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SPATIO-TEMPORAL ANALYSIS OF THERMAL COMFORT IN THE ASSIR REGION (KINGDOM OF SAUDI ARABIA)

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ABSTRACT:

Human physiological comfort depends on several criteria. In geography, we try to focus on the concept of climate comfort, which is particularly controlled by temperatures.Although these conditions the various anthropogenic activities such as tourism, this subject is not often addressed by researchers in Saudi Arabia. To make up for this, we try to do it in Aseer. Motivated by the future of this province which wants to be a tourist destination privileged. The spatial and temporal analysis of the thermal comfort allows besides the knowledge of the detailed thermal truth of this province, to search for possible complementarities to the spatial and temporal scales. To achieve this main objective, we statistically process the average, maximum and minimum thermal data of four stations recorded during the period 1985-2020. The results discussed and graphically illustrated reveal the existence of a spatial and-temporal calendar that can be implemented for the «comfort» of this «climatic island».

Key words: ***difficulty, thermal values, thermal comfort, Thermal Island,***

INTRODUCTION:

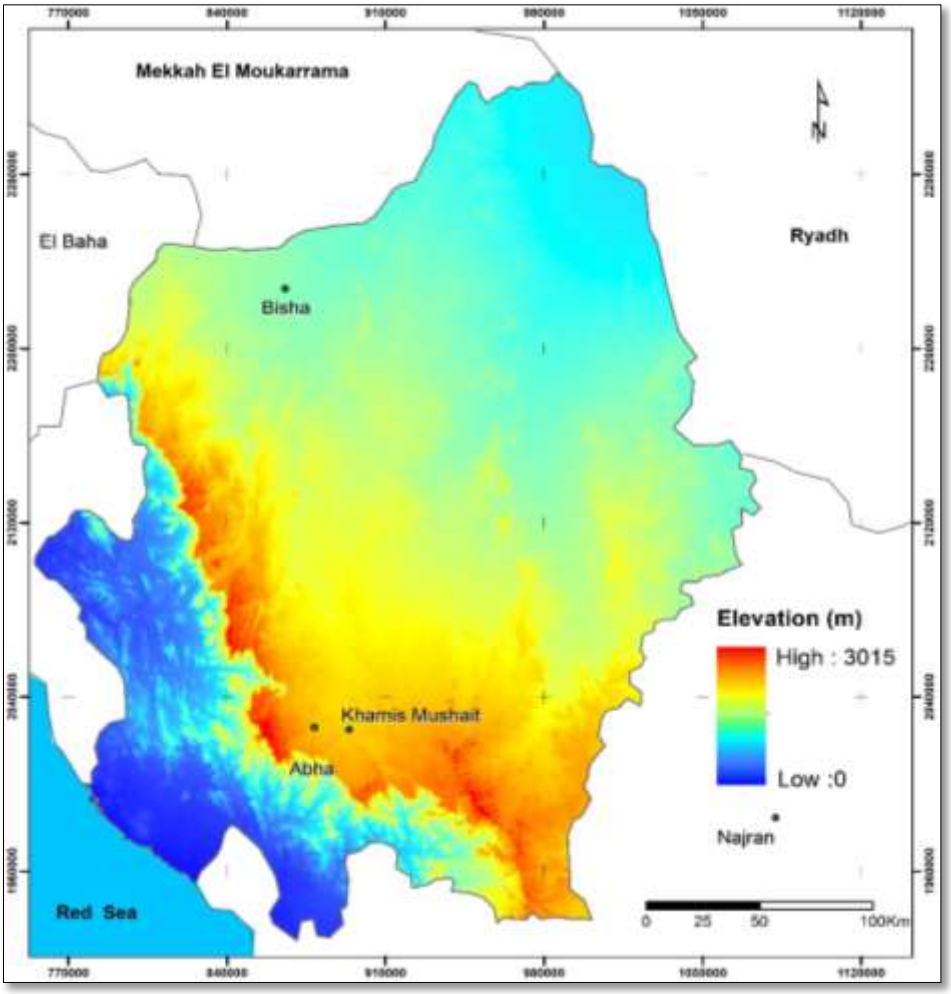
The climate, with all its factors such as humidity, wind, temperatures, etc., greatly influences the various anthropogenic activities. It can be disabling or encouraging of these. Tourism is the most sensitive activity to these climatic factors, especially temperatures. Indeed, high or low temperatures have a direct influence on the various tourist activities, especially those in the countryside.However, we point out that despite the importance of climate, we must not lose sight of the role played by various other factors such as the forms of the relief (mountains, plateaus, plains, canyons, seas, coasts, etc.), tourist infrastructure (hotels, recreation areas, monuments, museums, parks, recreation centres and other services) as well as human behaviour (reception, quality of services, etc).

In this study, we will try to focus on temperatures which are a major component of physiological comfort. Indeed, high or low temperatures result in uncomfortable situations while adequate thermal values generate thermal well-being. These degrees of thermal comfort or discomfort differ spatially and temporally. This is one of the concerns of applied climatology that we are trying to elucidate in the province of Aseer using the thermal data of 04 stations over a 36-year period (1985-2020). Note that this province has only three stations.

These are Abha, Khamis Mushait and Bisha. The fourth, Gizan, is in the province of Gizan. We incorporated it into this study to capture the thermal truth about the Aseer coast. These stations are relatively on the same longitudinal line.

The stations of Bisha and Gizan are shifted east for the first and west for the second and then Abha and Khamis Mushait are centered on the Aseer Mountains.Aseer province is located in the southwest of Saudi Arabia. Except for the Red Sea on the western side, Aseer is limited by vast expanses of land. It is characterized by a topographical diversity that is far from reflecting the geographical configuration of the rest of Saudi Arabia. From east to west, the landscape consists of several physical units. To the west, the Tihama plain runs along the Red Sea with altitudes of around 0 m. To the east, it follows a short and very steep slope. Indeed, over 50 km we go from 0 meter to 3015 m (Sawda). The East side, longer and less rugged, is formed by the Aseer plateau, where Bisha grazes the desert of (Rub'alkhali). The topographical profile, relative to this space, makes us think of an "asymmetrical camel back" (Fig. 1).

Fig. 1 map of the elevations of the region of Assir



Source: SRTM image (United States Geological Survey (USGS))

LITERATURE REVIEW:

This work is supported by a rich and varied literature review. the studies on trends temperature in the world remain Plenty. All researchers are agreeing on the importance of climatic comfort and especially the thermal atmosphere as an indispensable factor in the perception of tourist activity. Some studies have

emphasized the difference between thermal comfort calculated through purely physical formulas and that measured by referring to bioclimatic indices and thermal indices (ISO 7730, 1994; M'Sellem, 2007; M'Sellem and Alkama, 2009). Studies that focus on thermal comfort as basic data for estimating tourist attraction remain abundant and prosperous thanks to the availability of measurements, but also data obtained by remote sensing (Malik, 2021, Several studies were carried out with the aim of defining the notion of heat wave and responding to the challenges associated with periods of heat wave, in particular by establishing a forecasting and remediation system (Almazroui et al, 2013; Kerbe, 2014).

Others have focused on the comfort of inhabited spaces through the consideration of two dimensions socio-cultural on the one hand and climatic on the other (Kadioglu, 1997; Esawy and Hasanean, 1998; Giovani, 1998; Alkama and SELLEM. 2009; El Hozayen, 2013). Previous literature in Arab countries: The well-being or comfort, especially thermal, has attracted little attention from geographers. They have been particularly interested in tourism. It is true that tourism is relatively conditioned by the climate. However, we were able to get our hands on a few studies on this subject. Some are written in Arabic while others are written in English. We only mention those which are closely related to this study. Literature in Arabic has focused on the impact of temperatures on well-being (Abd-Laki. M. 2005. Habib, A. 1995. Thabet. A. 2001. Salam. T. 2003. Al-Yassiri. I. 2007. Al-Yassiri. A. 2010. Al-Arishi. A. 2010. Anbar. M. 2012. Al Qahtani. S. 2019…).

The relationship of wind chill by heat designed by Pissel, Siple (Zekri. Y. ND) was highlighted. Those written in English or French focused primarily on the impact of climate change and tourism (Goh, C. 2012.). Tourism seasonality has attracted the attention of several authors (Baron, R. 1975. Butler, R. 2001. Koc, E. and Altinay. 2007. Cuccia, T. Rizzo I. 2011…). The relationship between work and temperature is the subject of some studies Boniface, B. and C. Cooper. 1994. Burton, R. 1995.

In Saudi Arabia, studies on climate in general and specifically on thermal comfort are widely developed during the last years, especially for the cities of MehkahMusharaffa, Jeddah and Riyadh, which are the most visited cities by foreign tourists and for Muslim pilgrims for MehkahMukarama and El Medinah El Mounaouara (Abdou, 2014; Khan, 2015).

PRESENTATION OF THE STUDY AREA:

The study area is located in the southwest sector where altitudes vary between 0 m and more than 3015 m. It is represented by 03 stations all located on the eastern slope. Khamis Mushait 2066 m, Abha 2090 m and Bisha 1167 m. we added the station of Gizan, 06 m, to simulate the thermal data of Tihama, a plain that skirts the Red Sea and constitutes the western end of Aseer (Fig. 1). From east to west, there are the Tihama plain, the Aseer Mountains and the plateau of the same name.

This altitudinal grading is not without consequences on the temperatures in the sense that the heights (Aseer Mountains) are the land of minima while the plateaus are marked by maxima.Besides the thermal truth, which we want to understand, we try to define the degrees of thermal comfort according to the thermal averages, maximas and minima to establish a spatio-temporal calendar that takes into account these different degrees.

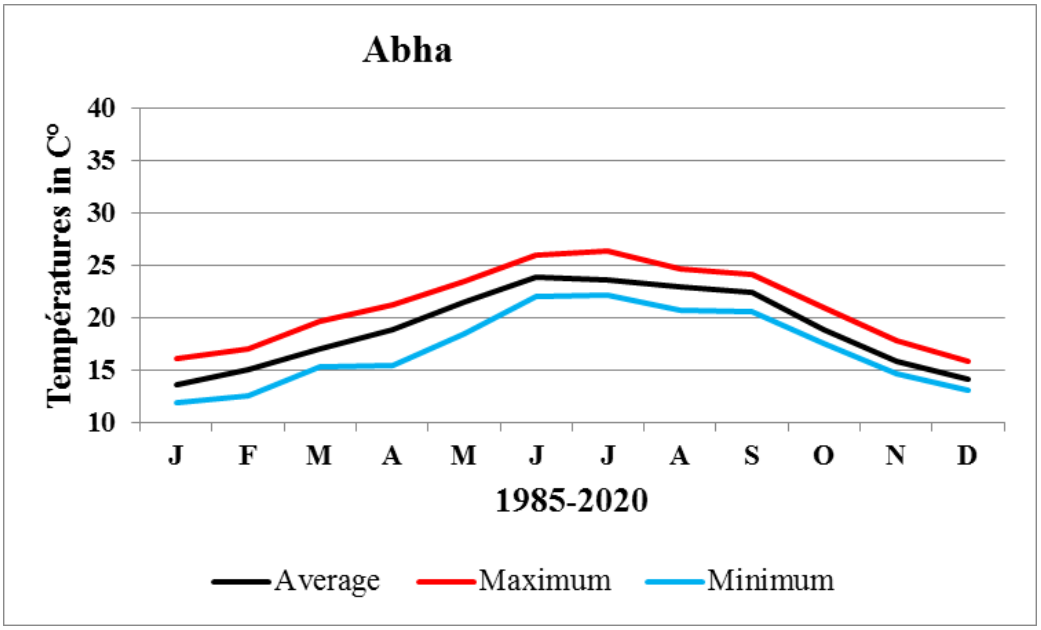
To achieve these objectives, we have monthly thermal data archived at the level of the Meteorological Authority and Environmental Protection, which are freely available to researchers and other users. These data relate to the period from 01 January 1985 to 31 December 2021. The achievement of these objectives requires rigorous statistical treatment and revealing graphic translation.

ANNUAL THERMAL OVERVIEW AND MONTHLY DISTRIBUTION:

Statistical treatment of the monthly thermal data for the period 1985-2020 for the 04 stations shows that the annual thermal averages range from 18°9 C in Abha to 30°5 C in Gizan. Khamis Mushait and Bisha record 19°9C and 23°3C, respectively. Two factors explain this thermal arrangement, altitude and lower latitude. The maximum values recorded during the period 1985-2020 are 20°4C to Abha, 21°1C to Khamis Mushait, 23°3C to Bisha and 31°5C to Gizan. The minimum averages are 17°0C, 18°2C, 23+3C and 29°5C at Abha, Khamis Mushait, Bisha and Gizan respectively (Fig. 2 (a, b, c and d)).

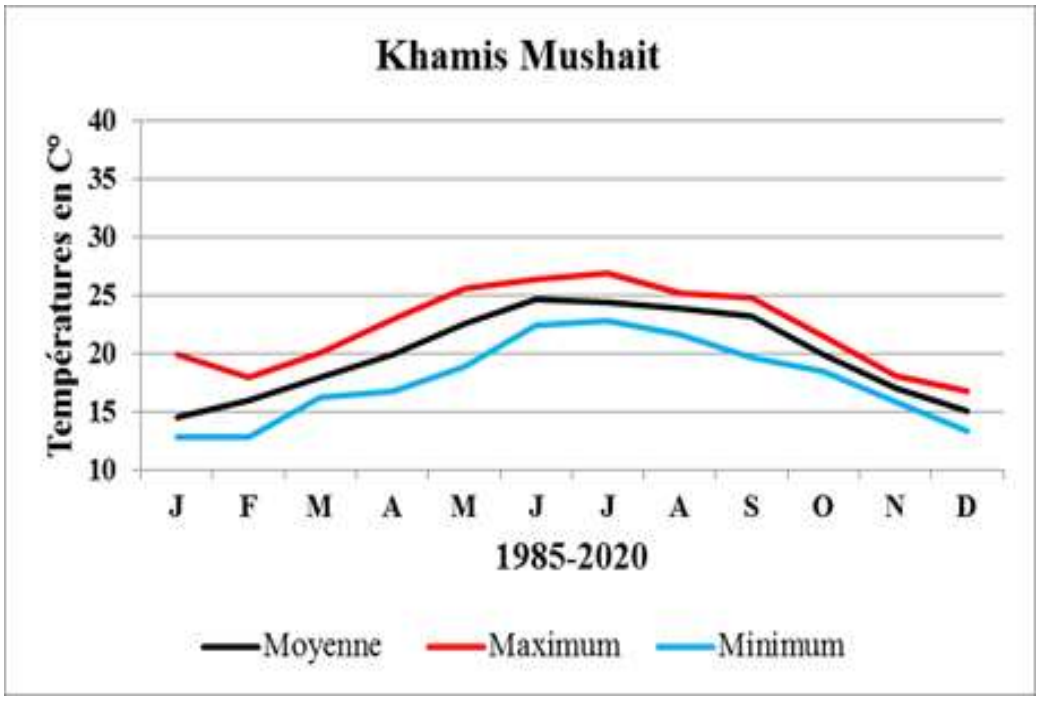
We note that the relatively low values took place in a mountainous environment while their opposites mark the low stations. The maximum values characterize the last years of the period 1985-2020 except for the Bisha station where the maximum was recorded in 2009 while the minima mark the beginning of this period. The annual thermal amplitudes are very close. We calculated 2°0C, 2°9C, 3°4C and 3°7C respectively at Gizan, Khamis Mushait, Abha and Bisha. This indicates a certain thermal stability which may, possibly, help to adapt to this thermal truth.

Fig. 2 a: Aseer thermal averages and extremes in Abha station



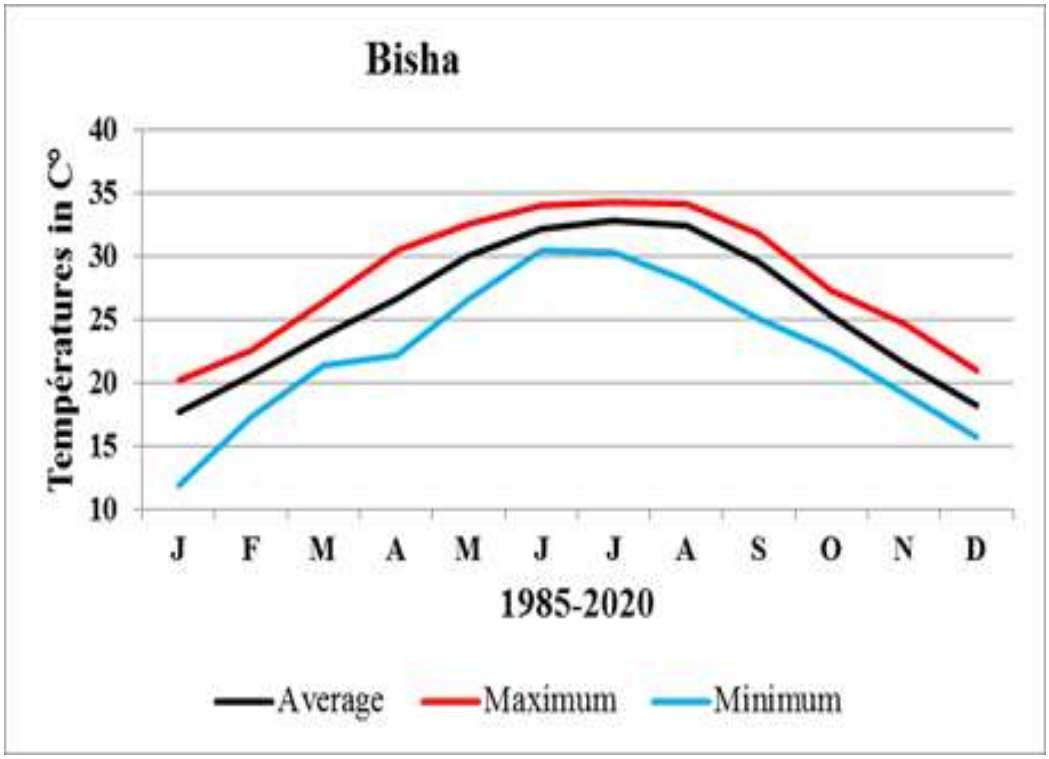
Source: Processing of temperature data between 1985-2020

Fig. 2 b: Aseer thermal averages and extremes in Khamis Mushait station



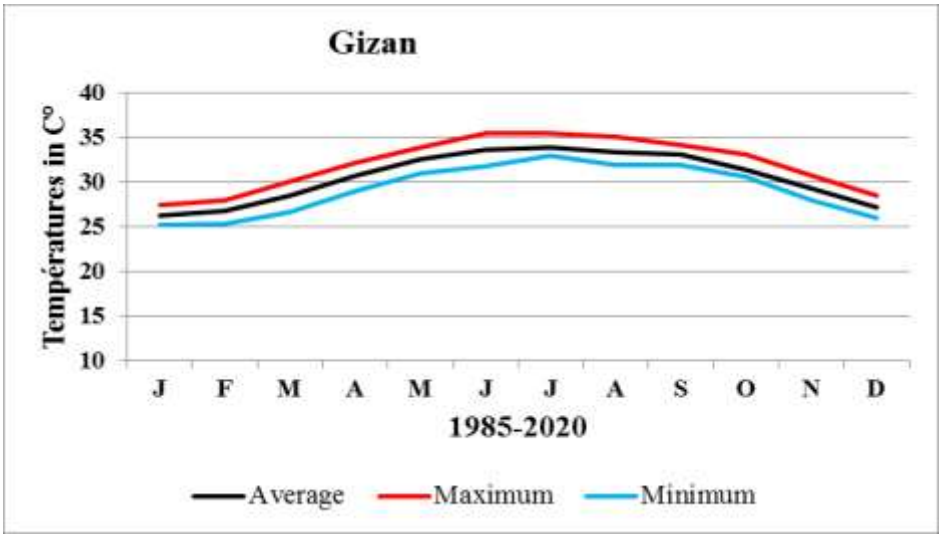
Source: Processing of temperature data between 1985-2020

Fig. 2 c: Aseer thermal averages and extremes in Khamis Bisha station



Source: Processing of temperature data between 1985-2020

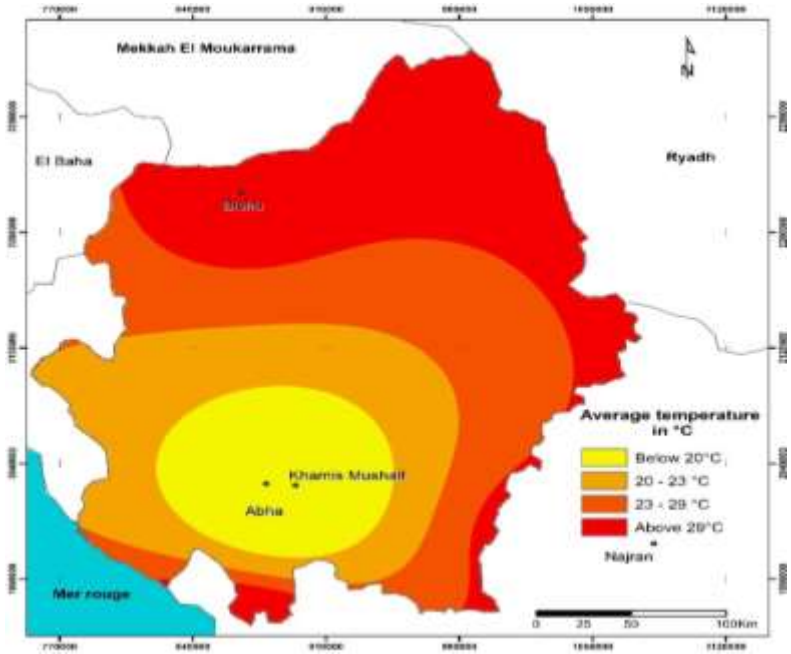
Fig. 2 d: Aseer thermal averages and extremes in Khamis Mushait station



Source: Processing of temperature data between 1985-2020

The spatial distribution of annual thermal averages for the period 1985-2020 reveals that they reflect the topographical physiognomy of this space. It shows a correlation between altitudes and thermal values. Upstream stations are marked by relatively low thermal values unlike downstream stations where temperatures are higher. Spatially, the Aseer Mountains, like Abha and Khamis Mushait, have relatively low thermal averages. Unlike the plateau represented by Bisha and the coast symbolized by Gizan where these thermal values are higher. The thermal reality relative to Aseer is the fruit, in part, of this topographical configuration «asymmetrical camel back». The Aseer Mountain is a "thermal island" from which temperatures decrease towards Gizan in the southwest and Bisha in the northeast (Fig. 3).

Fig. 3: Spatial distribution of average temperatures in Aseer region



Source: Processing of temperature data between 1985-2020

Thermal comfort, the subject of this study, is very closely related to thermal data. It would be, for the relevance of this subject, to have daily or even synoptic data. However, the absence of these long-term data requires us to study the monthly rate at the four stations over the period 1985-2020. The average heat rate is certainly important because it gives us a global overview of the phenomenon, but it is interesting to understand the scope of extreme thermal values. The relationship between temperature and well-being or thermal comfort is the subject of several studies.

CONCEPT OF PHYSIOLOGICAL COMFORT:

The use of all these studies has led to a definition of physiological comfort which "is a feeling of comfort, recreation and psychological tranquility in the prevailing weather conditions, and the exercise of one's work, whether inside or outside one's office, or anywhere without distress or discomfort from the heat, whether hot or cold, and without any means of dilution of air conditioners, fans, chillers..." (Anbar. M. 2012). However, it should be noted that thermal values have only relative significance. They are dependent on daily sensations such as between day and night, winter and summer, the type of climate, personal perceptions, etc. Indeed, any value can have several meanings depending on the above-mentioned elements. For example, 20°0C can take many meanings depending on the night or day, summer and winter and the person themselves. Despite all these meanings, we were able to define three thermal comfort thresholds on the monthly thermal scale (Al Qahtani. S. et al. 2019).

THEY ARE AS FOLLOWS:

- Less than 15°0C indicates thermal discomfort due to cold.
- 15° 0 m to 24°0 C, ideal thermal comfort.
- Greater than 24°0C heat discomfort.

However, we find that these "previous" studies have only studied the average aspect of thermal comfort. This seems absurd to us because the mean thermal values allow only a relative truth. Extreme thermal values are more expressive. They can be indicative of new degrees of comfort or thermal discomfort. To verify this hypothesis, we used the standard deviation calculation. These, deviating from the average, positively (maxima) or negatively (minima), is indicative of this new situation.

The treatment of the Monthly Thermal Averages of the 04 stations for the period 1985-2021 allowed us to achieve 07 degrees of thermal comfort. Around an average thermal comfort situation (15°0C – 24°0C) are organized 06 degrees on either side of this average situation (Fig. 4).

Fig. 4: Degrees of comfort/thermal discomfort

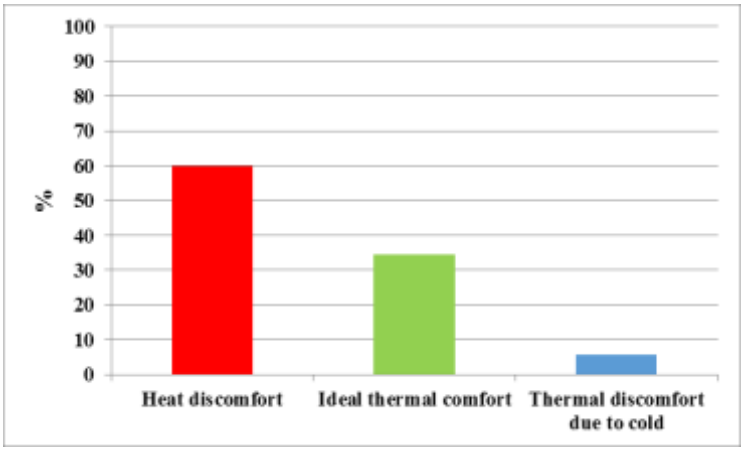
1	> 24°0 C + 04 σ	absolute thermal discomfort due to heat		ATDH
2	24°0 C + (02 σ - 4 σ)	heatrelateddiscomfort		HRD
3	24°0 C + 2 σ	relative thermal comfort due to heat		RTCH
4	15°0 C – 24°0 C	Ideal thermal comfort.		ITC
5	15°0 C – 2 σ	Relative thermal comfort due to cold.		RTCC
6	15°0 C – (2 σ – 4 σ)	relative thermal discomfort due to cold		RTDC
7	15°0 C – 4 σ	absolute thermal discomfort due to cold		ATDH

Source: Processing of temperature data between 1985-2020

DEGREES OF THERMAL COMFORT CONSIDERING THE MONTHLY THERMAL AVERAGES:

The period 1985-2020 has 36 years and the field of study has 04 stations or 36*04 = 144 thermal values. Monthly for the 04 stations we have 1728 thermal observations. Of the 1728 monthly thermal values in the study period, the ideal thermal comfort is 596 monthly values or 34.4%. The thermal discomfort due to the cold is only 98 months or 5.6% (Fig. 5).

Fig. 5: Thermal comfort levels in Aseer



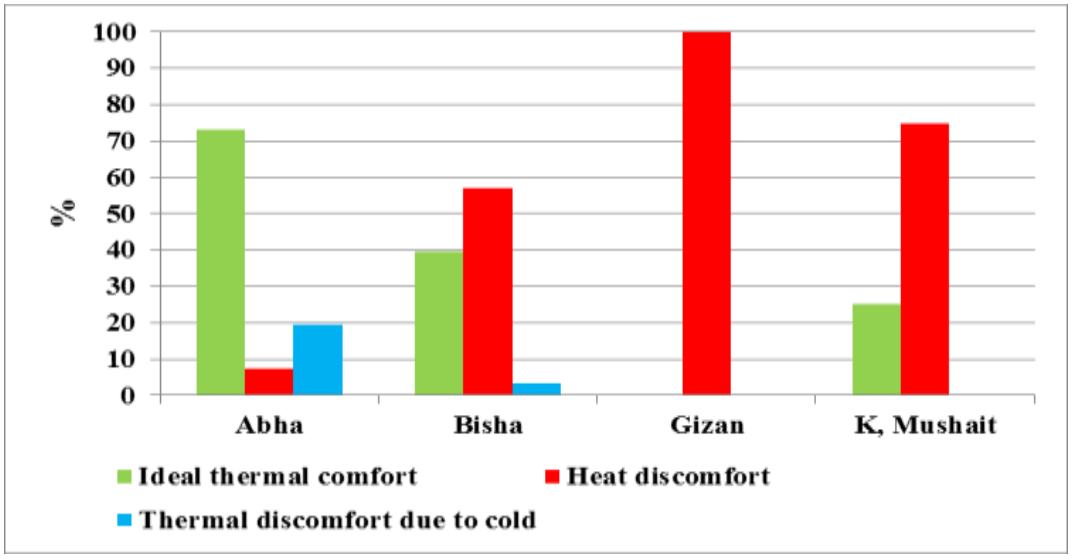
Source: Processing of temperature data between 1985-2020

We note, when considering the monthly thermal averages, the dominance of heat discomfort. The ideal thermal comfort is relatively important while the thermal discomfort due to cold is rather rare. Do these results reflect the thermal reality of Aseer? We are tempted to respond positively if we are in Bisha and Gizan and in the negative if we are in Abha. We try to test these assumptions in the following.

We see the absolute dominance of heat discomfort in Gizan (100%) which offers no opportunity for comfort. Khamis Mushait with 74.7% and Bisha with 57.1% offer few opportunities. The most favorable «comfortable» resort is Abha. Can we say that the mountain environment is more comfortable?

The answer seems positive in the sense that Abha has 73.1% ideal thermal comfort while thermal discomfort due to heat represents only 7.4% and that thermal discomfort due to cold is 19.4%. In Gizan and Khamis Mushait, the two degrees of thermal discomfort due to cold are zero. Bisha offers 39.5% of ideal thermal comfort while the heat discomfort is high with 57.1% (fig. 6).

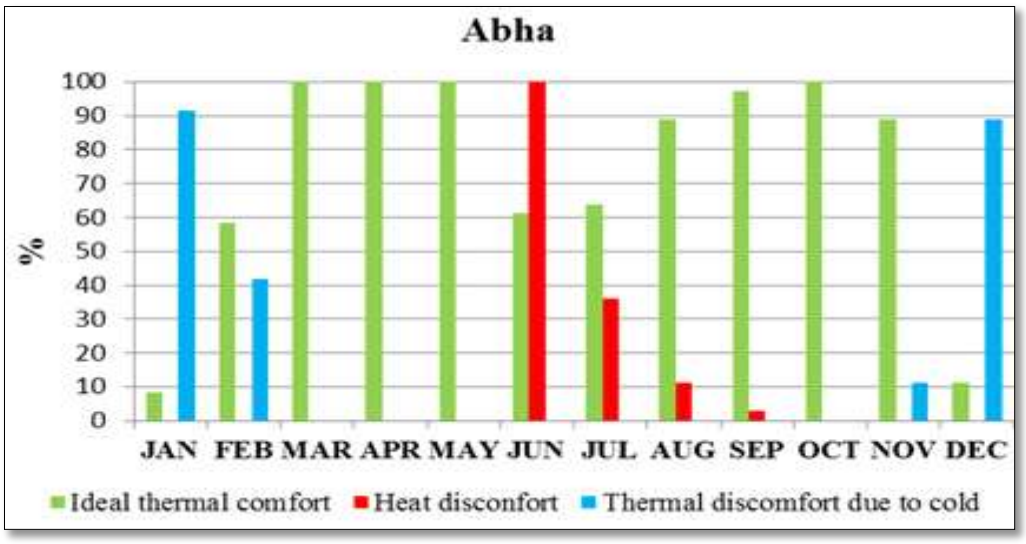
Fig. 6 : Degrés de confort thermique à Aseer



Source: Processing of temperature data between 1985-2020

We can argue that the Abha resort promises an attractive and promising tourist activity. Khamis Mushait and Bisha offer less opportunity for this activity which is nil in Gizan. The detailed study of each station on a monthly scale will provide us with more information.In Abha, the ideal thermal comfort represents (ITC) 73.1%, the thermal discomfort due to cold represents 19.4% while the thermal discomfort due to heat represents only 7.4%. However, this situation differs from one month to the next. The ideal thermal comfort marks every month. It is exclusive in March, April, May, October and to a lesser extent in August, September and November, 07 months when it is over 80% (Fig. 7).

Fig. 7: Thermal comfort at Abha average monthly thermal

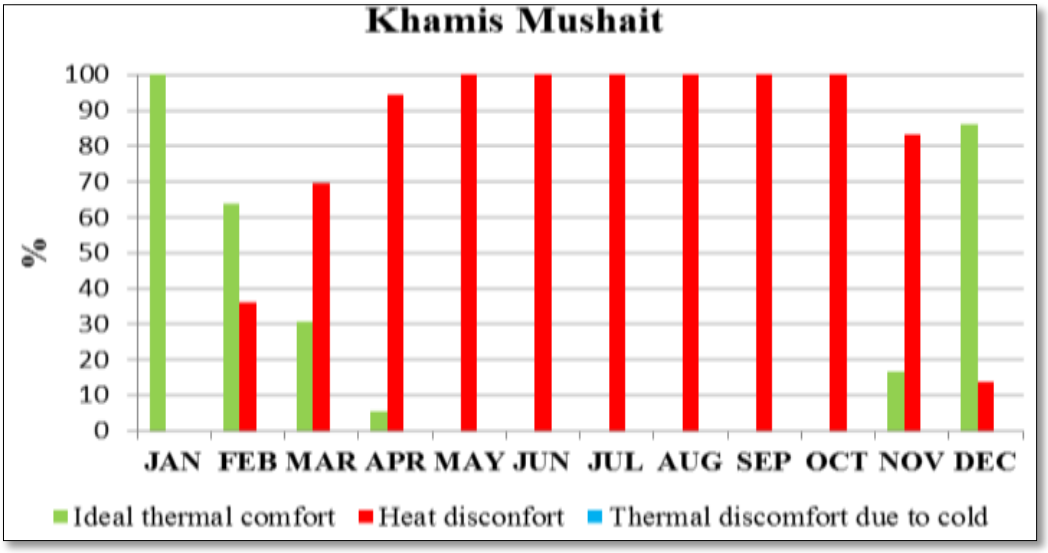


Source: Processing of temperature data between 1985-2020

Its presence is average in February, June and July when it exceeds 55.0%. January and December record 8.3% and 11.1% respectively and offer little or no thermal comfort. It is reduced during these two months by the thermal discomfort due to cold.

Thermal discomfort due to heat competes with the ideal thermal comfort in June and July. The station of Khamis Mushait is individualized by the absence of thermal discomfort due to cold (Fig. 8).

Fig. 8: Thermal comfort at Khamis Mushait average monthly thermal

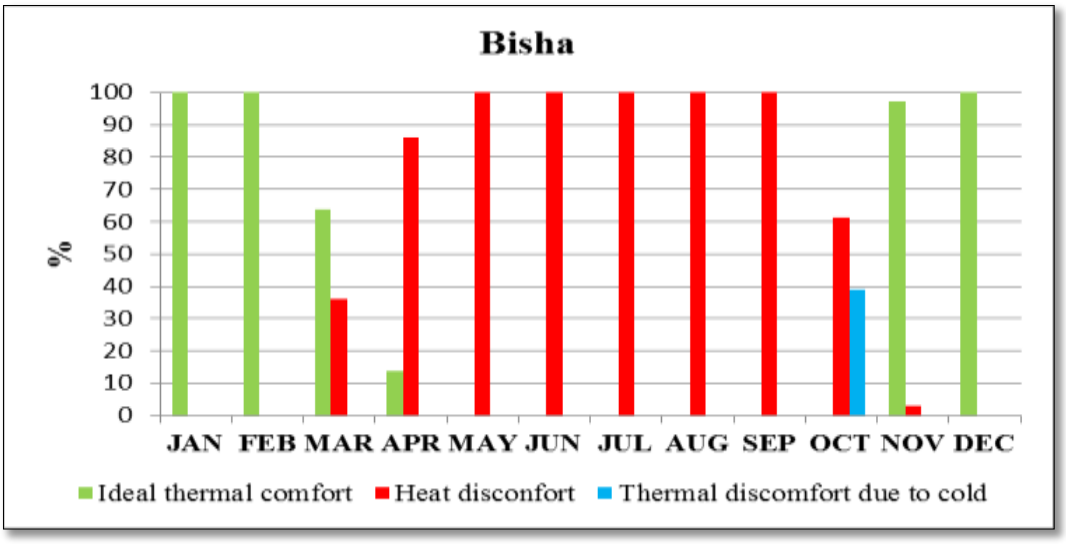


Source: Processing of temperature data between 1985-2020

It is divided between the ideal thermal comfort with 25.2% and the thermal discomfort due to heat at 74.7%.

The latter dominates the entire period April-November, or eight months. February and March are shared by the above-mentioned degrees with, however, an advantage for ideal thermal comfort in February and the reverse in March (Fig. 9).

Fig. 9: Thermal comfort at Bisha average monthly thermal



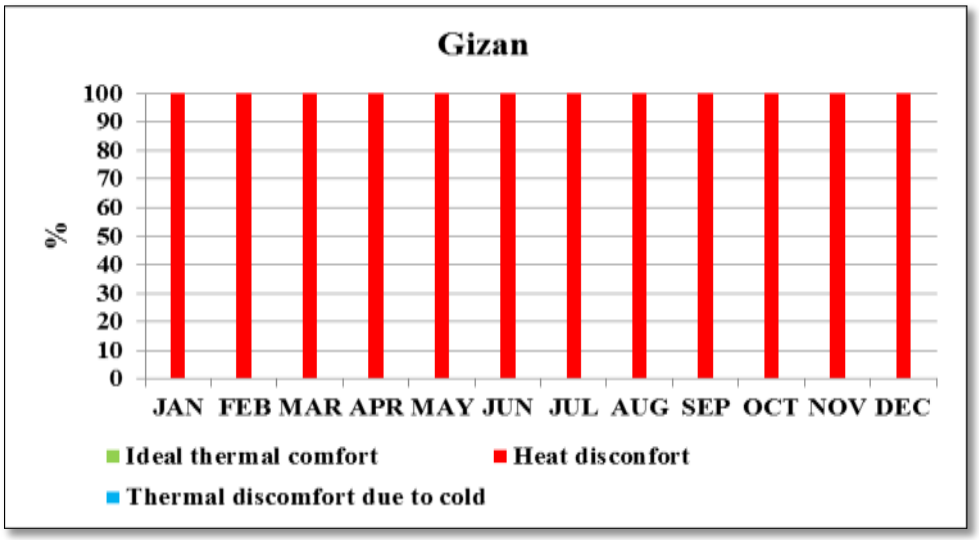
Source: Processing of temperature data between 1985-2020

December is acquired for the ideal thermal comfort. The Bisha station is shared between the three degrees of thermal comfort. The thermal discomfort due to heat marks 57.1%, it is followed by the ideal thermal comfort with 39.5%. The thermal discomfort due to cold represents only 3.2%.

April, May, June, July August and September, or six months, are totally dominated by heat discomfort. January, February, November, and December are the ideal thermal comfort. March and October are divided between three degrees with an advantage for the ideal thermal comfort in favor of the thermal discomfort due to heat and the latter which prevails to the thermal discomfort due to cold in October.The Gizan station is individualized by the absolute dominance of heat discomfort and offers no opportunity for any other degree of thermal comfort.

The Abha resort, considering the monthly thermal averages for the period 1985-2021, offers several opportunities, in particular, for tourist activities unlike the resort of Gizan where these opportunities are null. Bisha and Khamis Mushait have many similarities. Outdoor tourism can only be in a few months. In other words, the high and medium mountains constitute a space conducive to full-time tourism, unlike the plateau where this activity is temporally limited (Fig. 10).

Fig. 10: Thermal comfort at Bisha average monthly thermal

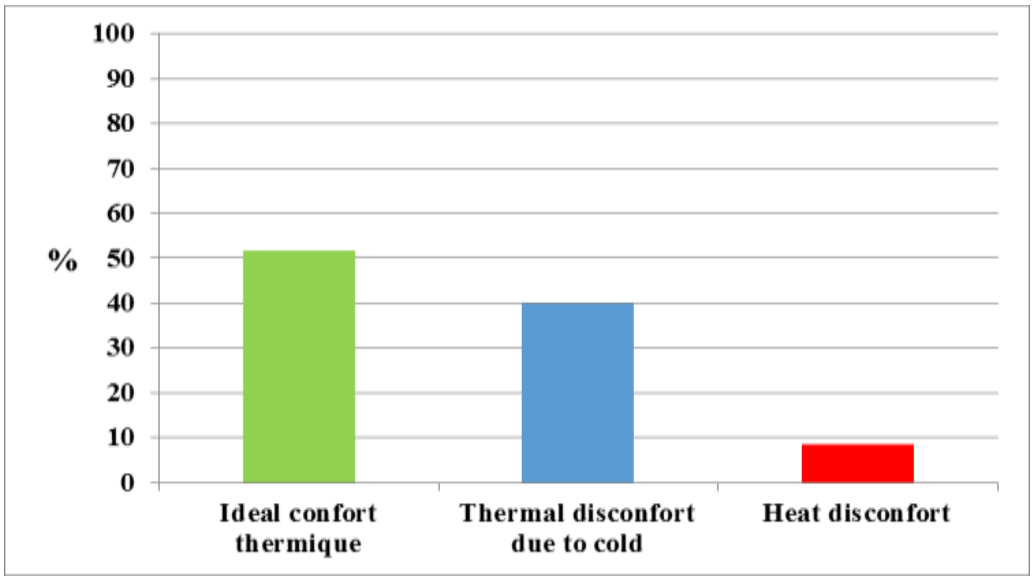


Source: Processing of temperature data between 1985-2020

THERMAL DISCOMFORT FROM COLD:

We are obliged to report that the minimum temperatures are recorded exclusively during the night and especially in the late evening and during the cold season. Therefore, they have an impact, particularly on night-time tourism activities. The treatment of the minimum thermal averages of the four stations for the period 1985-2020 shows that out of 1728 thermal values 892 provide an ideal thermal comfort of 51.6%, Cold discomfort is 690 or 39.9%, while heat discomfort is only 146 or 8.4% (Fig. 11).

Fig. 11: Thermal comfort as a function of minimum thermal averages



Source: Processing of temperature data between 1985-2020

The station of Abha, mountain station, is divided between two degrees. Ideal thermal comfort with 27.0% and thermal discomfort due to cold at 72.9%. It is individualized by the abundance of thermal discomfort due to cold. He scores every month at different values. It is absolute in November, December, January, February and March, very important in April and October with 86.1% and 88.8% respectively, average in May with 66.6% and in September with 72.2% and relatively low in June, July and August with 27.7% respectively, 13.8% and 19.4%.

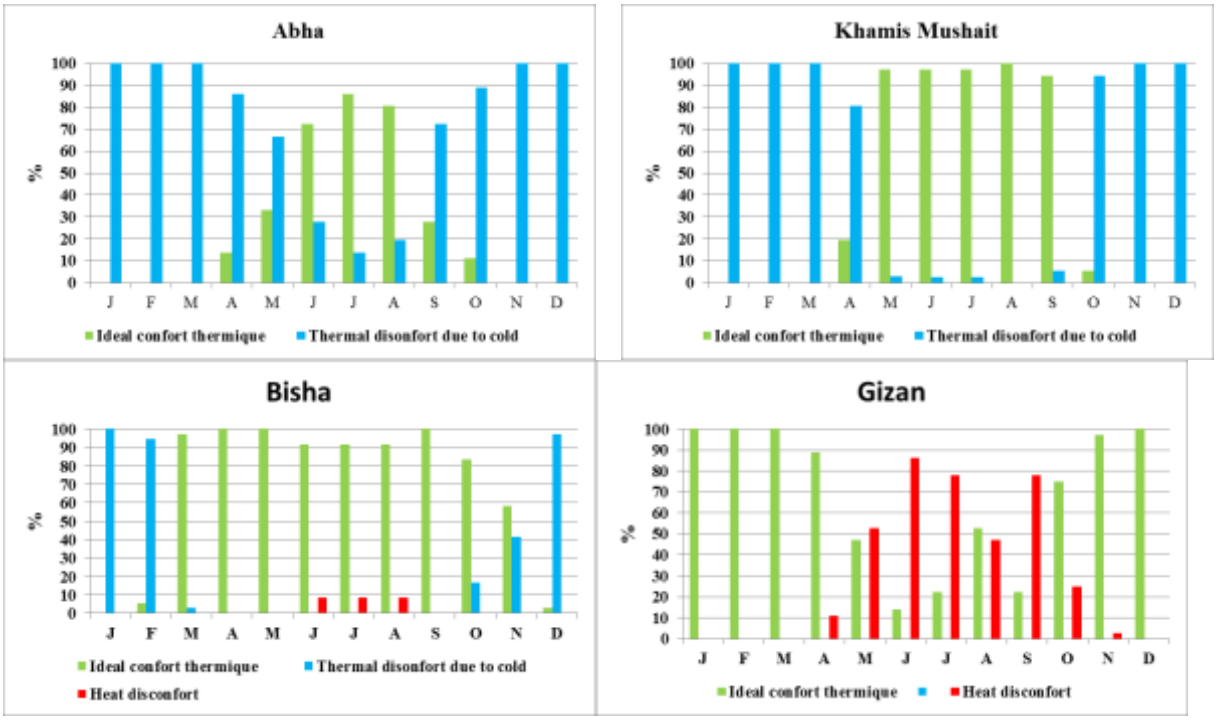
In other words, the thermal discomfort due to cold is absolute in winter, late autumn, and early spring. This time-frame, on a monthly basis, makes any tourist activity difficult. The ideal thermal comfort is almost present in summer with 72.2% in June, 86.1% in July and 80.5% in August.

This degree occurs weakly in April, May, September, and October. It is low where cold-induced thermal discomfort is high and vice versa.The Khamis Mushait station is also shared by the ideal thermal comfort and thermal discomfort due to cold with 42.5% and 57.4% respectively. The thermal discomfort due to cold is absolute in November, December, January, February, and March. It is very important in April with 80.5% and October with 94.4%. It is very low in May, June, and July with 2.7% each and 5.5% in September. The year is divided into two parts.

The first begins in October and ends in April dominated by the thermal discomfort due to the cold. The second starts in May and ends in September and is characterized by ideal thermal comfort.In Bisha, we see the appearance of thermal discomfort due to heat although we are facing the minimum thermal averages. However, this level is only 2.0%. The ideal thermal comfort represents more than 2/3, more precisely 68.5%.

The thermal discomfort due to the cold is 29.3%. Thermal comfort, considering the minimum thermal averages, characterizes the period from March to October, or eight months. It is absolute in April, May and September and hardly competed by the heat discomfort during the summer season.

Fig. 12: Minimum thermal averages and thermal comfortat the four stations of Aseer region



Source: Processing of temperature data between 1985-2020

The thermal discomfort due to the cold is rampant during the winter season. In short, tourist activities, which can be affected by thermal minima, are favourable from March to October or even November. However, they are negatively affected in December, January and February.Although we face the minimum thermal averages, we point out two important and illogical facts.

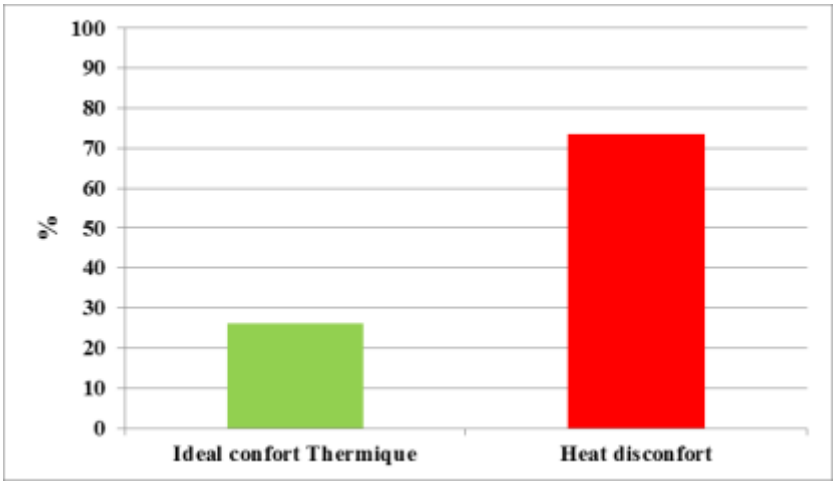
The first concerns the absence of thermal discomfort due to cold. The second is related to the thermal discomfort due to the increasing heat in this station. It represents 31.7% or 1/3, the 2/3 are marked by the ideal thermal comfort, which favours all activities from October to April.

The summer season in addition to September offers few opportunities in relation to these activities (Fig. 12).

HEAT DISCOMFORT:

It is imperative to note that the maximum temperatures are, essentially, recorded during the day most often around midday and during the summer season. Therefore, they usually condition diurnal activities. The treatment of the minimum thermal averages of the seven stations for the period 1985-2020 shows that out of 1728 maximum thermal values 1272, or 73.6%, represent a risk of discomfort that manifests itself in heat discomfort. Thermal comfort marks 456 values or 26.3%. Thermal discomfort due to cold is non-existent. It must be pointed out that the ideal thermal comfort marks less than 1/3 of the maximum thermal averages of the four stations during the period 1985-2020. While thermal discomfort due to heat affects more than 2/3 (fig. 13).

Fig. 13: Thermal comfort as a function of maximum thermal averages



Source: Processing of temperature data between 1985-2020

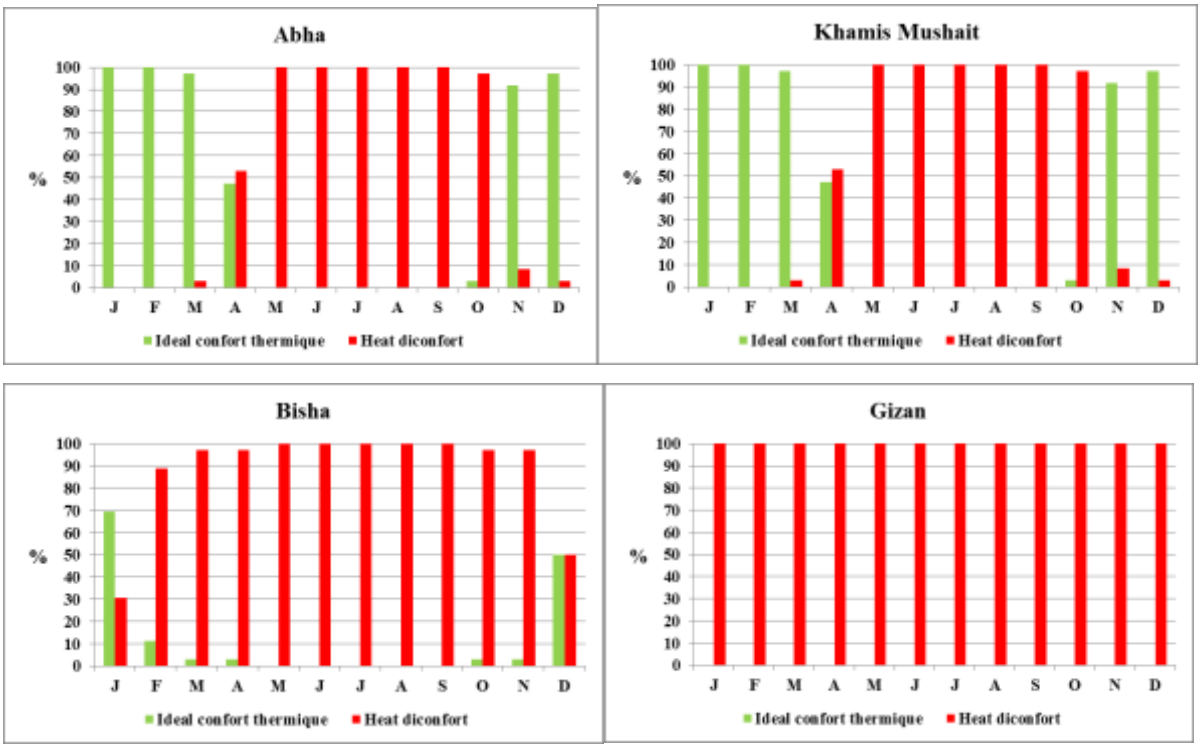
This will certainly affect all activities related to thermal comfort, as is the case with tourism. However, a few nuances need to be noted. They relate to the four stations.

In Abha, although we are in front of the maximum thermal values, thermal comfort is shared between the thermal discomfort due to heat which represents 50.9% and the ideal thermal comfort which marks 49.0%. The year is divided into two semesters. The first is marked by ideal thermal comfort. It begins in November and ends in April. The second begins in May and ends in October.Khamis Mushait station has a similar scenario in Abha. Only in April there are slight differences.

In Abha, April is dominated by ideal thermal comfort (72.2%) while Khamis Mushait, this month is shared, relatively fairly, by ideal thermal comfort (47.2%) and thermal discomfort due to heat (52.7%). The Bisha station is dominated by heat discomfort. It is absolute for five months: May, June, July, August and September, almost absolute in March, April, October and November with 97.2% for each of these months and February which records 88.8%. In other words, the thermal discomfort due to heat affects ten months. December is shared between the two degrees of thermal comfort. January is most marked by thermal comfort 69.4% and thermal discomfort due to heat with 30.5%.

In view of the maximum thermal averages relative to the period 1985-2020, shows that in Gizan the thermal discomfort due to heat is absolute and marks every month (Fig. 14).

Fig. 14: maximum thermal averages and thermal comfort



Source: Processing of temperature data between 1985-2020

CONCLUSION:

At the end of this study on thermal comfort in the Aseer region. A theme dictated by the thermal characteristics of this region where the thermal values are the lowest in Saudi Arabia, especially in mountainous environments, which constitutes a «thermal island».

The low thermal values give this region the quality of a vast tourist and resort region to value. The statistical processing and graphic translation of the monthly thermal data recorded during the period 1985-2020 at the stations of Abha, Khamis Mushait, Bisha and Gizan allows to highlight the different degrees of thermal comfort. The study of thermal averages, maxima and minima made it possible to grasp quantitatively the ideal thermal comfort, the thermal discomfort due to heat and the thermal discomfort due to cold.

We note a certain spatial-temporal complementarity between the different stations in this region. A guarantee of a future with promising year-round tourism prospects. The splendour of this future will depend, essentially, on the contribution of all stakeholders.

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التحليل المكاني والزمني للراحة الحرارية في منطقة عسير

(المملكة العربية السعودية)

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الملخص:

تتوقف الراحة الفيزيولوجية للإنسان على عدة معايير، تتحكم فيها الظروف المكانية والزمانية التي يعيش فيها. ففي الجغرافيا، نحاول التركيز على مفهوم الراحة المناخية التي تتأثر بدرجات الحرارة بشكل خاص. وعلى الرغم منأهمية الدور الذي تلعبه الظروف الحرارية في التأثير على مختلف الأنشطة البشرية خاصة النشاط السياحي، فإن الباحثين لم يعتنوا بالكتابة في هذا الموضوع بشكل كافي قادر على الامام بمختلف جوانبه. لتدارك هذا النقص، نحاول من خلال هذا البحث الذي يركزعلى منطقة عسيربخاصة دراسة التغيرات الزمكانية لمعدلات الحرارة بحثا عن أماكن وفصول الراحة الحرارية. وهنالك عدة أسباب دفعت إلى اختيار هذا الموضوع . من أهمها، استشراف مستقبل هذه المنطقة، التي يراد لها أن تكون وجهة سياحية بامتياز وقادرة على توفير أسباب الراحة لمرتاديها. وتهدف هذه الدراسة، إضافة إلى الوقوف على الحقيقة الحرارية التفصيلية لهذه المنطقة، والبحث عن أوجه التكامل المحتمل مكانيا وزمنيا، والتحليل المكاني والزمني لدرجات الراحة الحرارية. ولتحقيق هذه الأهداف ، وقع تفضيل الأسلوب الاحصائي لمعالجة البيانات الحرارية التي تم فيها الأخذ بعين الاعتبار القيم المتوسطة، والقصوى، والدنيا المسجلة خلال الفترة الممتدة بين ١٩٨٥-٢٠٢٠ لمحطات الرصد الجوي لمنطقة عسير (أبها، خميس مشيط وبيشة) إضافة إلى محطة جازان الواقعة خارج المنطقة لكنها قريبة منها. وكشفت النتائج التي تم التوصل إليها، بعد مناقشتها وتوضيحها برسوم بيانية، عن وجود تقويم مكاني زمني يمكن تنفيذه من أجل «استغلال مختلف فترات الراحة الحرارية للزائرين» في هذه المنطقة التي تتسم بصفات «الجزيرة الحرارية».

الكلمات المفتاحية: *عسير، القيم الحرارية، الراحة الحرارية، جزيرة حرارية.*