of the Melanesian subregion, which also includes Papua New Guinea, Vanuatu, Solomon Islands, and New Caledonia [39].

The two largest islands, Viti Levu (Figure 1; western and central divisions shown in purple and pink, respectively) and Vanua Levu (Figure 1; northern division shown in green), account for nearly 87% of the total land area and are home to the majority of the population and economic activity [37]. Viti Levu houses the capital city, Suva (Figure 1), and the tourism hub, Nadi (Figure 1), both of which are critical to the nation's tourism infrastructure. According to Worldometer's adaptation of the most recent United Nations data, the country's population was estimated to be 936,375 at mid-year in 2023, and as of July 1, 2024, it is ~943,067 [40]. The population is unevenly distributed, with higher concentrations in coastal urban areas, particularly along the western and southern coasts of Viti Levu, where tourism is most heavily developed [41].

Fiji Islands experiences a tropical marine climate [42], characterized by warm temperatures and high humidity year-round [42, 43]. The climate is divided into two distinct seasons, the wet season from November to April, which brings heavy rainfall and a heightened risk of tropical cyclones, and the dry season from May to October, which features lower humidity, cooler temperatures, and more stable weather conditions [44].

Fiji's geographical location and topography contribute to microclimatic variability across the islands [3]. The ecological diversity,

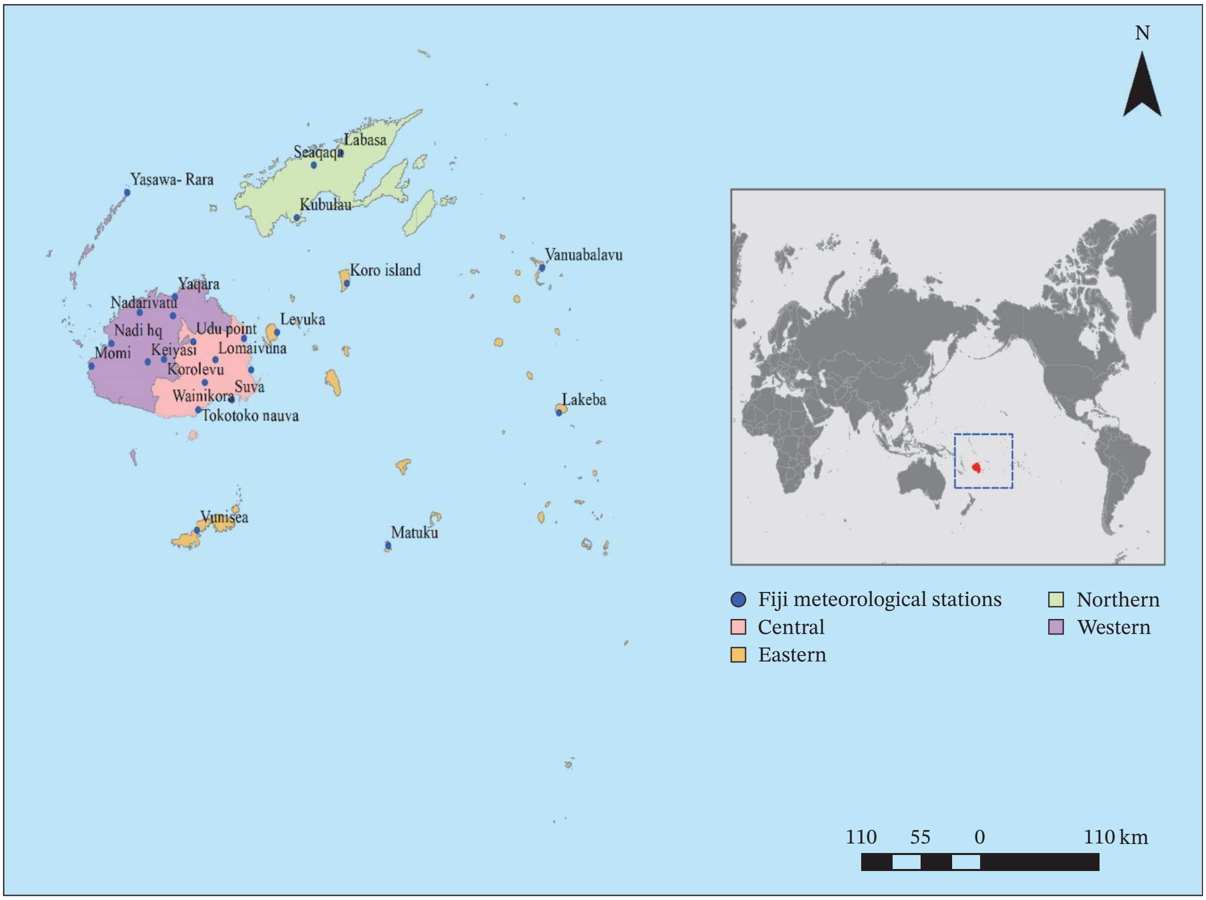


**FIGURE 1** | Data collected from stations of Fiji Islands.

ranging from coral reefs and mangroves to highland forests, is associated with exposure to climate-related hazards such as sea-level rise, coral bleaching, and cyclone damage [42, 45, 46].

## 2.2 | Data Collection

The study utilized two primary datasets from ground-based observational data and downscaled climate model outputs. Fiji Islands has a well-established meteorological monitoring system, and data are publicly available through the Fiji Meteorological Service at https://www.met.gov.fj/ [47]. For this study, climate data from 25 meteorological stations across the country were considered [47]. They are Seaqaqa, Yaqara, Wainikoro, Suva, Labasa, Tokotoko Navua, Lomaivuna, Vunisea, Vanubalavu, Koro Island, Yasawa-I-Rara, Nadarivatu, Keiyasi, RKS Lodoni, Rarawai Mill, Korolevu, Matuku, Udu point, Viwa Island, Lakeba, Levuka, Rotuma Island, Kubulau, Nadi HQ, and Momi. Some of these station locations are illustrated in Figure 1.

In addition to observed data, the study incorporated historical and future climate projections based on RCP 4.5 and RCP 8.5 using monthly climate data that was continuously downscaled by the global circulation model (GCM) and further refined through downscaling via the regional climate model (RCM) [48]. The dataset included key climatic parameters relevant to tourism [46], such as maximum temperature, minimum temperature, relative humidity, cloud cover, precipitation flow, and wind speed. The coordinated regional climate downscaling experiment (CORDEX) platform was used to obtain the climate data (https://cordex.org/). CORDEX provides high-resolution regional climate projections that support the assessment of regional climate variability and its impacts [49].

## 2.3 | Methodology

### 2.3.1 | Bias Correction of Climate Data and Spatial Interpolation

Prior to HCI computation, bias correction was applied to the climate model outputs to improve their reliability. The linear scaling (LS) method was used to adjust systematic deviations between observed and modeled data. Temperature was corrected with additive adjustments, while precipitation and relative humidity were corrected using multiplicative factors [50]. This step is essential to ensure that the input climate variables used in the HCI calculations accurately represent local conditions, thereby improving the robustness of the results.

The bias-corrected monthly temperature, precipitation, and relative humidity data for available gauging stations were input into an ArcGIS environment, where the inverse distance weight (IDW) approach was used for spatial interpolation [50, 51]. The IDW method has been widely applied in similar studies [52]. In addition, the interpolated IDW outputs had a fine spatial resolution of 0.009°×0.009°.

The historical period (2014–2024) was selected based on the availability of continuous and reliable observed climate data.

Future periods (2025–2050 and 2071–2100) were selected to represent near- and far-future climate conditions, consistent with IPCC–[6] based climate projection practices. The intermediate period (2051–2070) was not included, as it represents transitional conditions between the selected time slices.

### 2.3.2 | HCI Computation Framework

The HCI for beaches (HCI beach) and urban areas (HCI urban) is calculated using Equations (1) and (2) [19, 53, 54]. Both HCI beach and HCI urban indices range from 0 to 100, where a higher value indicates ideal conditions for tourism, and lower values reflect less suitable conditions for leisure travel. Monthly averaged climate data were used for all variables, including temperature (°C), relative humidity (%), precipitation (mm), wind speed (m/s), and cloud cover (%). Sunshine duration was not explicitly included, as its effect is represented indirectly through cloud cover within the HCI framework.

$$\text{HCI urban} = 4\text{TC} + 2A + 3P + W \quad (1)$$

$$\text{HCI beach} = 2\text{TC} + 4A + 3P + W \quad (2)$$

$$\text{TC} = T + \frac{5}{9}\times\left(\left(6.112\times 10^{\frac{(7.5\times T)}{(237.7+T)}}\times\frac{H}{100}\right) - 10\right) \quad (3)$$

The HCI framework integrates multiple climatic variables that jointly determine tourism suitability. Equation (3) was used to calculate the thermal comfort (TC) rating, where $H$ and $T$ represent relative humidity and air temperature. The other variables $A$, $P$, and $W$ represent aesthetic rating (based on cloud cover), precipitation rating, and wind speed rating, respectively.

In this study, "ratings" refer to standardized numerical scores assigned to each climatic variable used in the HCI framework. These include TC, aesthetic conditions ($A$), precipitation ($P$), and wind speed ($W$). Temperature was expressed in degrees Celsius (°C), relative humidity in percentage (%), precipitation in millimeters (mm), wind speed in meters per second (m/s), and cloud cover as percentage (%). TC is calculated using temperature and relative humidity (Equation 3), reflecting human thermal perception.

- The aesthetic rating ($A$) is based on cloud cover, where lower cloud cover corresponds to higher ratings due to increased sunshine and visual appeal.
- The precipitation rating ($P$) reflects the negative impact of rainfall on outdoor tourism activities, with higher rainfall leading to lower scores.
- The wind rating ($W$) accounts for the influence of wind speed on comfort, where moderate wind enhances comfort, while very low or very high wind speeds reduce suitability.

All ratings were assigned using standardized classification schemes adopted from Rutty et al. [10] and Scott et al. [19]. For both HCI beach and HCI urban, the aesthetic score decreases as cloud cover increases [50]. The highest cloud cover ratings for HCI beach and HCI urban cases are 15% and 11%, respectively, while the lowest ratings occur at 100% cloud cover. Table 1 presents the HCI score classification used to interpret tourism suitability, where values range from "Unacceptable" (<40) to "Ideal" (90–100), representing increasing levels of climatic comfort for tourism activities.

The MATLAB software was used to automate the assignment of rating values and the calculation of HCI scores. In the ArcGIS environment, IDW interpolation has been applied to generate a spatial distribution of indices for both urban and coastal locations across the Fiji Islands. Then, the HCI values were calculated for three time periods, historical baseline years 2014–2024 and the projected near future (2025–2050) and the distant future (2071–2100). Future HCI projections were generated under two RCPs, RCP 4.5 for moderate emissions and RCP 8.5 for high emissions. These scenarios help evaluate how changing climate conditions could affect the suitability of climate-tourism destinations in the Fiji Islands over time.

### 2.3.3 | Selection of Study Locations

Considering the data coverage of the Fiji Islands, the destinations given in Section 2.1 were selected for calculating both HCI beach and urban scores. To ensure national representation, four major geographical regions of the Fiji Islands were considered, from which a total of 24 locations were selected. Among them, 20 destinations were used for HCI beach score analysis, as four inland locations were excluded due to their limited relevance to coastal (beach) tourism conditions. Seaqaqa, Labasa, and Kubulau were used to cover the northern area; Yaqara, Rarawai Mill, Nadi HQ, Momi, and Tokotoko Navua were used to cover the western area; and Lodoni, Viwa Island, and Suva were used to cover the central area. Vunisea was used to cover the Eastern area.

For HCI Urban, all 24 urban tourist locations were analyzed to represent tourism conditions across the country. Seaqaqa, Labasa, Vanuabalavu, and Kubulau were used to cover the northern area; Yaqara, Korolevu, Keiyasi, Rarawai Mill, Nadi HQ, Momi, Udu point, and Tokotoko Navua were used to cover the western area; and Lodoni, Viwa Island, Wainikoro, Lomaivuna, Nadarivatu and Suva were used to cover the central area. Vunisea was used to cover the eastern area, and Yasawa Rara, Koro Island, Levuka, Lakeba, and Matuku were used to cover other small islands. This distinction between locations used for beach and urban analyses is illustrated in Figure 1.

**TABLE 1** | HCI score classification.

| HCI score | Classification |
|---|---|
| 90–100 | Ideal |
| 80–89 | Excellent |
| 70–79 | Very Good |
| 60–69 | Good |
| 50–59 | Acceptable |
| 40–49 | Marginal |
| <40 | Unacceptable/dangerous |

## 3 | Results

### 3.1 | HCI Under General Condition

#### 3.1.1 | HCI Beach

Figure 2 illustrates the spatial (November to April) seasons for the historical period 2014–2024. In this study, the winter season in the Fiji Islands is defined as May to October (dry season), while the summer season is defined as November to April (wet season), consistent with regional climatology [47, 43].

The results of the analysis show that beach destinations in the Fiji Islands generally receive higher HCI scores during the winter season, with most areas falling within the "Very Good" to "Excellent" categories. In contrast, the summer season exhibits a greater spatial distribution of lower scores, with many regions falling within the "Marginal" to "Acceptable" categories. These seasonal differences are reflected in the HCI components, including TC (temperature and humidity), precipitation, cloud cover (aesthetic rating), and wind. Lower HCI scores during the summer season are primarily driven by reduced TC and increased precipitation within the HCI framework, while improved winter scores reflect more favorable combinations of these climatic variables.

Monthly HCI beach values for the selected locations are provided in Table S1, illustrating detailed temporal variability. The results highlight substantial seasonal and spatial variation in climate suitability for beach tourism. From a regional perspective, the western region (Nadi HQ, Momi, and Rarawai Mill) consistently exhibits higher HCI scores during the winter season, with most locations falling within the "Very Good" (80–89) to "Ideal" (90–100) range, particularly between June and August. Similarly, locations in the central region (Suva and Viwa Island) also show favorable winter conditions, although slightly more variability is observed compared to the western region.

In contrast, the Northern region (Labasa and Kubulau) demonstrates greater seasonal variability, with notable declines in HCI values during the summer months. Kubulau, in particular, records very low scores in September (18), October (17), and November (26), corresponding to "unacceptable" conditions for tourism. Island locations in the Eastern region (Vunisea, Vanuabalavu, and Koro Island) maintain relatively stable and moderate-to-high HCI scores throughout the year, generally falling within the "Good" to "Excellent" categories, indicating suitability for year-round beach tourism. The results indicate that June to August represent the most climatically favorable period for beach tourism in the Fiji Islands, while February and March are the least favorable months.

#### 3.1.2 | HCI Urban

The spatial distribution of HCI urban scores across the Fiji Islands during the winter (May to October) and summer (November to April) seasons for the period 2014–2024 are shown in Figure 3. The results of the analysis indicate that the urban destinations generally experience higher HCI scores in the winter season, with most regions falling within the "Good" (60–69) and "Very Good" (70–79) categories. In contrast, during the summer months, HCI urban scores decline, with many areas classified as "acceptable" (50–59), "marginal" (40–49), and in some locations, even "Unacceptable" (<40). This seasonal disparity suggests that urban climate suitability for tourism is generally higher during the winter season.

Monthly HCI urban values for all locations are provided in Table S2. Spatial analysis reveals notable regional differences in urban

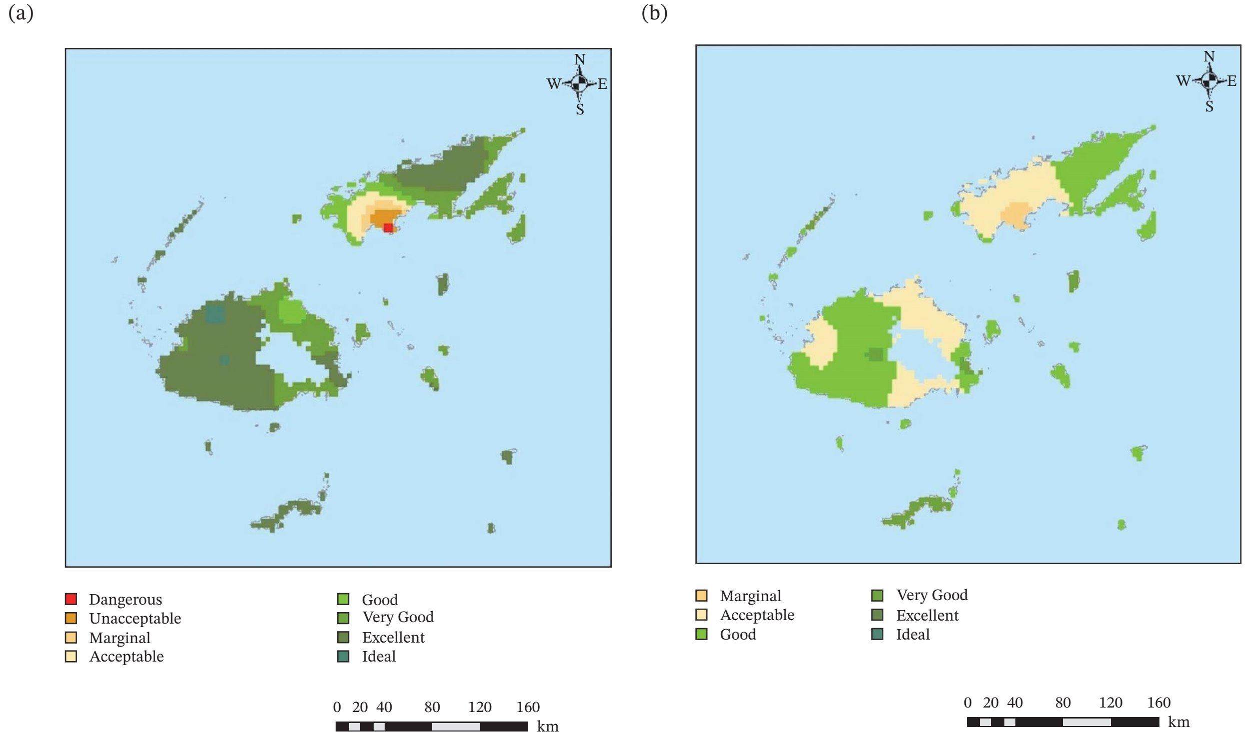


**FIGURE 2** | Spatial distribution of HCI beach scores across Fiji Islands during the (a) winter season and (b) summer season for the historical period 2014–2024.

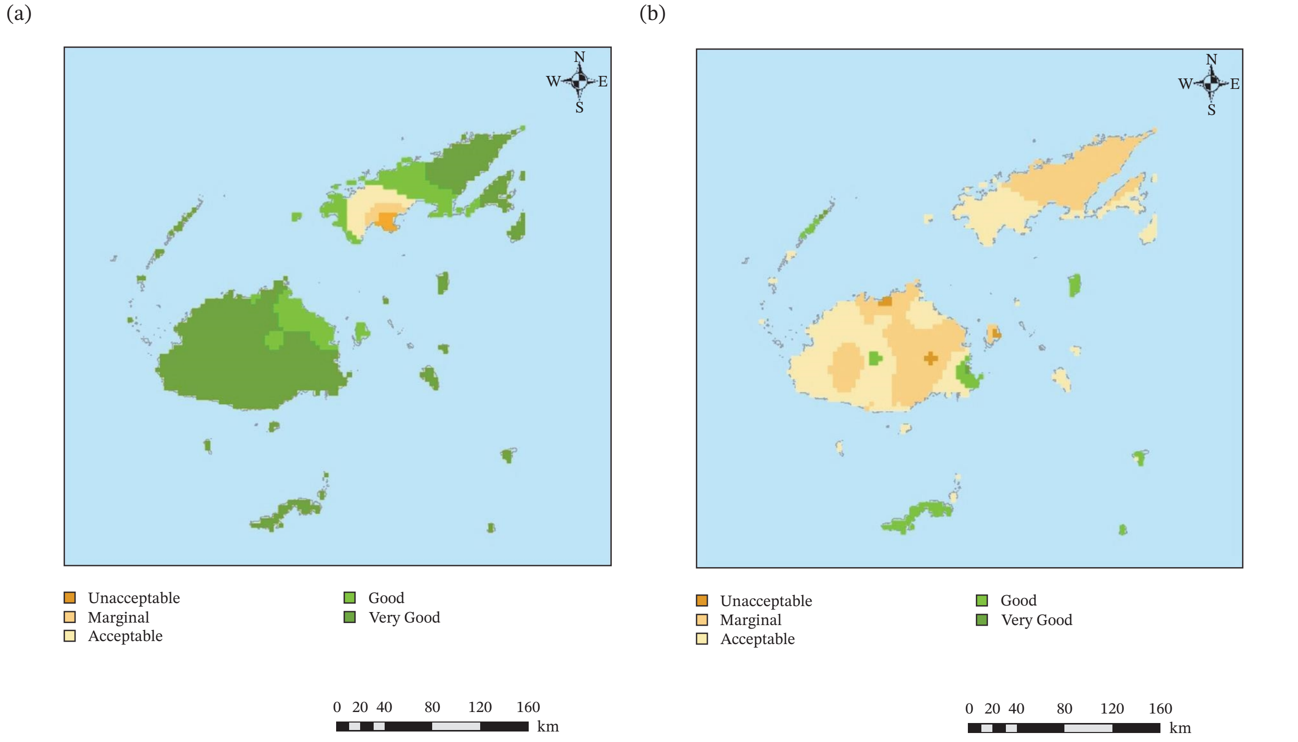


**FIGURE 3** | Spatial distribution of HCI urban scores across Fiji Islands during the (a) winter season and (b) summer season for the historical period 2014–2024.

tourism suitability. The western and central regions generally exhibit higher HCI scores during the winter months, with locations such as Suva, Korolevu, and Rarawai Mill frequently falling within the "Good" to "Very Good" categories. In some cases, locations such as Matuku and Vunisea reach values exceeding 90 during July and August, corresponding to the "ideal" category and reflecting optimal climatic conditions for tourism within the HCI framework.

In contrast, the northern and some inland locations (Keiyasi, Tokotoko Navua, RKS Lodoni, and Levuka) show greater seasonal variability, with HCI scores dropping below 40 during peak summer months (January–March), indicating reduced climatic suitability for urban tourism.

Several island locations, including Koro Island, Yasawa-I-Rara, Matuku, and Vanuabalavu maintain relatively high HCI scores year-round, remaining within "Good" to "Excellent" categories, suggesting these locations are suitable for continuous urban tourism development. However, sustainable tourism aspects have to be considered in any developments. On the other hand, locations like Keiyasi, RKS Lodoni, Levuka, and Kubulau exhibit extreme variability, with very low HCI scores during the summer, pointing to seasonally constrained tourism potential. Overall, the results indicate that urban tourism in the Fiji Islands is most favorable during the winter months (May–October), while summer conditions present lower climatic suitability.

## 3.2 | Climate Projections and HCI

It remains uncertain how urban and beach tourism locations in the Fiji Islands may be affected by future climate change. This study evaluates projected changes in climatic suitability using RCPs (RCP 4.5 and RCP 8.5). Under these scenarios, climate projections indicate a general trend of rising temperatures and decreasing precipitation. The analysis was conducted for two future periods, (2025–2050) near future and (2071–2100) distant future. To ensure consistency across projections, the analysis was based on annual HCI values, rather than separating into winter and summer seasons.

### 3.2.1 | HCI Beach Under RCP 4.5 and RCP 8.5

The spatial distribution of HCI scores under RCP 4.5 is shown in Figure 4. During the near-future period (2025–2050), most coastal areas fall within the "Unacceptable" to "Marginal" categories. In contrast, during the far-future period (2071–2100), a shift toward "Acceptable" and "Good" categories is observed, indicating a relative improvement in climate suitability.

Lower HCI scores during 2025–2050 are associated with projected increases in temperature and precipitation variability, which reduce TC and increase precipitation-related constraints within the HCI framework. The relative improvement in 2071–2100 may be attributed to changes in the balance of HCI components, particularly variations in precipitation wind and cloud cover in the model projections, rather than nonclimatic adaptation factors.

The spatial distribution of HCI beach scores under RCP 8.5 is presented in Figure 5. During the near-future period (2025–2050) (Figure 5a), most coastal areas fall within the "Unacceptable" to "Marginal" categories, indicating low climatic suitability for beach tourism. In contrast, during the far-future period (2071–2100) (Figure 5b), most areas shift toward the "Acceptable" to "Good" categories, suggesting improved climatic conditions. This shift indicates a relative increase in HCI beach scores between the two projection periods under the high-emission scenario.

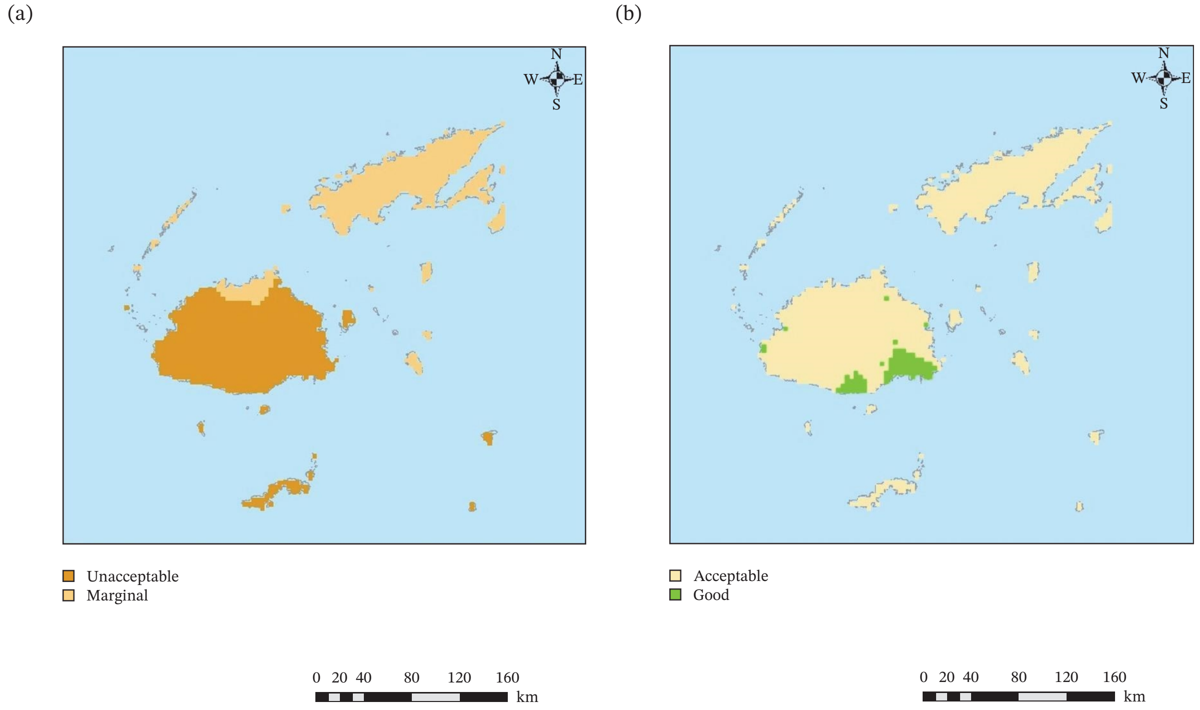


**FIGURE 4** | Spatial distribution of HCI beach scores across Fiji Islands under RCPs (a) RCP 4.5 2025–2050 and (b) RCP 4.5 2071–2100.

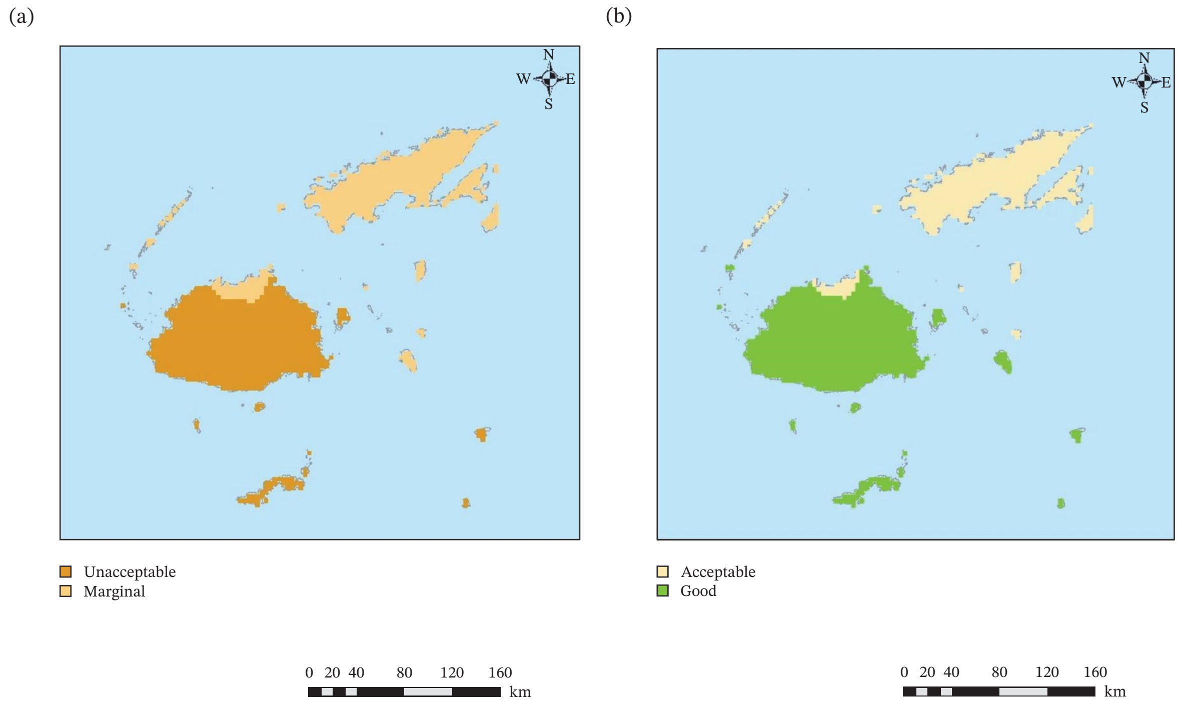


**FIGURE 5** | Spatial distribution of HCI beach scores across Fiji Islands under RCPs (a) RCP 8.5 2025–2050 and (b) RCP 8.5 2071–2100.

These changes are associated with variations in projected climatic variables, particularly temperature, precipitation, wind, and cloud cover, which influence the HCI components and overall tourism suitability.

When comparing the two projection periods, the 2071–2100 period consistently shows higher HCI beach scores than 2025–2050 under both RCP 4.5, as shown in Figures 4a and 5a, indicating relatively improved climatic suitability for beach tourism in the far future. A comparison between the two scenarios further shows that HCI scores under RCP 8.5 are slightly higher than those under RCP 4.5 for 2071–2100. This difference reflects variations in projected climatic conditions, particularly temperature, precipitation, wind, and cloud cover, which influence the HCI components and overall tourism suitability.

### 3.2.2 | HCI Urban for RCP 4.5 and RCP 8.5

HCI Urban projections were evaluated for two future periods, 2025–2050 and 2071–2100, under both RCP 4.5 and RCP 8.5

scenarios. Figures 6 and 7 illustrate the spatial distribution of the HCI Urban score under both RCP scenarios. Under RCP 4.5 (2025–2050) results, most of the areas fall into the "Unacceptable" range, with some areas categorized as "Marginal" and "Acceptable" as depicted in Figure 6. In contrast, under RCP 4.5 (2071–2100), the entire area falls within the "Acceptable" range, indicating a notable improvement. When comparing RCP 4.5 across both periods, it is evident that the 2071–2100 period has a better HCI urban score range than the 2025–2050 period. Therefore, the future time frame of 2071–2100 is projected to offer more favorable urban climatic conditions for tourism under RCP 4.5.

A similar pattern is observed under RCP 8.5 (Figure 7). During 2025–2050 (Figure 7a), most regions fall within the "Unacceptable" to "Marginal" categories, whereas in 2071–2100 (Figure 7b), the majority of areas shift toward the "Acceptable" category. This indicates improved urban climatic suitability in the far-future period under the high-emission scenario.

A similar pattern is observed under RCP 8.5 Figure 7. During 2025–2050 Figure 7a, most regions fall within the "Unacceptable" to "Marginal" categories, whereas in 2071–2100 Figure 7b, the majority of areas shift toward the "Acceptable" category. This indicates improved urban climatic suitability in the far-future period under the high-emission scenario. Comparison between the two scenarios suggests that HCI urban scores exhibit similar spatial patterns under both RCP 4.5 and RCP 8.5, with only minor differences. These differences may be influenced by variations in projected climatic variables and the spatial resolution of the interpolation methods.

Detailed HCI values for both urban and beach tourism are provided in Table S3. During the near-future period (2025–2050), urban tourism conditions are generally less suitable, with several locations such as Suva, Wainikoro, and Nadarivatu recording low HCI urban scores around 32. These scores fall within the "Unacceptable" or "Marginal" range for tourism. In contrast, areas like Seaqaqa, Yaqara, and Labasa exhibit relatively higher scores of 58, indicating more suitable conditions. Under both RCP 4.5 and 8.5, a modest increase in HCI urban values in some locations, with scores suitable for 48 in previously lower-scoring areas.

The increase in HCI scores between the two periods reflect changes in HCI components, particularly temperature, precipitation, and wind conditions, within the climate projections. Overall, the results show that the distant future period (2071–2100) offers more suitable conditions for both urban and beach tourism compared to the near future (2025–2050), under both RCP scenario.

## 4 | Discussion

This study provides a comprehensive assessment of climatic suitability for tourism in the Fiji Islands using the HCI. The results demonstrate clear spatial and temporal variations in tourism suitability, with higher HCI scores observed during the dry season and lower scores during the wet season. These patterns indicate that climatic conditions play a significant role in determining tourism comfort for both beach and urban environments.

The findings of this study are consistent with previous research conducted in other island and coastal regions [26, 34–36] where climate variability has been identified as a key determinant of tourism conditions. However, unlike previous studies, this research applies the HCI framework specifically to the Fiji Islands, addressing a significant geographical research gap [54].

The novelty of this study lies in three key aspects. First, it provides the first comprehensive application of the HCI to both urban and beach tourism in the Fiji Islands. Second, it integrates

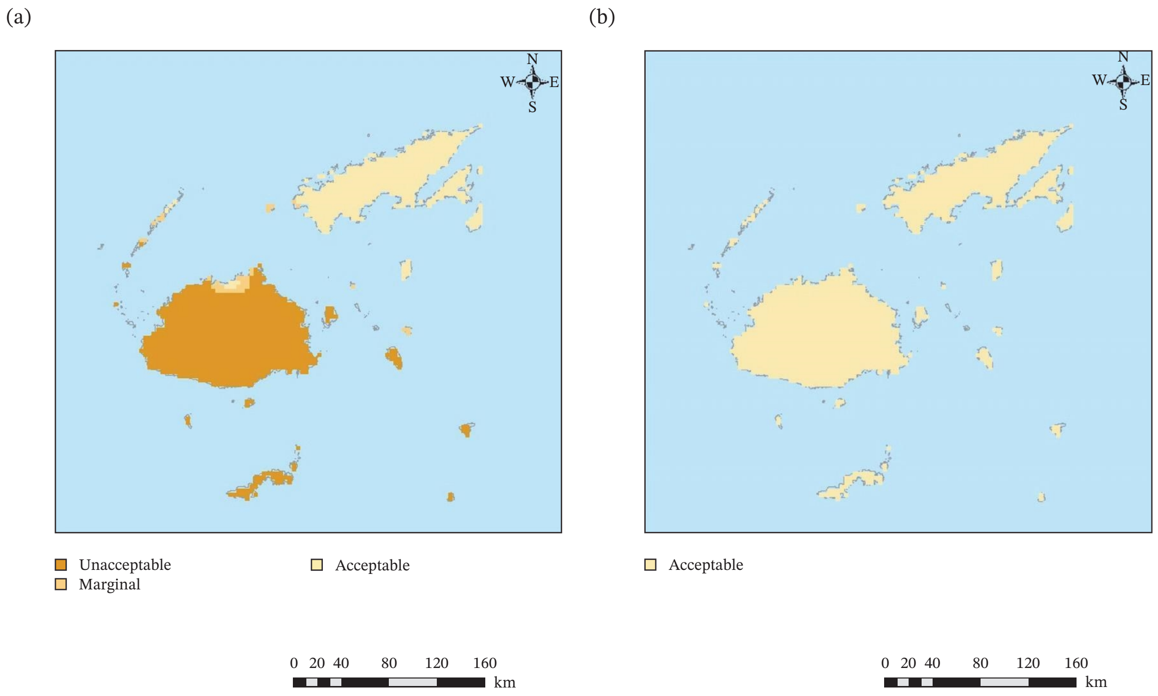


**FIGURE 6** | Spatial distribution of HCI urban scores (a) under RCP 4.5 2025–2050 (b) under RCP 4.5 2071–2100.

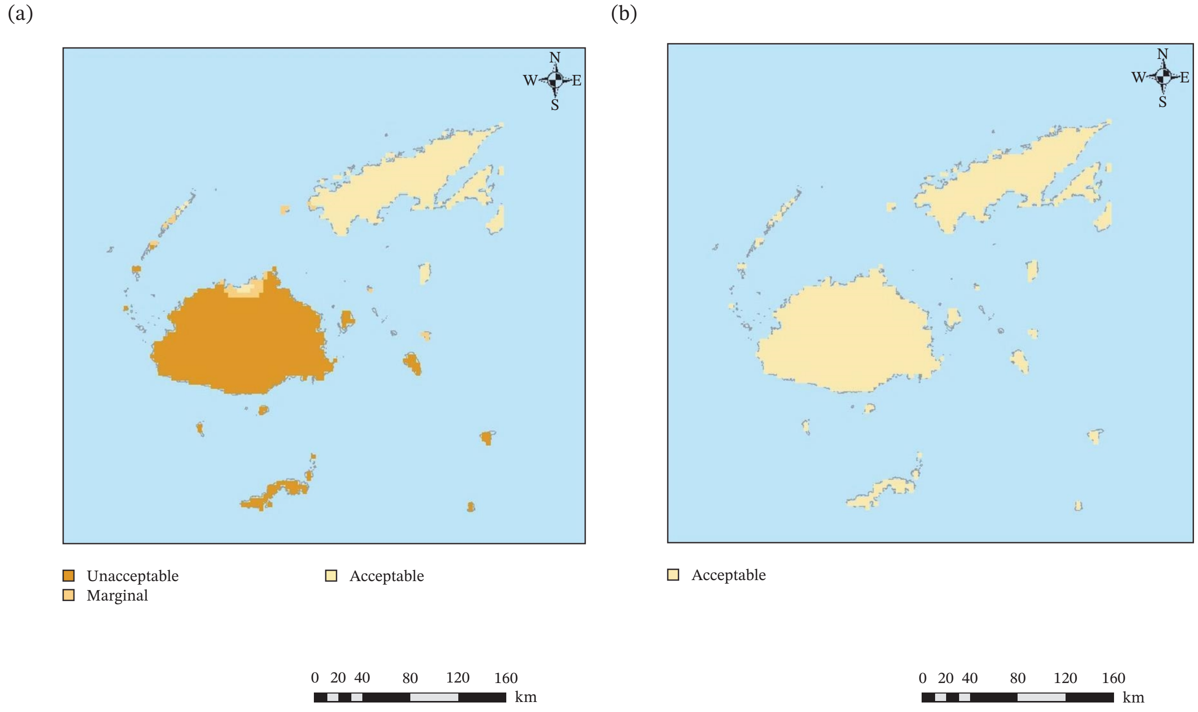


**FIGURE 7** | Spatial distribution of HCI urban scores (a) under RCP 8.5 2025–2050 (b) under RCP 8.5 2071–2100.

bias-corrected climate projections from GCMs and RCMs to assess future tourism suitability under selected RCP scenarios. Third, it evaluates both historical and projected conditions, enabling a comparative assessment of climate impacts over time.

From a practical perspective, the results provide useful insights for tourism planning and management. Seasonal variations in HCI scores highlight the importance of aligning tourism activities with periods of higher climatic suitability. In addition, locations with relatively stable HCI scores throughout the year may offer opportunities for year-round tourism development and diversification.

Despite these contributions, the study has several limitations. The analysis is constrained by the availability of historical climate data, which is limited to the period 2014–2024. In addition, the HCI framework considers only climatic factors and does not account for nonclimatic influences such as infrastructure, accessibility, and socioeconomic conditions. Furthermore, uncertainties associated with climate projections may influence the results.

Future research could build upon this work by integrating tourism demand data, such as visitor arrivals, to better evaluate the relationship between HCI scores and tourism patterns. Incorporating socioeconomic and infrastructural variables would also provide a more comprehensive understanding of tourism vulnerability and resilience in the Fiji Islands.

## 5 | Conclusions

This study presents the first comprehensive assessment of climatic suitability for tourism in the Fiji Islands using the HCI. The HCI, which integrates key climatic variables including temperature, humidity, precipitation, wind, and cloud cover to evaluate the tourism comfort conditions. Based on the spatial distributions of HCI beach for the period 2014–2024, most beach destinations exhibit favorable climatic conditions, particularly during the winter (dry) season. Urban tourism conditions were generally classified as "Good" to "Very Good" during winter, while summer conditions showed reduced suitability.

However, future projections reveal important changes. During the near-future period (2025–2050), many locations for both beach and urban tourism fall within "Unacceptable" to "Marginal" categories, indicating reduced climatic suitability. In contrast, the distant-future period (2071–2100) shows a relative improvement, with most locations shifting toward "Acceptable" or "Good" conditions under the analyzed RCP 4.5 scenario. Limitations in spatial resolution may affect the representation of localized variability in HCI scores.

The findings of this study provide useful insights for tourism planning and climate adaptation strategies in the Fiji Islands. Future research should incorporate additional factors influencing tourism, including infrastructure development, accessibility, tourism services, socioeconomic conditions, and visitor preferences, to provide a more comprehensive assessment. Overall, integrating climate projections into tourism planning is essential to support sustainable development and long-term resilience in the Fiji Islands.

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## Conflicts of Interest

The authors declare no conflicts of interest.

## Data Availability Statement

The data that support the findings of this study are available upon request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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## Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Supporting Information.** The complete monthly HCI urban values for all study locations are provided in Supporting Information Tables S1–S3. Table S1 presents the HCI beach values under measured climatic data (2014–2024), while Table S2 presents HCI urban values under measured climatic data (2014–2024) and Table S3 summarizes the projected HCI beach and HCI urban scores for considered cases, respectively.