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The Impact of Climate Change on Tourism Demand in Türkiye

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November 2024

Creating Opportunities

The climate change is found to affect overall tourism demand negatively

Objective

Analyze the current and potential future impacts of climate change on tourism demand in Türkiye at provincial level, considering various emission concentration scenarios (RCP2.6, RCP4.5, and RCP8.5) until 2100.

Reference: Regional impact of climate change on European tourism demand

Main takeaways

- **Shifting tourism across seasons,** mainly from summer to spring and autumn, is observed.
- **The tourism in South Coast is hurt the highest,** followed by winter tourism, whereas the North Coast and Urban cities' tourism gain only slightly.
- The thresholds of climate indexes (TCI, HCI) based on data, surveys, or reference papers, are crucial and determine the results.

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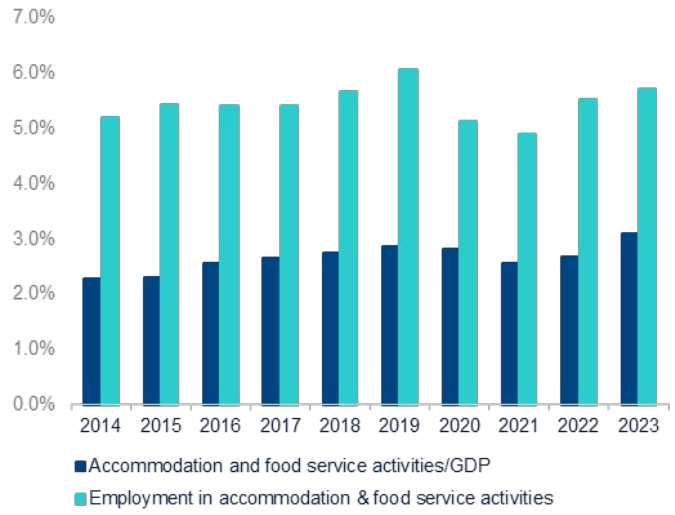
01

Main determinants of tourism demand

The economic importance of tourism in Türkiye: a driving engine

CONTRIBUTION OF THE TOURISM SECTOR TO GDP AND EMPLOYMENT IN TÜRKIYE
(%)



Source: BBVA Research, Turkstat

The tourism sector, with a 3.1% share of GDP as of 2023 and constituting 5.7% of employment, could be considered as one of the main activities driving economic growth in Türkiye.

Economic effects of tourism activity

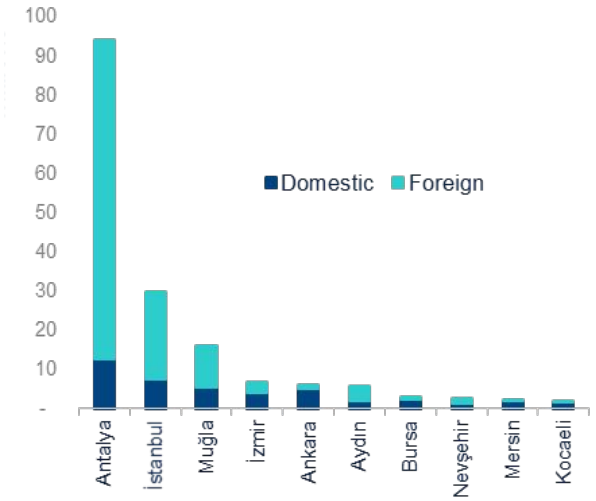
Direct	Indirect	Induced
GDP generated by activities directly related to tourism, including industries, commodities and sources of spending (accommodation, transportation, culture…).	Impacts attributed to activities undertaken by the tourism sector (investment, government spending,...).	Additional contribution of tourism through the expenditures (food and beverages, recreation, clothing, housing,…).

Source: BBVA Research from WTTC 2012

Tourism demand in Türkiye exhibits seasonal pattern with higher relevance of foreign tourism in Southern Coast during summer season

BED NIGHTS OF DOMESTIC AND FOREIGN TOURISTS BY PROVINCE

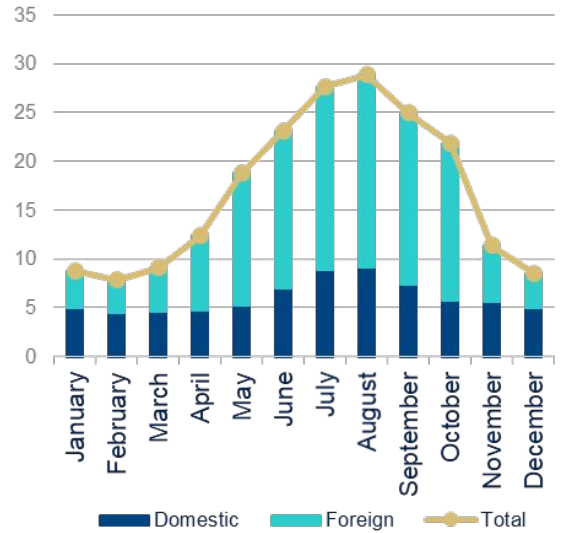
(*) (2023, millions)



Source: BBVA Research, Ministry of Culture & Tourism
(*) Not displayed provinces have on average a 17.3% share of total tourism.

BED NIGHTS PER MONTH IN TÜRKIYE

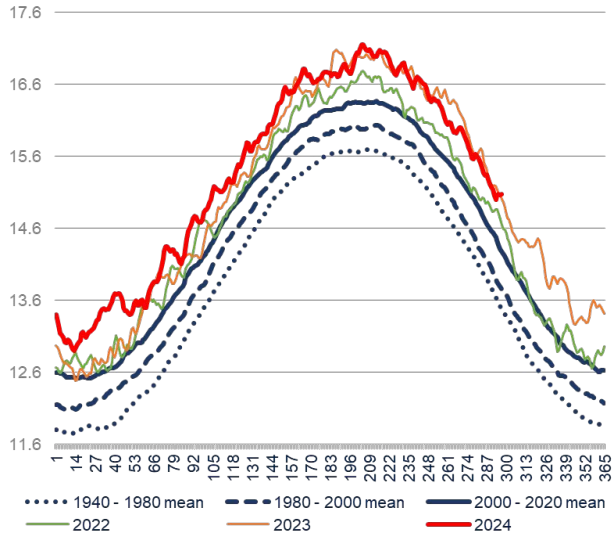
(2023, milllions)



Source: BBVA Research, Ministry of Culture & Tourism

DAILY WORLD TEMPERATURE

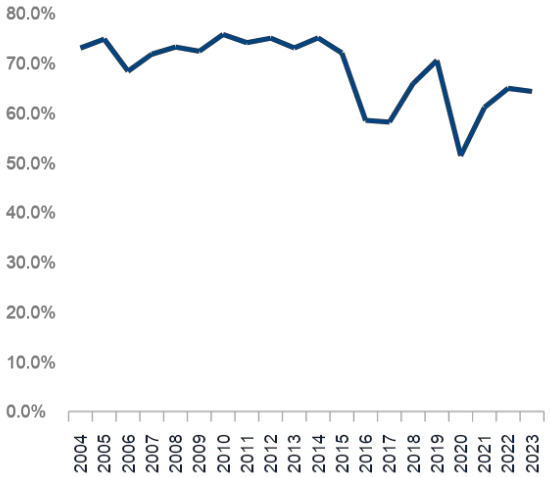
(1940-present, ºC)



Source: BBVA Research from Daily 2-meter Air Temperature.

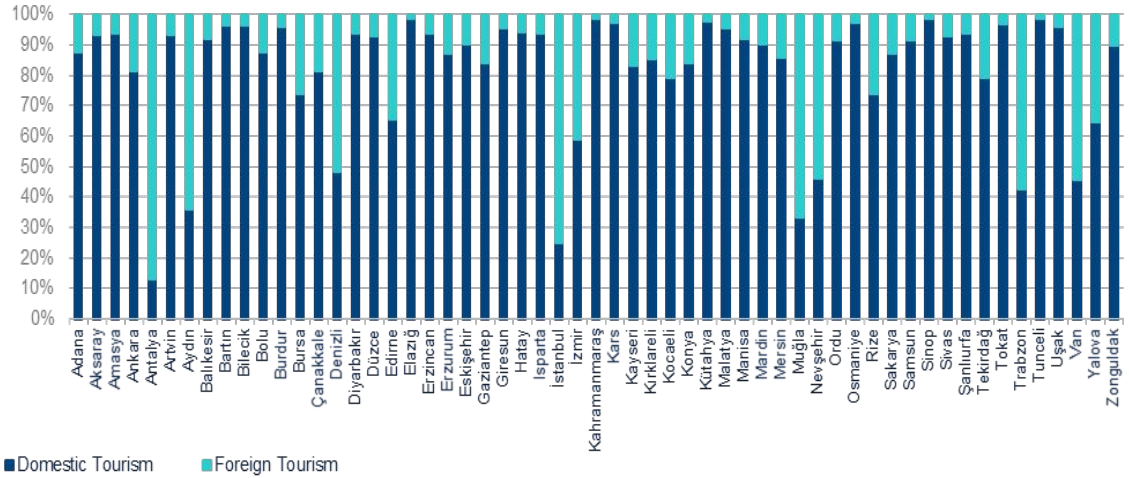
Tourism demand in Türkiye exhibits seasonal pattern with higher relevance of foreign tourism in Southern Coast during summer season

SHARE OF FOREIGN TOURIST IN TOTAL BEDNIGHTS (%)



Source: BBVA Research, Ministry of Culture & Tourism

DISTRIBUTION OF DOMESTIC AND FOREIGN TOURISM BY SELECTED PROVINCES (2023)



Source: BBVA Research, Ministry of Culture & Tourism

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02

Data and Empirical Approach

Variables and data

Time Period:
2004-2021

Data frequency:

Monthly

Geographical unit:

72 provinces in Türkiye

Not seasonally adjusted data

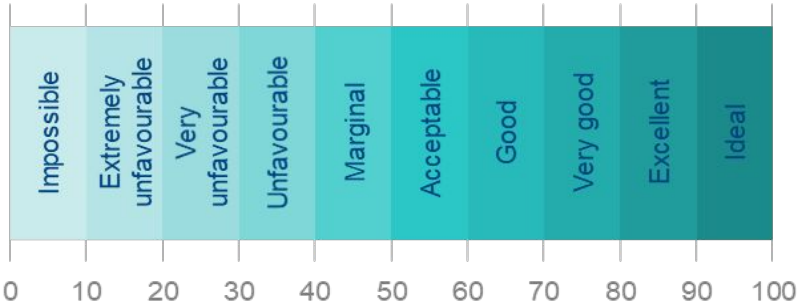
Data transformation:
Variables in logs

Variables	Definition	Source
Total Bed Nights	Number of bed nights	Ministry of Culture & Tourism
Foreign Bed Nights	Number of bed nights from foreigners	Ministry of Culture & Tourism
Tourism Climate Index (TCI)	Climate composite of thermal comfort, precipitation, cloud cover and wind, with values that range from 0 (potentially dangerous) to 100 (ideal conditions)	Own calculation based on Mieczkowski (1985) using ERA5 monthly data (Copernicus CDS)
Holiday Climate Index (HCI)	Climate composite of thermal comfort, precipitation, cloud cover and wind, with values that range from 0 (potentially dangerous) to 100 (ideal conditions)	Own calculation based on Scott et al. (2016) and Rutty et al. (2020) using ERA5 monthly data (Copernicus CDS)
Real Gross Domestic Product (RGDP)	Monthly RGDP for each province	Turkstat and own calculations
Consumer Price Index (CPI)	Monthly CPI for each province (The data is available for Jan 2004-Apr 2022)	Turkstat
Relative ratio of foreign RGDP per capita	Weighted average of the monthly RGDP per capita from the top 35 visitor countries to Türkiye, relative to the RGDP per capita of the destination province	Oxford Economics and own calculations
Relative ratio of foreign CPI	Weighted average of the CPI index from the top 35 visitor countries to Türkiye, relative to the CPI of the destination province	IMF, Turkstat and own calculations

Tourism Climatic Index (TCI), the most widely used to describe the attractiveness of tourist destinations

The first composite index was the **Tourism Climate Index (TCI)** (Mieczkowski, 1985), designed to integrate climate variables relevant to tourism.

TCI values range from 0 to 100, where 0 represents potentially dangerous and 100 ideal. A value lower than 50 represents conditions that are considered unsuitable.



TCI includes four **components**: daily comfort, precipitation, cloud cover and wind.

$$TCI = 5\,\text{Daily Comfort Index} + 2\,\text{Precipitation} + \\ + 2\,\text{Cloud Cover} + \text{Wind}$$

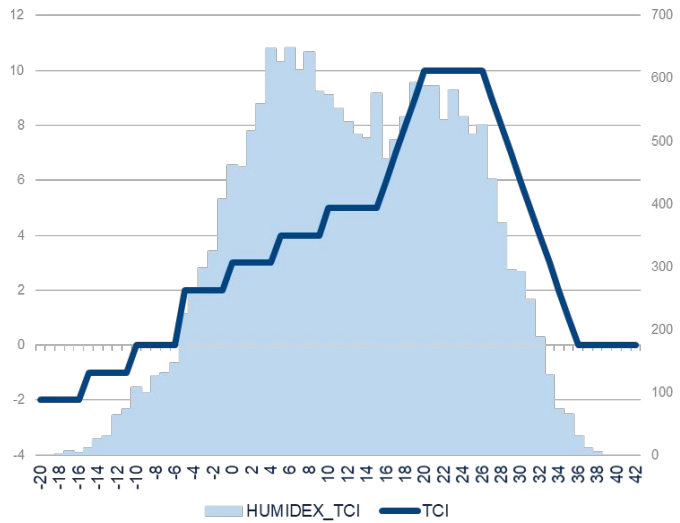
Sub-index	Climate variable	Weight
Daily Comfort Index (CIA) - Humidex	Mean daily air temperature (°C) and Mean daily humidity (%)	50%
Precipitation (P)	Total daily precipitation (mm)	20%
Wind (W)	Mean wind speed (km/h)	10%
Aesthetic (A)	Cloud cover (%)	20%

More details on TCI in Annex

The TCI accounts for temperature variations, with limited observations exceeding the upper threshold

HUMIDEX HISTORICAL DISTRIBUTION 1980-2023 (RIGHT- AXIS) AND RATING (LEFT-AXIS)

(calculated using monthly average mean temp.)



Source: BBVA Research
Note: The left-hand side axis represents the score from the TCI ranking, while the right-hand side axis represents the number of times (frequency) a temperature level was registered.

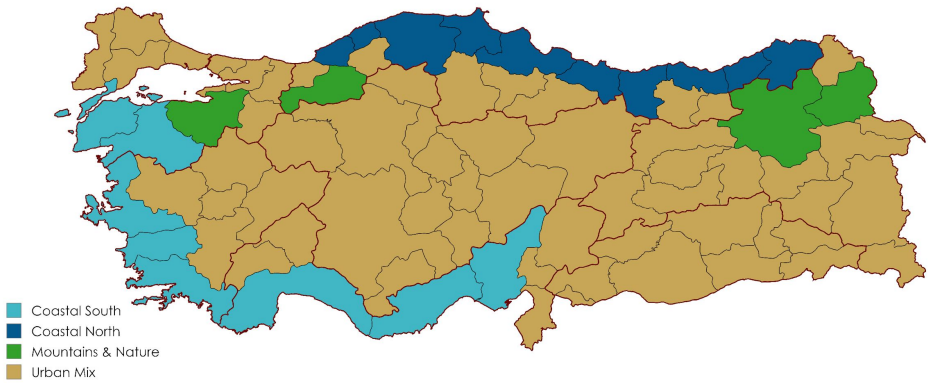
THERMAL COMFORT RATING SYSTEM

Rating	Humidex (ºC)
0	≥ 36
1	[35.0, 35.9)
2	[34.0, 34.9)
3	[33.0, 33.9)
4	[32.0, 32.9)
5	[31.0, 31.9)
6	[30.0, 30.9)
7	[29.0, 29.9)
8	[28.0, 28.9)
9	[27.0, 27.9)
10	[20.0, 26.9)
9	[19.0, 19.9)
8	[18.0, 18.9)
7	[17.0, 17.9)
6	[16.0, 16.9)
5	[10.0, 15.9)
4	[5.0, 9.9)
3	[0.0, 4.9)
2	(-5.9, -0.1]
0	(-10.9, -6.0]
-1	(-15.9, -11.0]
-2	(-20.9, -16.0]
-6	≤ -21

Source: BBVA Research adapted from Mieczkowski, 1985. More details on TCI in Annex

Types of Tourism across provinces takes reference from Batista e Silva et al. (2021) with a change of perspective to differentiate between tourism categories

TURKISH PROVINCES CLASSIFIED BY TYPE OF TOURISM



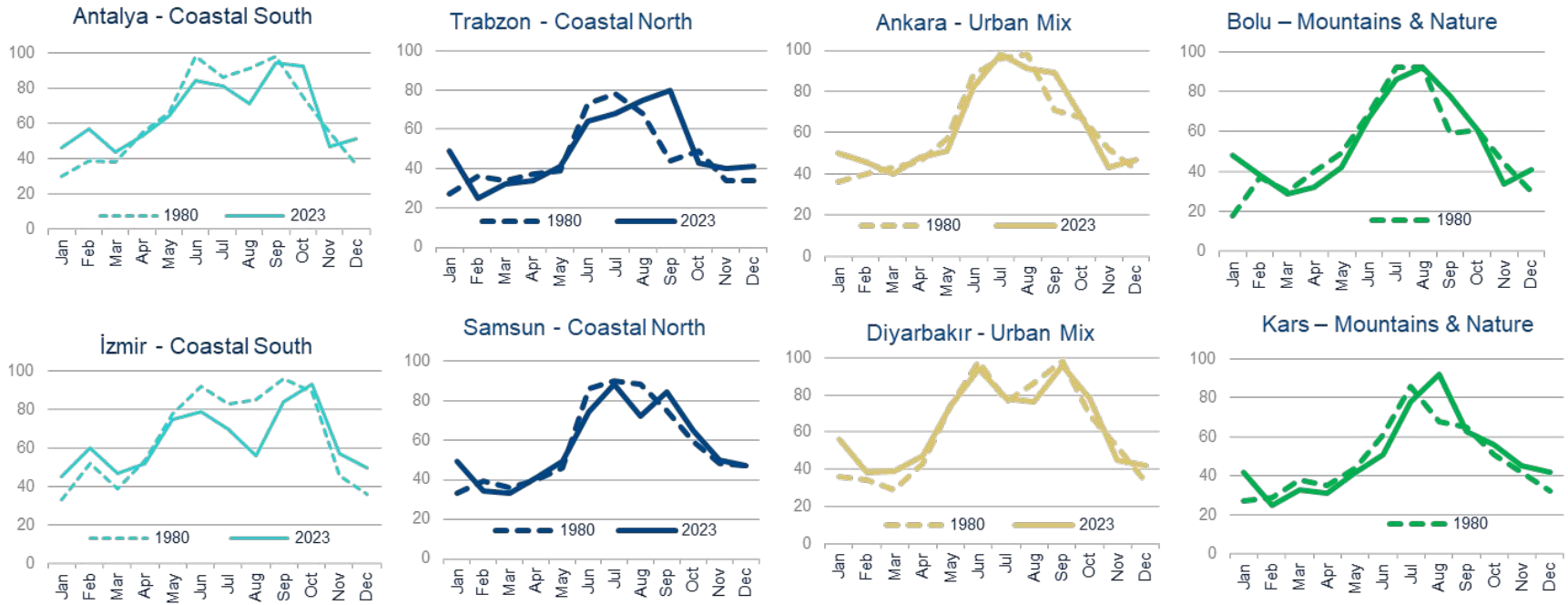
- **TCI is further analyzed together with each province's tourism typology** to capture the climatic preferences across major tourism segments and destination types.
- **The methodology, used by JRC, is well-established.** We modified it by:
  - Splitting the coastal category into South and North.
  - Reclassifying cities reporting an equal distribution of avg. tourism shares across the year and where the cultural & historical sightseeing activities are more prominent as Urban Mix.
  - Classifying the rural places reporting higher average tourism shares during winter times particularly due to ski season under Mountains and Nature.

Source: BBVA Research adapted from Batista e Silva et al. (2021)

Coastal areas demonstrate a clearer worsening in climate conditions in summer months, represented lower TCI values as a result of increasing temperatures

TCI EVOLUTION IN SELECTED PROVINCES (BY TYPE OF TOURISM)

1980 vs 2023



Source: BBVA Research calculations using ERA 5 Copernicus Climate Change Service (C3S)

Empirical framework: a panel data regression with fixed effects

Following Barrutiabengoa et. al. (2024) the model was estimated using **Feasible Generalized Least Squares** with **AR(1) autocorrelation in the residuals** as well as cross-sectional correlation across panels.

$$y_{it} = \alpha + \beta_1 TCI_{it} + \beta_2 TCI_{it} \times type\_tourism_i + \\ + \beta_3 season_t + \beta_4 X_{it} + \eta_i + \epsilon_{it}$$

y_{it}: total bed nights at time t in province i

TCI_{it}: Tourism Climate Index at time t in province i

$type\_tourism_i$: Coastal North, Coastal South, Mountains & Nature and Urban Mix

$season_t$: season to which the month t belongs (Autumn, Spring, Summer, Winter)

X_{it}: matrix of control variables: Real GDP (destination), CPI (destination), Relative foreign Real GDP per capita, Relative foreign CPI, monthly covid dummy variable

α intercept, **η_i** fixed effects by province i, **ε_{it}** residuals ($\varepsilon_{it} = \rho\varepsilon_{it-1} + v_{it}$)

Empirical results: Tourism demand responds to the changes in climate conditions

	Total Bed Nights
Coastal South x TCI	0.462***
	(21.16)
Coastal North x TCI	0.035**
	(2.37)
Mountains and Nature x TCI	−0.347***
	(-12.39)
Urban Mix x TCI	−0.011
	(− 1.30)
GDP	0.742***
	(15.33)
CPI	0.286***
	(7.46)
Relative Foreign GDP Per Capita	0.081***
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Relative Foreign CPI	−0.044***
	(− 6.65)
Spring	0.052**
	(2.55)
Summer	0.143***
	(7.95)
Winter	−0.094***
	(− 5.15)
COVID	−0.299***
	(− 6.27)

t statistics in parantheses.

$***\rho < 0.01, **\rho < 0.05, *\rho < 0.10,$

Climatic conditions, measured by the TCI, have a positive effect on tourism demand in coastal regions, with the highest impact reported in Southern coastal provinces. Because the Urban Mix provinces have much lower variability in tourism demand across seasons, it reports lower sensitivity to changes in climate conditions. Furthermore, the Mountain and Nature provinces, particularly famous for ski tourism thereby exhibiting higher tourism shares during winter season, report higher tourism demand as the climate conditions worsen.

Economic factors: GDP and inflation of the destination province significantly impact bed nights both reporting a positive effect on the tourism demand. The relative foreign real GDP per capita positively affects tourism demand, indicating the higher purchasing power of foreign tourists. On the other hand, the relative foreign CPI reports negative coefficient indicating that the foreign tourists demand declines as the price index of the tourists' origin country increases relative to the price index of the destination. We further checked whether the results change significantly if we exclude the CPI-related indicators (See Appendix A3.2). Accordingly, we found that inclusion of the CPI of the destination result in a statistically significant coefficient for Coastal North and slightly higher impact of climatic conditions on Coastal South, but overall, the significance, direction and magnitude of the coefficients remain robust.

Seasonal tourism patterns confirm that summer has the highest overnight stays, whereas winter reports the lowest.

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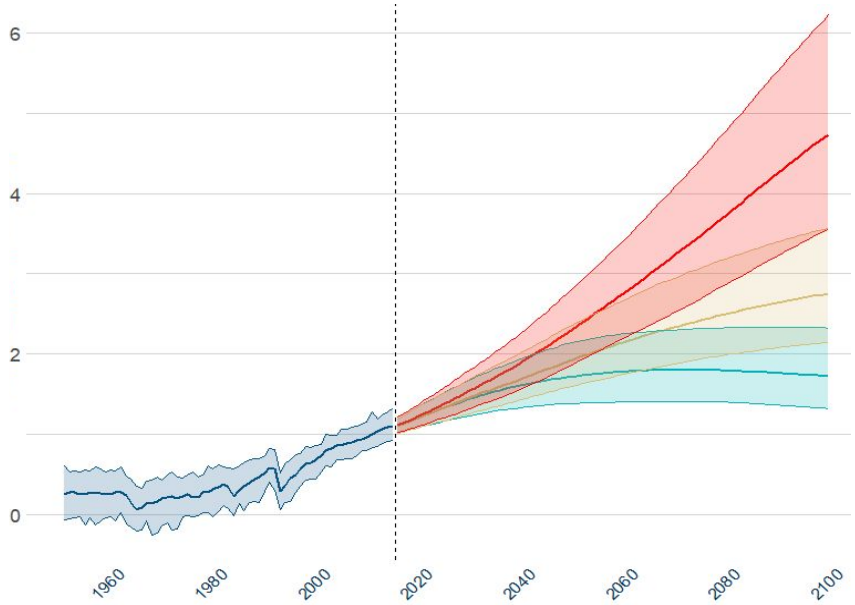
03

Climate Change Future Pathways (RCP)

RCP: Future GHG Concentration pathways for scenario analysis

GLOBAL SURFACE TEMPERATURE CHANGE (ºC)
(relative to 1850-1900)



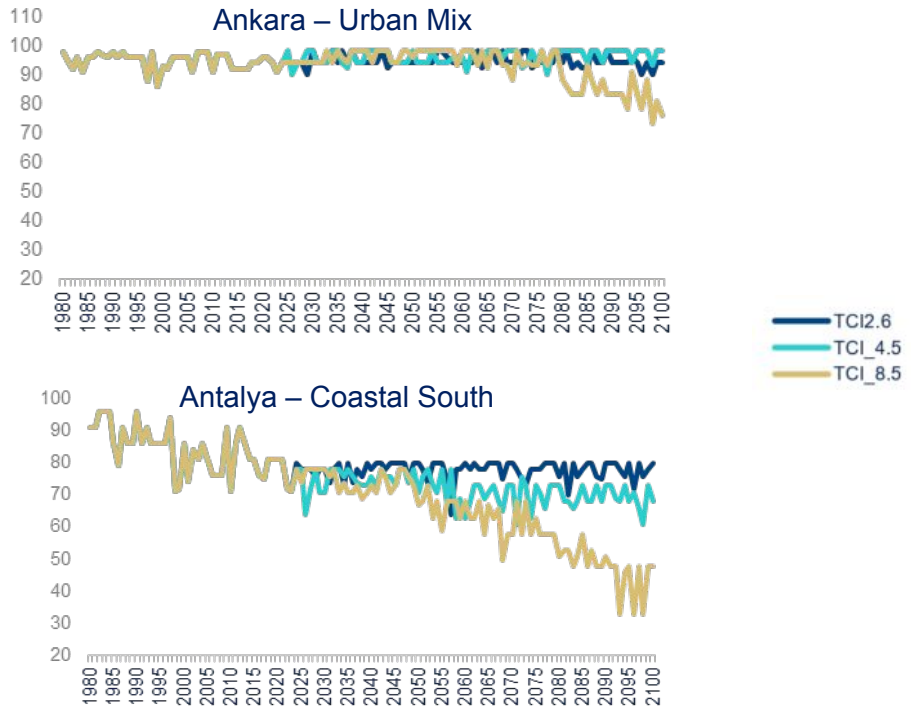
Source: BBVA Research from IPCC Sixth Assessment Report
Note: The dark blue line and shaded area represent the historical observed changes. The lights blue, yellow and red solid line and shaded areas represent the estimated point and 95% uncertainty bands for each of the RCP scenarios

Climate change scenarios, known as **Representative Concentration Pathways (RCPs)**, to project future GHG concentrations. These scenarios have been formally adopted by the **IPCC**.

- **RCP 8.5**: very high future emissions tripling emissions by the end of the century (projected median increase of 4.8ºC by 2100)
- **RCP 4.5**: low to moderate future emissions (projected median increase of 2.8ºC by 2100)
- **RCP 2.6**: low future emissions trend, declining by 2020 and reaching net zero by 2100 (projected median increase of 1.8ºC)

Evolution of tourism demand based on climate scenarios, holding all other factors constant

TCI EVOLUTION IN AUGUST



Source: BBVA Research calculations

- **To project Turkish tourism demand at provincial level,** the TCI has been calculated for different concentration pathways to estimate conditional forecasts up to 2100.
- **Assumptions**:
  - ➔ Relationship between bednights and climate variables remains constant over time.
  - ➔ Absence of adaptation to changes in climate patterns.
  - ➔ Absence of non-linearities in the impact of climate comfort on tourism.
  - ➔ Economic variables are held constant over time at their 2021 values.

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04

Results: Conditional Forecasts using RCP Pathways

RCP 2.6 | Net effect on tourism: Slight tourism demand loss in autumn

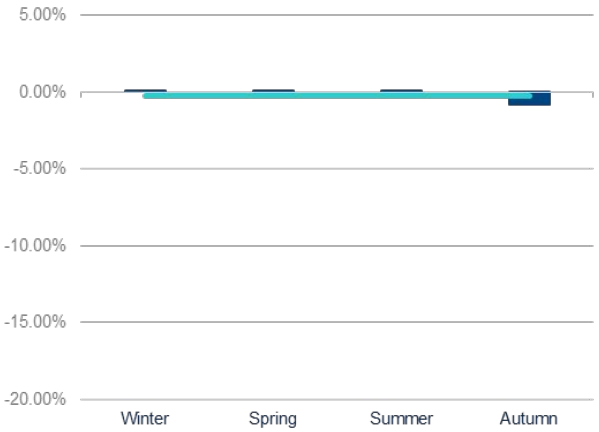
NET EFFECT BY PROVINCE IN RCP2.6, 2091-2100*

(%, using as base 2024-2030)

National Net effect ≈ -0.3%

NET EFFECT BY SEASON IN RCP2.6, 2091-2100

(%, using as base 2024-2030)



- Scenario 2.6 reports very limited tourism loss in some of the Urban Mix and North Coast cities, while a couple of South Coast and Mountains & Nature cities gain in tourism demand.

Source: BBVA Research calculations

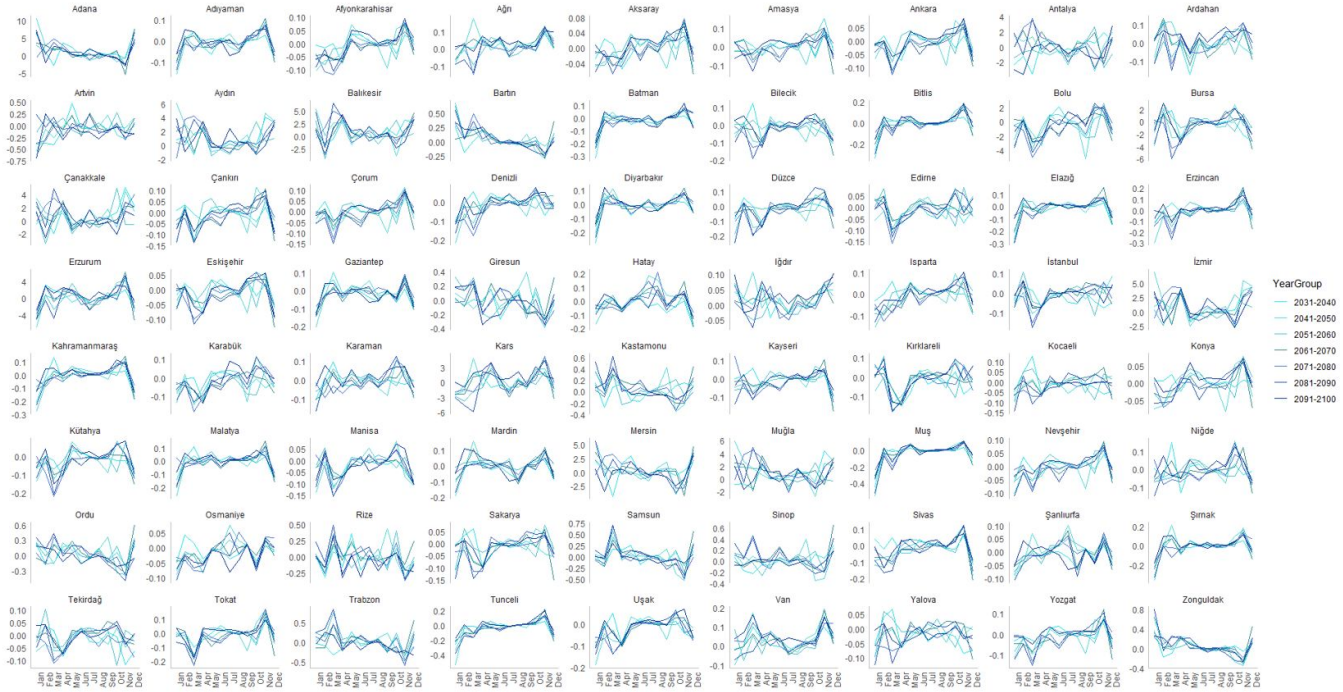
*Provinces highlighted in gray are excluded from the analysis due to lack of data availability

See next slide for further details

RCP 2.6 | Net effect on tourism: Slight tourism demand loss in autumn

CHANGE IN TOURISM DEMAND THROUGH DECADES IN RCP 2.6

(%, using as base 2024-2030)



Source: BBVA Research calculations

RCP 4.5 | Net effect on tourism: The tourism demand loss in autumn is compensated by the rest of the seasons

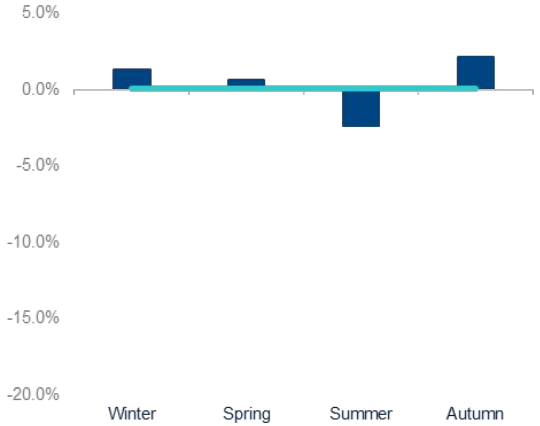
NET EFFECT BY PROVINCE IN RCP4.5, 2091-2100*

(%, using as base 2024-2030)

National Net effect ≈ +0.03%

NET EFFECT BY SEASON IN RCP4.5, 2091-2100

(%, using as base 2024-2030)



- Scenario 4.5 reports a slight and negligible tourism gain, probably caused by the variations in the model which results slight increases especially in Urban Mix and Southern Coast.

Source: BBVA Research calculations

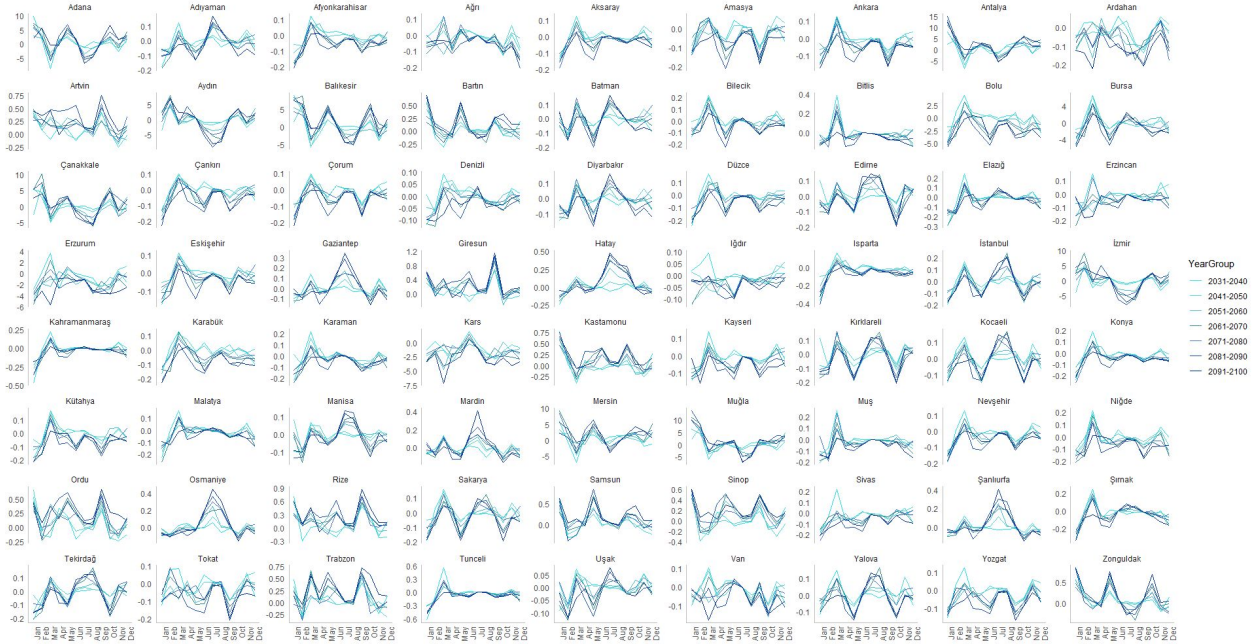
*Provinces highlighted in grey are excluded from the analysis due to lack of data availability

See next slide for further details

RCP 4.5 | Net effect on tourism: The tourism demand loss in autumn is compensated by the rest of the seasons

CHANGE IN TOURISM DEMAND THROUGH DECADES IN RCP 4.5

(%, using as base 2024-2030)

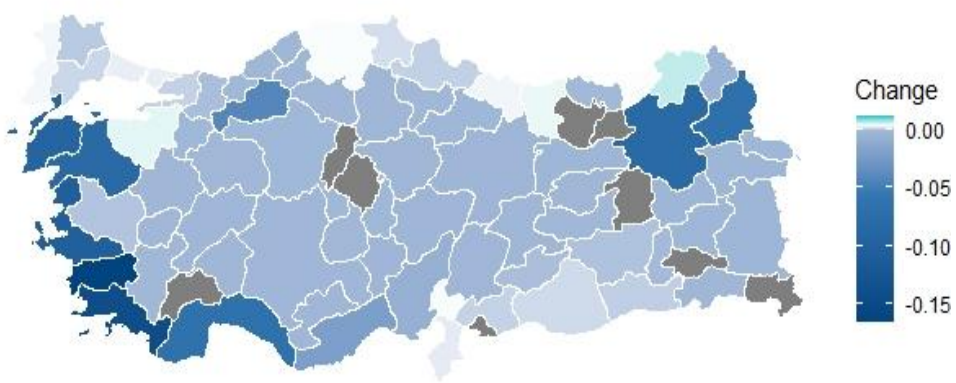


Source: BBVA Research calculations

RCP 8.5 | Net effect on tourism: Prominent loss in summer tourism which can not be compensated by the increasing tourism demand for the rest of the year

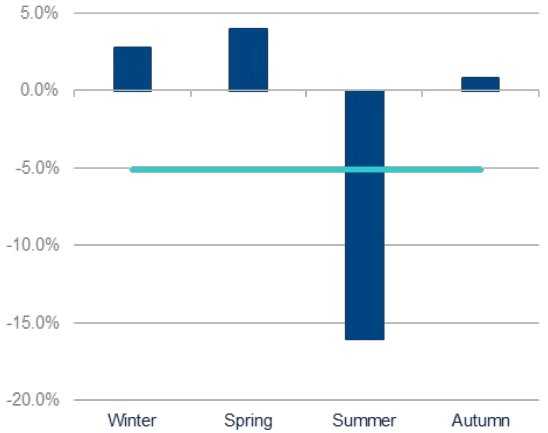
NET EFFECT BY PROVINCE IN RCP8.5, 2091-2100*

(%, using as base 2024-2030)



NET EFFECT BY SEASON IN RCP8.5, 2091-2100

(%, using as base 2024-2030)



National Net effect ≈ -5.1%

Source: BBVA Research calculations

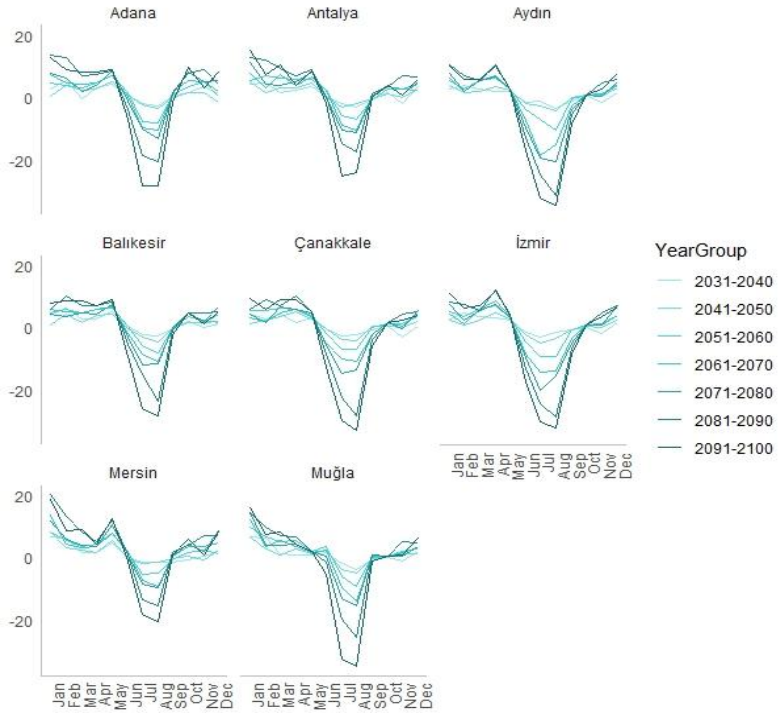
*Provinces highlighted in grey are excluded from the analysis due to lack of data availability

Evolution by decades in RCP 8.5 scenario: Coastal South

- Among all tourism types, the Southern Coast provinces experience the largest decline in tourism demand due to climate change, with highest decline recorded in Aydın with 16.5% on average in 2090s, compared to base period.
- In contrast, all provinces report increasing tourism demand during spring and autumn, which indicates the shifting of seasonality of tourism demand, slightly more in favor of spring season. In terms of summer months, the highest decline in tourism demand is reported by Muğla in August with 35%.
- The net decline in **tourism demand is around 7.9%** on average in this group of provinces, for the 2090's with respect to 2024-2030 period.

CHANGE IN TOURISM DEMAND (%)

(using as base 2024-2030)



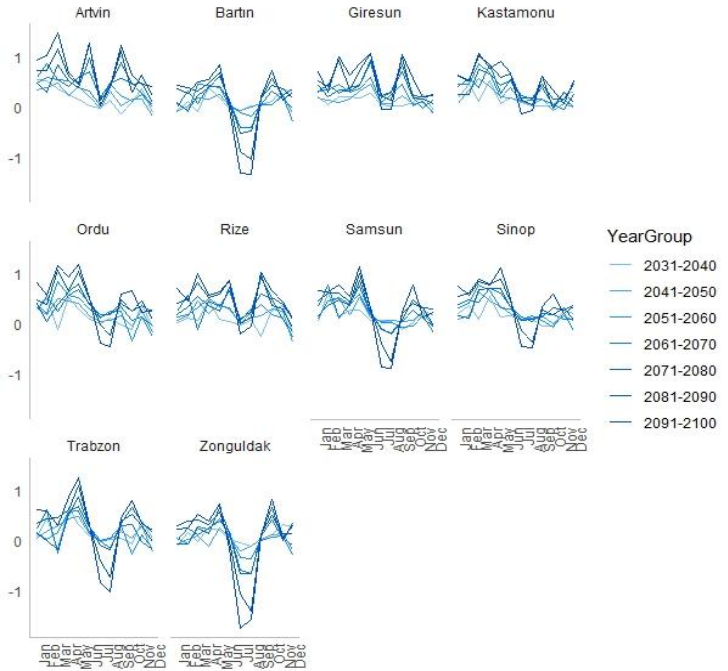
Source: BBVA Research calculations

Evolution by decades in RCP 8.5 scenario: Coastal North

- The Coastal North provinces, in general, reflect **less favourable tourism conditions during summer**, along with an increase in spring and autumn. In this respect, Coastal North demonstrates a similar picture as in Coastal South, though the tourism demand loss is at a much lower magnitude.

- Despite decreasing tourism demand during summer months, the mean net impact in Coastal North is 0.2%, in the 2090's compared to 2024-2030. Albeit being small, this increase in tourism demand could be explained with the substitution effect: Having beaches along the Black Sea, the region could attract some of the tourists preferring not to spend their vacation in Coastal South where the climate comfort declines considerably.

CHANGE IN TOURISM DEMAND (%)
(using as base 2024-2030)

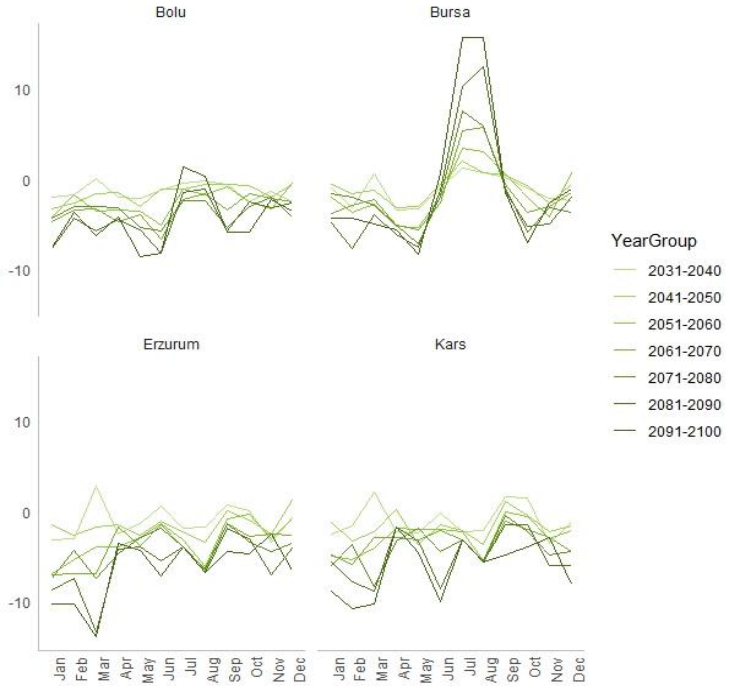


Source: BBVA Research calculations

Evolution by decades in RCP 8.5 scenario: Mountains and Nature

- At first glance, there does not seem to be a clear pattern in tourism demand in Mountain and Nature provinces, except for Bursa.
- However, **a closer look** reveals that all 4 of the provinces lose tourism demand during winter seasons. This could happen due to the possibility that the climate change deteriorates the winter conditions needed for ski season. Since, the provinces classified under Mountains & Nature are known to receive more tourists during ski season (evident by their higher avg. tourist shares during winter months), their tourism is hurt by the higher temperatures during summer.
- Overall, the average the net effect is negative, around -2.4% in the 2090's, compared to 2024-2030 period.

CHANGE IN TOURISM DEMAND (%)
(using as base 2024-2030)



Source: BBVA Research calculations

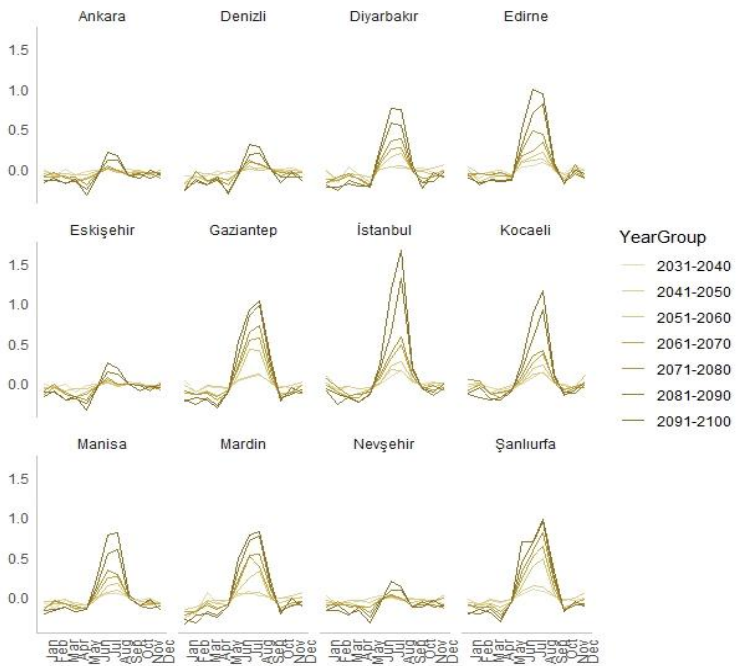
Evolution by decades in RCP 8.5 scenario: Urban Mix

- Urban tourism cities report differing impact with Central Anatolia experiencing slight decrease, whereas Southern Anatolia and Northwestern Anatolia (ie. Marmara Region) reporting slight increase.

- Urban tourism may have a substitution effect with beach tourism, making it less sensitive to weather conditions. Additionally, urban tourism typically involves more indoor activities, like the cultural attractions of İstanbul, Diyarbakır or Mardin, further reducing its sensitivity to weather.

- Still, the slight increase in tourism demand during summer season is offset by slight decline in winter season, limiting the overall net effect to +0.1% in 2090s.

CHANGE IN TOURISM DEMAND (%)
(selected provinces, using as base 2024-2030)



Source: BBVA Research calculations

Foreign Tourism Demand: similar conclusions with subtle variations along the coast

	Total Bed Nights	Foreign Bed Nights
Coastal South x TCI	0.462***	0.481***
	(21.16)	(13.86)
Coastal North x TCI	0.035**	0.0901**
	(2.37)	(2.38)
Mountains and Nature x TCI	−0.347***	−0.288***
	(−12.39)	(−5.57)
Urban Mix x TCI	−0.011	0.067***
	(− 1.30)	(3.87)
GDP	0.742***	1.367***
	(15.33)	(14.11)
CPI	0.286***	−0.312***
	(7.46)	(−3.67)
Relative Foreign GDP Per Capita	0.081***	0.101***
	(15.54)	(7.47)
Relative Foreign CPI	−0.044***	−0.109***
	(−6.65)	(−6.43)
Spring	0.052**	0.079**
	(2.55)	(2.48)
Summer	0.143***	0.134***
	(7.95)	4.81
Winter	−0.094***	−0.174***
	(− 5.15)	(− 6.12)
COVID	−0.299***	−0.669***
	(− 6.27)	(− 8.30)

t statistics in parantheses.

$***\rho < 0.01, **\rho < 0.05, *\rho < 0.10,$

Model 1: Total tourism demand

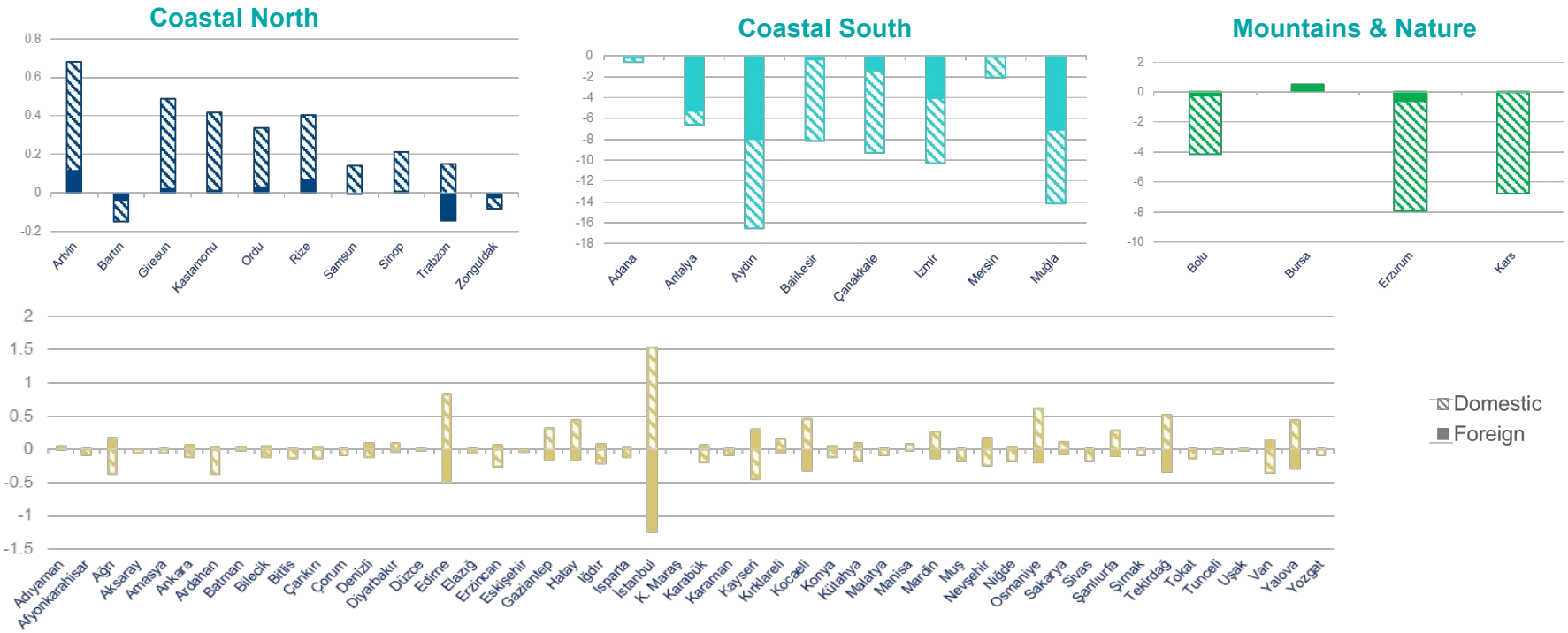
Model 2: Foreign tourism demand

- We studied the models separately for foreign bed nights in order to test whether the response to changing climate conditions differs across foreign & domestic.
- Overall, the results are similar with Tourism Climate Index (TCI) having a positive and significant effect on both total and foreign bednights.
- Foreign tourists have slightly higher elasticity than for total tourism to climate in coastal cities, and lower in Mountains & Nature cities.
- Urban mix coefficient is higher than total tourism for foreign tourists, indicating that foreigners' demand declines for urban tourism as the climate comfort declines, even though the tourism demand loss is not as high as in Southern coast. This is partly due to the fact that foreign tourists tend to do less work-related tourism, which is not really affected by the weather.

Foreign vs. Domestic tourists?: Domestic tourism accounts for the majority of the decline in the tourism demand of Southern coast

BED NIGHTS CHANGE DECOMPOSITION, RCP 8.5 2090-2100

(%, using as base 2024-2030)



Source: BBVA Research calculations

BBVA Research

05

Robustness Analysis: Holiday Climate Index

Holiday Climate Index (HCI), an alternative proxy for climatic comfort

The **Holiday Climate Index (HCI)**, an alternative proxy for climatic comfort to the TCI, was designed to be specified for major tourism segments and destination types by Scott et al. (2016) and Rutty et al. (2020).

An advantage of HCI is that its design is **not subjective but rather empirically validated** by surveys.

HCI presents **two different specifications,** distinguishing between **Beach** and **Urban** tourism(*). It also employs different thresholds in its rating scheme, reflecting distinct climatic preferences.

HCI COMPONENTS AND WEIGHTS

Index Component	Weather Variables	HCI: Urban	HCI: Beach
Thermal comfort (TC)	Average maximum daily air temperature (° C) and relative humidity (%)	40%	20%
Precipitation (P)	Total daily precipitation (mm)	30%	30%
Aesthetic (A)	Cloud cover (%)	20%	40%
Wind (W)	Mean wind speeds (km/hr)	10%	10%

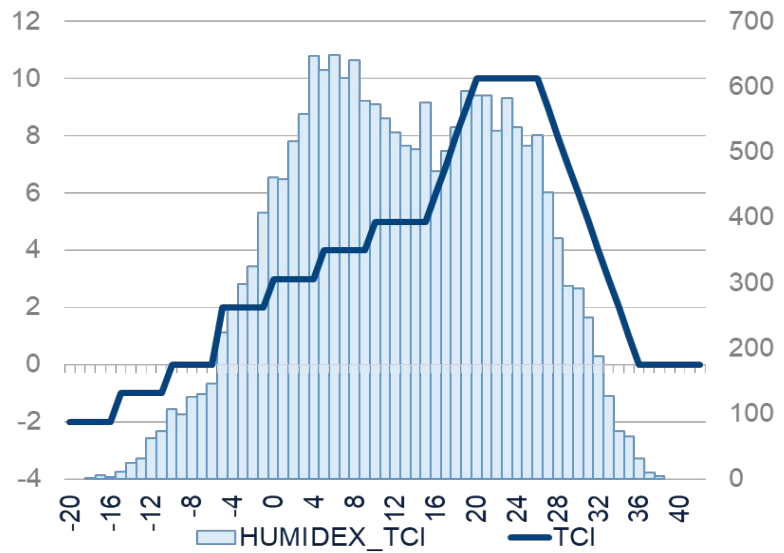
(*) Provinces with a coast either on Mediterranean or Black Sea are calculated with the HCI Beach, while inland provinces of the Urban Mix and Mountains and Nature category are calculated with the HCI Urban.

Source: BBVA Research adapted from Scott et al. (2016) and Rutty et al. (2020). More details in the Annex.

Comparing thermal comfort of TCI and HCI: changing the thresholds makes the difference, specially in the upper limit

HUMIDEX HISTORICAL DISTRIBUTION 1980-2023 (RIGHT- AXIS) AND RATING (LEFT-AXIS)

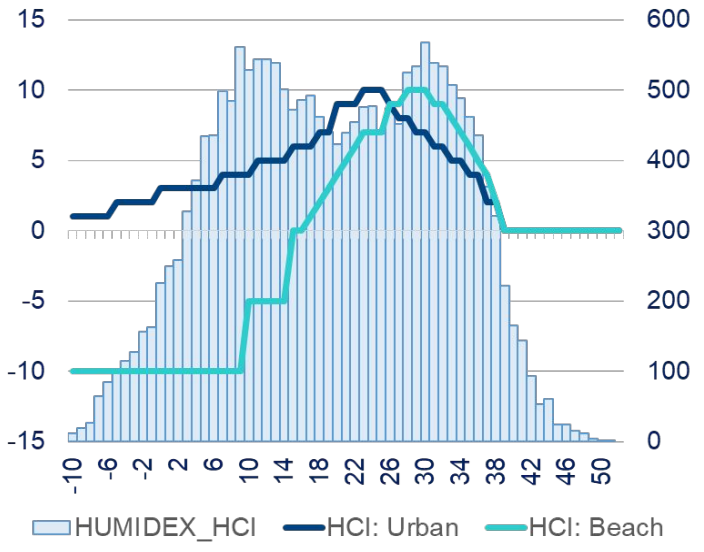
(calculated using monthly average mean temp.)



Source: BBVA Research
Note: The left-hand side axis represents the score from the TCI ranking, while the right-hand side axis represents the number of times a temperature was registered.

HUMIDEX HISTORICAL DISTRIBUTION 1980-2023 (RIGHT- AXIS) AND RATING (LEFT-AXIS)

(calculated using monthly average maximum temp.)



Source: BBVA Research
Note: The left-hand side axis represents the score from the TCI ranking, while the right-hand side axis represents the number of times a temperature was registered.

Results: The models with HCI reports less impact for South Coast

Model 1: TCI as the climate index

Model 2: HCI (Beach and Urban) as the climate index

- **The model remains robust**, with most variables showing similar values. The two main differences across the models:
  1. The coefficient for Coastal South tourism has slightly decreased. Hence, compared to the model with TCI, the impact of the worsening in climate conditions is less pronounced for Southern coast in the model with HCI.
  2. Statistically, the coefficients are similar except for the urban mix, which proves as a robustness check for TCI models. The coefficient for Urban mix differs due to the fact that HCI_Urban gives less importance to temperature and higher to precipitation, and hence, could be better capturing the elasticity

	TCI	HCI
Coastal South x TCI	0.462***	0.395***
	(21.16)	(19.64)
Coastal North x TCI	0.035**	0.052**
	(2.37)	(3.02)
Mountains and Nature x TCI	−0.347***	−0.520***
	(− 12.39)	(− 13.90)
Urban Mix x TCI	−0.011	0.699***
	(− 1.30)	(5.19)
GDP	0.742***	0.701***
	(15.33)	(14.33)
CPI	0.286***	0.301***
	(7.46)	(7.79)
Relative Foreign GDP Per Capita	0.081***	0.784***
	(15.54)	(15.08)
Relative Foreign CPI	−0.044***	−0.414***
	(− 6.65)	(− 6.34)
Spring	0.052**	0.055*
	(2.55)	(2.68)
Summer	0.143***	0.148***
	(7.95)	(8.21)
Winter	−0.094***	−0.0797***
	(−5.15)	(− 4.33)
COVID	−0.299***	−0.297***
	(−6.27)	(− 6.18)

t statistics in parantheses.

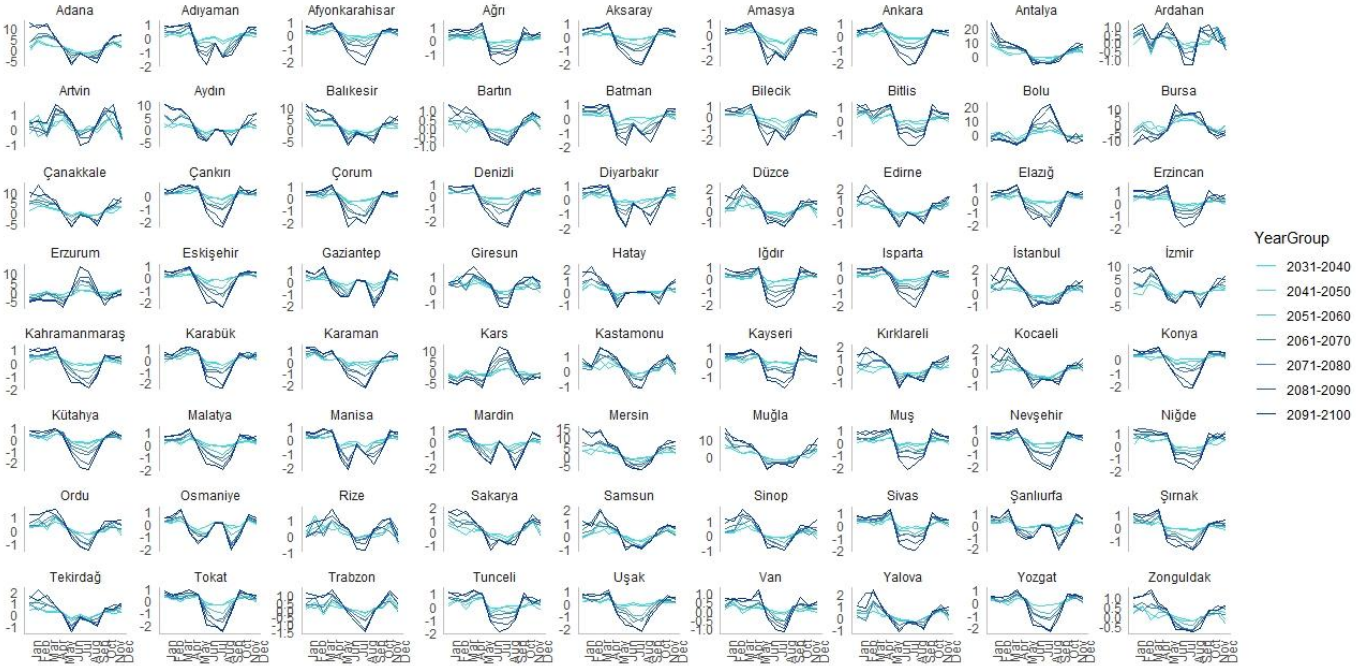
$^{***}\rho < 0.01, ** \rho < 0.05, *\rho < 0.10,$

More details on the coefficients in the Annex.

Results: HCI reduces climate impact on beach tourism while making urban tourism more climate-sensitive

CHANGE IN TOURISM DEMAND THROUGH DECADES IN RCP 8.5

(%, using as base 2024-2030)



Source: BBVA Research calculations

Net effect on tourism: Holiday climate index (HCI) under RCP scenarios shows moderate but widespread declines across territories

NET EFFECT BY PROVINCE AND SEASON IN RCP2.6, 2091-2100

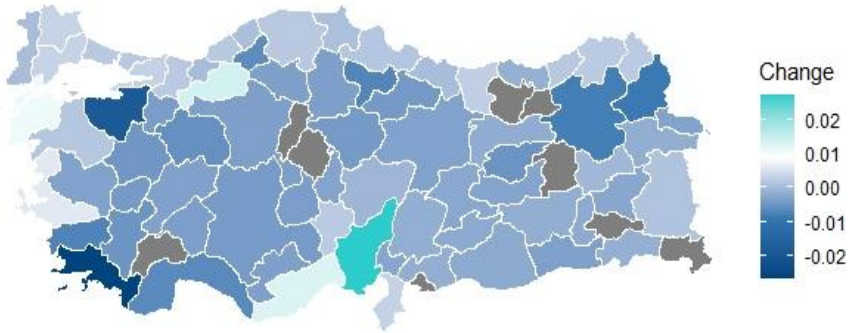
(%, using as base 2024-2030)

National Net effect
≈ +0.2%

Source: BBVA Research

NET EFFECT BY PROVINCE AND SEASON IN RCP8.5, 2091-2100

(%, using as base 2024-2030)



National Net effect
≈ -0.4%

Source: BBVA Research

Main takeaways: Clear shift in seasonality of the tourism trends, though the results depend on the use of temperature thresholds

- **The results point to a clear shift of tourism demand** away from summer months to spring and autumn in the Southern Coast of Türkiye, which is a region highly crucial for sea & sand tourism garnering the attraction of both domestic and foreign tourism. Even though a small portion of the tourism loss is compensated by the increases in the tourism demand for urban mix cities, it is clear that climate change results in an overall tourism loss.

- **Not only sea and sand tourism is hurt by the increasing temperatures:** Regions characterized by winter tourism also loses tourism demand.

- **The choice of tourism climate indices (TCI vs. HCI or others) changes the magnitude of tourism loss:** The established thresholds of Climate Indexes, based on data, surveys, or reference papers, are crucial and determine all results. A dynamic selection of temperature thresholds depending on the destination's type of tourism reflecting changing preferences of tourists may result in more specialized outcomes.
- **The results with the TCI indicate that the net effect in tourism for RCP scenarios 2.6, 4.5, and 8.5 by 2100 compared to the current decade is around -0.3%, +0.03% and -5.1% respectively.**

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The Impact of Climate Change on Tourism Demand in Türkiye

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November 2024

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07

Annex

A1 - Modelling tourism demand: a literature review

Literature has modelled the tourism demand in multiple ways depending on the analysis goals:

Model Estimation Techniques

- ***Single-equation specifications and time series analysis:*** focus on pure forecasting
- ***Gravity models:*** identification of factors driving tourism demand and impact from a certain phenomenon or policy
- ***Panel data models:*** use of regional/ cross-countries dimension to evaluate phenomena

Dependent Variable

- The choice of the measure for tourism demand can be controversial since the ***tourism activity is a multidimensional variable.***
- Literature mostly uses ***tourist arrivals*** (totals or bilateral). Other times it uses ***number of nights, expenditures, length of stay, purpose.***

Explanatory Variables

- ***Economic and Political***
  - Income of the travelers/countries
  - Prices
  - Quality of offer
  - Government regulations, security, safety, visa agreements
- ***Non-economic***
  - Geographical and physical factors
  - Cultural factors
  - Tastes
  - Type of tourism
  - Sociodemographic characteristics of travelers

A1 - Modelling tourism demand: a literature review

Study	Time	Countries	Climate variable	Methodology	Main Results
Amelung & Moreno (2012)	2080s projections	European countries	Tourism climate index (TCI)	Linear regression and climate scenarios	Southern Europe less favorable in summer and Northern Europe more favorable. Economic impacts depend on tourists' flexibility in holiday planning.
Rosselló & Santana-Gallego (2014)	2005-2007	Spain	Temperature	Gravity model domestic tourism	Temperature is a positive factor in tourism flows. Future competitiveness of northern provinces.
Barrios & Ibañez (2015)	2010-2011, projections	EU regions	Temperature	Tourism demand equation	Southern EU regions lose tourism revenues and Northern EU regions gain modestly, especially due to timing adaptation of holidays.
Scott et al. (2016)	1961-2099	27 EU countries	TCI, HCI	Comparative analysis of TCI and HCI	HCI offer insights for urban and beach tourism.
Bilgin et. al (2024)	1976-2020	Türkiye	HCI	Panel data with fixed-effects	Mediterranean coast will experience a decline in attractiveness by the 2050s that can be attributed to declining climate comfort during the summer months.
Barrutiabengoa et al. (2024)	2002-2023	Spanish provinces	TCI, HCI	Feasible Generalized Least Squares	The northern provinces of the country are likely to benefit from global warming, while Mediterranean provinces could experience declines in tourism demand.
Oğur & Baycan (2022)	2008-2017, projections until 2100	Türkiye	TCI	Log-linear model specification à la Hein et.al (2009)	Shift in the seasonal patterns of tourism demand from summer to winter and overall decline in tourism demand as a result of climate change.
Matei et al. (2023)	2000-2019	269 European regions	TCI	Fixed effects monthly panel	North-south tourism pattern change and seasonality shift. Coastal regions most impacted.

A2 - Tourism Climate Index: Insights on the climate variables

- All the climate data required to compute the Tourism Climate Index(TCI) was obtained from the ERA5 database provided by Copernicus. This dataset is provided here is a grid with a horizontal resolution of 0.25º x 0.25º at a global level from 1940 until the present.
- The TCI consists of 5 variables:
  - **2m temperature (ºC):** temperature of air at 2m above the surface of land, sea or inland waters. 2m temperature is calculated by interpolating between the lowest model level and the Earth's surface, taking account of the atmospheric conditions.
  - **2m dew point temperature(ºK):** temperature to which the air, at 2 metres above the surface of the Earth, would have to be cooled for saturation to occur. It is a measure of the humidity of the air. Combined with temperature and pressure, it can be used to calculate the relative humidity
  - **Total daily precipitation (mm):** This parameter is the accumulated liquid and frozen water, comprising rain and snow, that falls to the Earth's surface. It is the sum of large-scale precipitation and convective precipitation.
  - **10m wind speed (km/hr):** This parameter is the horizontal speed of the wind, or movement of air, at a height of ten metres above the surface of the Earth.
  - **Total cloud cover (%):** This parameter is the proportion of a grid box covered by cloud.. Cloud fractions vary from 0 to 1.

A2 - Tourism Climate Index: : Insights on the climate variables

- The main component of the TCI is a compound humidity index indicating the daily thermal comfort know as the Humidex. This indicator is a build as a function of temperature and relative humidity, and was thought to represent how hot the weather feels to the average person.
- The Humidex formula is as follows:

$$H = T_{\text{air}} + 0.5555\left(6.11 \times \exp\left[5417.7530\left(\frac{1}{273.15} - \frac{1}{273.15 + T_{\text{dew}}}\right)\right] - 10\right)$$

where

- ➔ H denotes the Humidex
- ➔ T_{air} is the air temperature in ºC
- ➔ T_{dew} is the dew point temperature ºC
- ➔ The rounded constant 5417.7530 is based on the molecular weight of water, latent heat evaporation, and the universal gas constant. The 0.5555 factor (from the relation 1 °F = 5/9 °C)

- Nevertheless, this index can also be built using the relative humidity (%).

A2 - Tourism Climate Index: Insights on the climate variables

TOURISM CLIMATE INDEX RATING SYSTEM

Rating	Humidex (ºC)
0	≥ 36
1	[35.0, 35.9)
2	[34.0, 34.9)
3	[33.0, 33.9)
4	[32.0, 32.9)
5	[31.0, 31.9)
6	[30.0, 30.9)
7	[29.0, 29.9)
8	[28.0, 28.9)
9	[27.0, 27.9)
10	[20.0, 26.9)
9	[19.0, 19.9)
8	[18.0, 18.9)
7	[17.0, 17.9)
6	[16.0, 16.9)
5	[10.0, 15.9)
4	[5.0, 9.9)
3	[0.0, 4.9)
2	(-5.9, -0.1]
0	(-10.9, -6.0]
-1	(-15.9, -11.0]
-2	(-20.9, -16.0]
-6	≤ -21

Rating	Precipitation (mm)
10	[0.0, 0.5)
9	[0.5, 1.0)
8	[1.0, 1.5)
7	[1.5, 2.0)
6	[2.0, 2.5)
5	[2.5, 3.0)
4	[3.0, 3.0)
3	[3.5, 4.0)
2	[4.0, 4.5)
1	[4.5, 5)
0	≥ 5

Rating	CC (%)
10	0.0-16.6
9	16.7-24.9
8	25.0-33.2
7	33.3-41.6
6	41.7-49.9
5	50.0-58.2
4	58.3-66.6
3	66.7-74.9
2	75.0-83.2
1	83.3-91.6
0	$\geq$91.7

Rating (≤ 23.9ºC)	Rating ($24 - 32.9C$)	Rating ($\geq 32.9C$)	Wind (km/h)
10	4	4	≤ 2.88
9	5	3	2.89-5.75
8	6	2	5.76-9.03
7	8	1	9.04-12.23
6	10	0	12.24-19.79
5	8	0	19.80-24.29
4	6	0	24.30-28.79
3	4	0	28.80-38.51
0	0	0	≥ 38.52

A3.1 - Statistical Tests & Results with variations in tourism type classifications

Model 1: Northwestern provinces located in Marmara region are reclassified under Coastal North

Model 2: Northwestern provinces located in Marmara region are reclassified under Coastal North, while Ankara is introduced separately

Model 3: Northwestern provinces located in Marmara region reclassified under Urban Mix & Ankara and İstanbul are introduced separately

Model 4: Northwestern provinces located in Marmara region are reclassified under Coastal North & Ankara and İstanbul are introduced separately

	Model 1	Model 2	Model 3	Model 4
IST x TCI			−0.065**	−0.067**
			(-3.04)	(-3.09)
ANK x TCI		−0.211***	−0.209***	−0.208***
		(-9.46)	(-9.37)	(-9.27)
Coastal South x TCI	0.461***	0.455***	0.455***	0.453***
	(21.18)	(20.83)	(20.61)	(20.58)
Coastal North x TCI	0.015**	0.014	0.348	0.025*
	(1.25)	(1.18)	(2.33)	(1.86)
Mountains and Nature x TCI	−0.348***	−0.347***	−0.345***	−0.346***
	(-12.42)	(-12.36)	(-12.3)	(-12.33)
Urban Mix x TCI	−0.009	−0.005	−0.035	−0.040
	(-0.97)	(-0.57)	(-0.40)	(-0.43)
GDP	0.745***	0.743***	0.739***	0.742***
	(15.40)	(15.43)	(15.33)	(15.39)
CPI	0.284***	0.284***	0.286***	0.284***
	(7.44)	(7.42)	(7.45)	(7.43)
Relative Foreign GDP Per Capita	0.081***	0.081***	0.081***	0.812***
	(15.49)	(15.68)	(15.67)	(15.65)
Relative Foreign CPI	−0.043***	−0.044***	−0.044***	−0.044***
	(-6.63)	(-6.73)	(-6.75)	(-6.75)
Spring	0.052**	0.050**	0.048**	0.049**
	(2.55)	(2.45)	(2.35)	(2.41)
Summer	0.143***	0.142***	0.140***	0.141***
	(7.93)	(7.83)	(7.70)	(7.77)
Winter	−0.094***	−0.094***	−0.094***	−0.095***
	(-5.20)	(-5.18)	(-5.19)	(-5.18)
COVID	−0.300***	−0.301***	−0.300***	−0.300***
	(-6.31)	(-6.30)	(-6.27)	(-6.31)

T statistics in parantheses.

$***\rho < 0.01, **\rho < 0.05, *\rho < 0.10$

A3.2 - Statistical Tests & Results with different set of independent variables

	Base Model	Model 1	Model 2	Model 3
Coastal South x TCI	0.462***	0.455***	0.462***	0.455***
	(21.16)	(21.03)	(21.07)	(20.91)
Coastal North x TCI	0.035**	0.024	0.034**	0.021
	(2.37)	(1.63)	(2.26)	(1.40)
Mountains and Nature x TCI	−0.347***	−0.374***	−0.347***	−0.378***
	(−12.39)	(−13.50)	(−12.39)	(−13.66)
Urban Mix x TCI	−0.011	−0.0254***	−0.011	−0.027***
	(−1.30)	(−2.94)	(−1.28)	(−3.07)
GDP	0.742***	1.064***	0.725***	1.070***
	(15.33)	(28.59)	(14.95)	(28.66)
CPI	0.286***		0.305***	
	(7.46)		(7.96)	
Relative Foreign GDP Per Capita	0.081***	0.0844***	0.0603***	0.055***
	(15.54)	(16.26)	(14.11)	(13.00)
Relative Foreign CPI	−0.044***	−0.0604***		
	(−6.65)	(−9.28)		
Spring	0.052**	0.0606**	0.0511**	0.059***
	(2.55)	(2.98)	(2.49)	(2.89)
Summer	0.143***	0.150***	0.143***	0.151***
	(7.95)	(8.36)	(7.90)	(8.33)
Winter	−0.094***	−0.088***	−0.093***	−0.086***
	(−5.15)	(−4.83)	(−5.09)	(-4.72)
COVID	−0.299***	−0.268***	−0.295***	−0.258***
	(−6.27)	(−5.94)	(−6.16)	(−5.68)

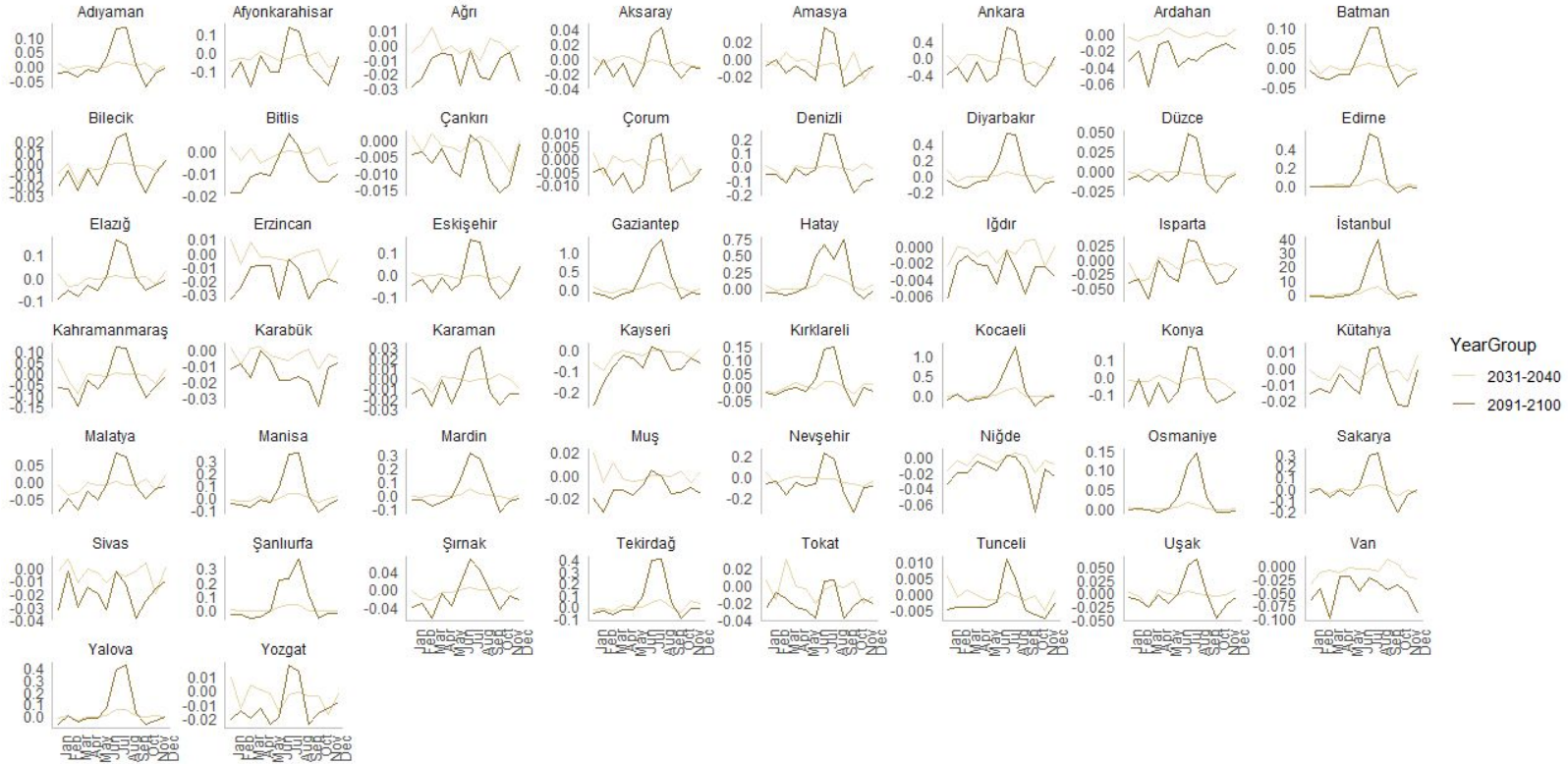
t statistics in parantheses.

$***\rho < 0.01, **\rho < 0.05, *\rho < 0.10,$

A4 - Overview of the net effect by province

COMPARISON ACROSS SCENARIOS BY TOURISM TYPES (RCP 2.6 - RCP 8.5), THOUSANDS BEDNIGHTS

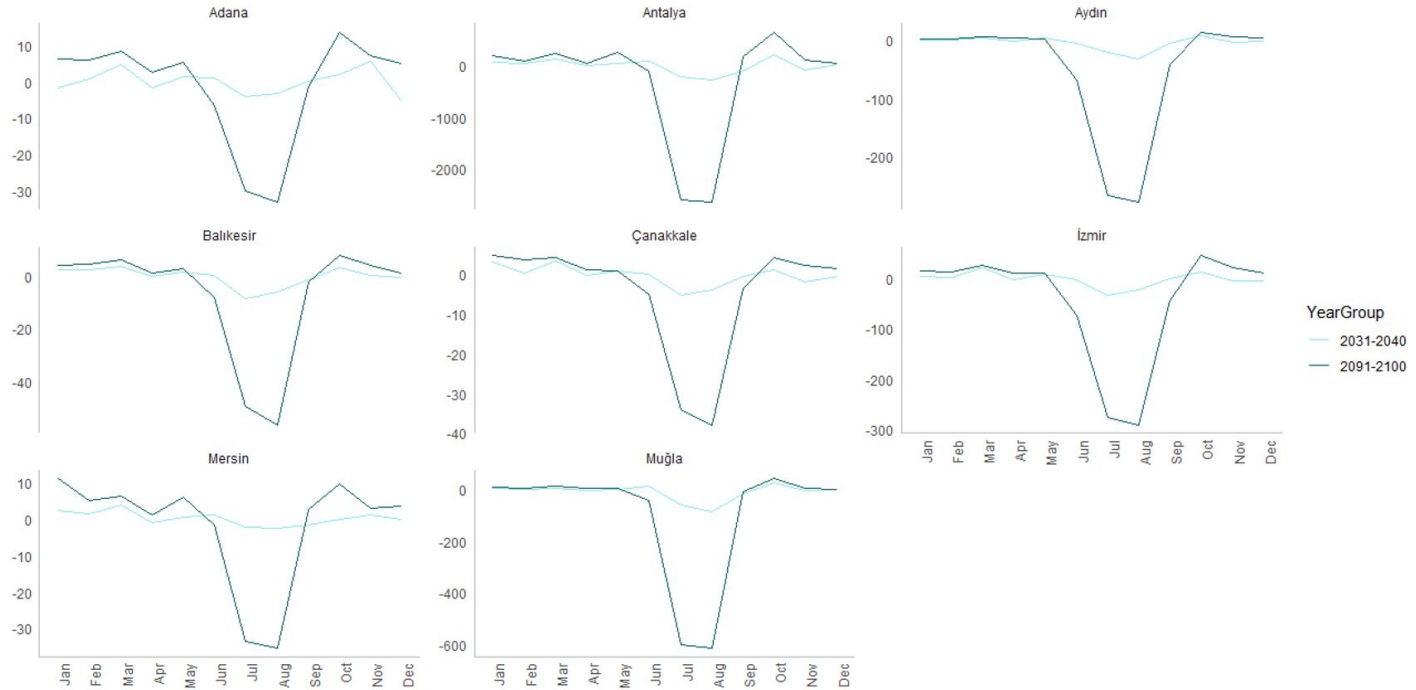
Urban Mix



A4 - Overview of the net effect by province

COMPARISON ACROSS SCENARIOS BY TOURISM TYPES (RCP 2.6 - RCP 8.5), THOUSANDS BEDNIGHTS

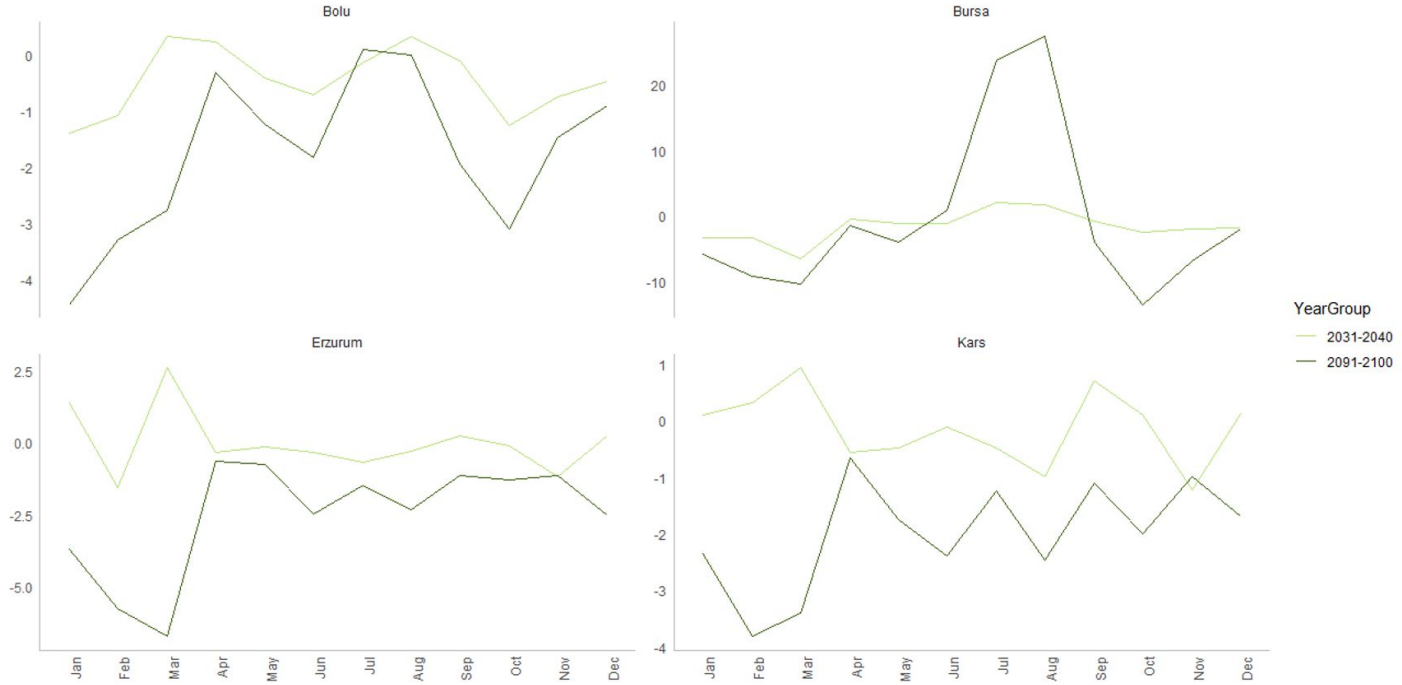
Coastal South



A4 - Overview of the net effect by province

COMPARISON ACROSS SCENARIOS BY TOURISM TYPES (RCP 2.6 - RCP 8.5), THOUSANDS BEDNIGHTS

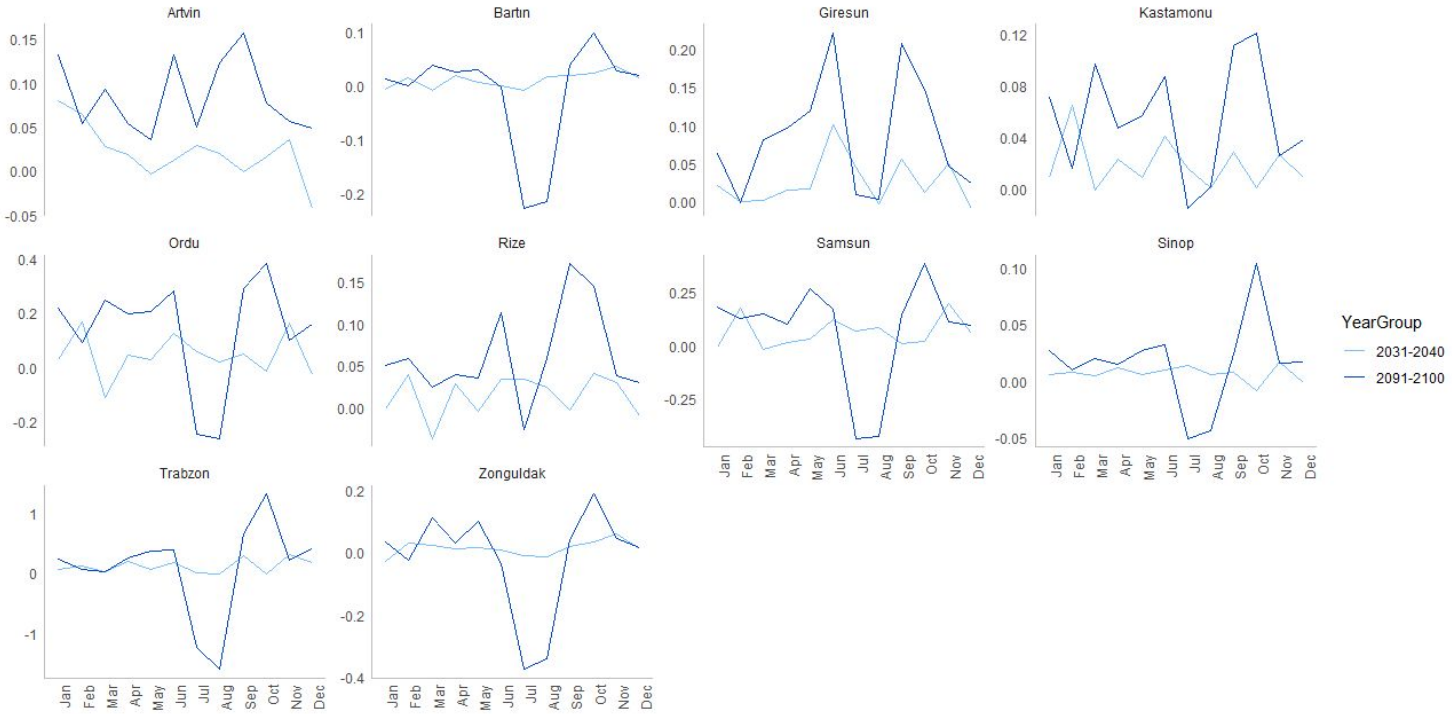
Mountains and Nature



A4 - Overview of the net effect by province

COMPARISON ACROSS SCENARIOS BY TOURISM TYPES (RCP 2.6 - RCP 8.5), THOUSANDS BEDNIGHTS

Coastal North



A5 - Comparison of the TCI and HCI: rating scheme and weights

TCI vs HCI THERMAL COMFORT RATING

TCI		HCI:Urban		HCI:Beach	
Rating	THumidex (°C)	THumidex (°C)	Rating	THumidex (°C)	Rating
0	≥36.0	≥39.0	0	≥39.0	0
		37.0–38.9	2	38.0–38.9	2
1	35.0–35.9			37.0–37.9	4
2	34.0–34.9	35.0–36.9	4	36.0–36.9	5
3	33.0–33.9			35.0–35.9	6
4	32.0–32.9	33.0–34.9	5	34.0–34.9	7
5	31.0–31.9	31.0–32.9	6	33.0–33.9	8
6	30.0–30.9	29.0–30.9	7	31.0–32.9	9
7	29.0–29.9	27.0–28.9	8	28.0–30.9	10
8	28.0–28.9	26.0–26.9	9	26.0–27.9	9
9	27.0–27.9	23.0–25.9	10	23.0–25.9	7
10	20.0–26.9	20.0–22.9	9	22.0–22.9	6
9	19.0–19.9			21.0–21.9	5
8	18.0–18.9	18.0–19.9	7	20.0–20.9	4
7	17.0–17.9	15.0–17.9	6	19.0–19.9	3
6	16.0–16.9	11.0–14.9	5		
5	10.0–15.9	7.0–10.9	4	18.0–18.9	2
4	5.0–9.9	0–6.9	3	17.0–17.9	1
3	0.0–4.9			15.0–16.9	0
2	−0.1–−5.9	−0.1–−5.9	2	10.0–14.9	-5
0	−6.0–−10.9				
−1	−11.0–−15.9	≤−6.0	1	≤9.9	-10
−2	−16.0–−20.9				
−6	≤−21.0				

- The main component of the indexes driving different comfort levels is the compound humidity index, indicating the daily thermal comfort.
- HCI Beach assigns the highest rating for higher temperature levels compared to the other indexes.

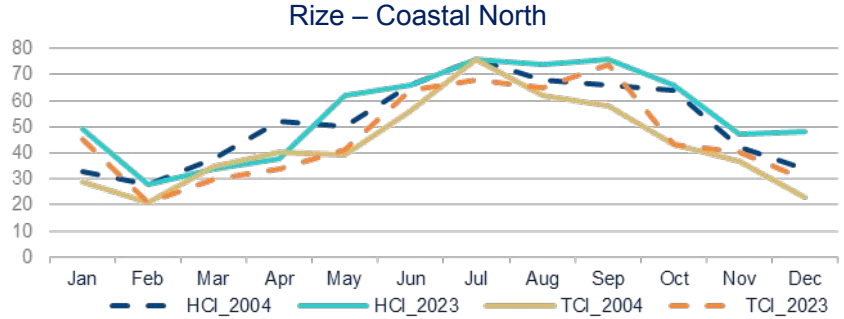
TCI vs HCI INDEX COMPONENTS

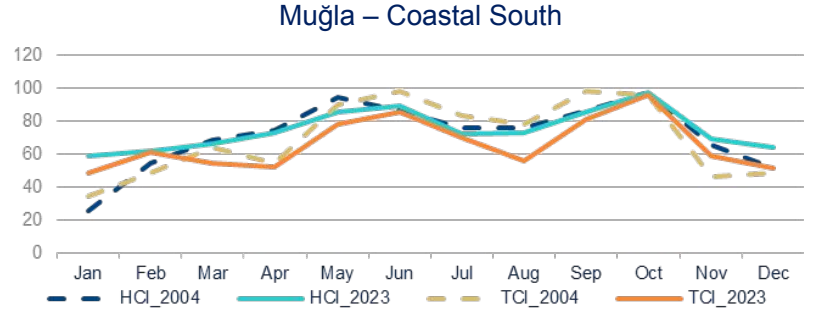
Index Component	Weather Variables	TCI	HCI: Urban	HCI: Beach
Thermal comfort (TC)	Temperature and Humidity (°C)	50%	40%	20%
Aesthetic (A)	Cloud cover (%)	20%	20%	40%
Precipitation (P)	Total precipitation (mm)	20%	30%	30%
Wind (W)	Mean wind speeds (km/hr)	10%	10%	10%

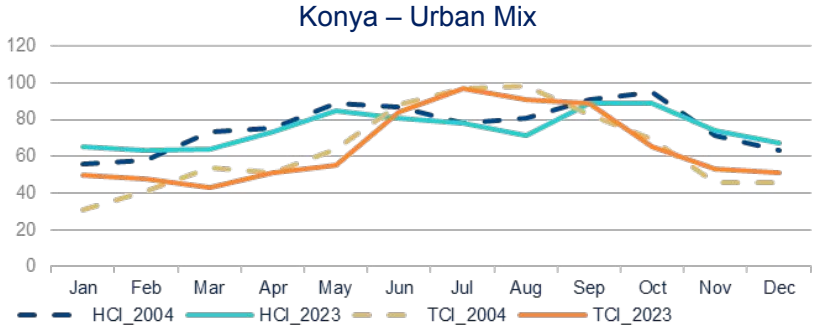
A5 - Comparison of the TCI and HCI: High temperatures have less negative impact on beach tourism comfort according to the HCI

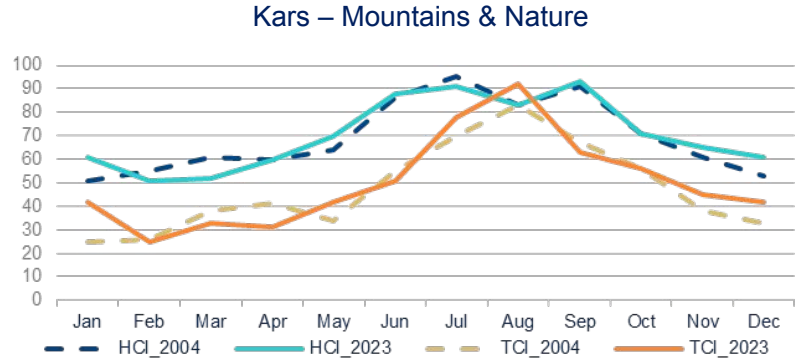
HCI AND TCI EVOLUTION IN SELECTED PROVINCES (BY TYPE OF TOURISM)

2004 vs 2023 (*)









(*) Provinces in Coastal North and Coastal South are calculated with the HCI Beach, while provinces in the Urban Mix and Mountains and Nature category are calculated with the HCI Urban.

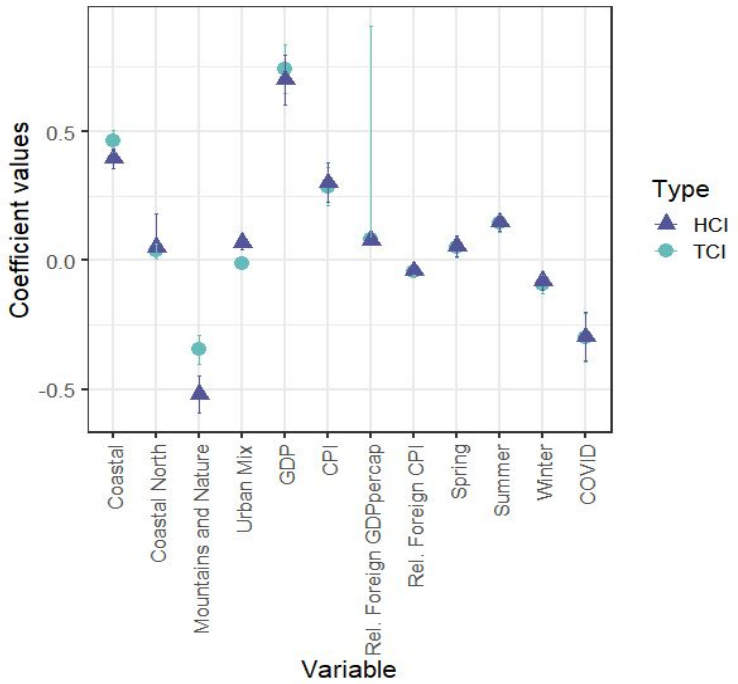
Source: BBVA Research calculations

A6 - Comparing the results using TCI and HCI

- The most apparent difference between the two models is the coefficients of Urban Mix and Mountains & Nature provinces: The model with HCI models points to a higher decline in tourism demand in Mountain & Nature provinces in the case of increasing temperatures. On the other hand, the response of the urban tourism is higher for the model with HCI with higher tourism demand loss in the case of worsening in climate comfort. Statistically, there is no evidence to suggest that the coefficients of the two models are significantly different, except for Urban Mix and Mountains & Nature.

- Still, differences in the results come mainly from how the reference climate scenarios (RCPs) are translated to the respective proxy, TCI or HCI over the forecasted period (2022-2100). That is, given that TCI and HCI use different classifications, what will change is the classification of the same future climate variables and thus the future scenario.

COMPARISON OF TCI AND HCI COEFFICIENTS WITH 95 PERCENT CONFIDENCE INTERVALS



Source: BBVA Research calculations

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