A Study of Cooling and Heating Requrements in Northwest of Iran

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Extanded Abstract

Introduction

If the human comfort temperature (threshold temperature) is defined as X, the average deviation of daily temperature from the comfort level is termed a degree-day, which represents the need to cool the environment from temperatures above the threshold temperature and the need to warm the environment from temperatures below the threshold temperature (i.e., cooling and heating needs, respectively). Heating degree day and cooling degree day values for a given area indicate the harshness of the climate and bear a direct relation to an area's population and size of residential areas. HDD and CDD values are also related to climatic change.

Materials and Methods

The area considered in this research is northwest Iran (44–50°E and 34–40°N), including the provinces of Gilan, Ardebil, Eastern and Western Azarbaijan, Ghazvin, Hamedan, Kurdestan, Kermanshah, and Markazi. We analyzed daily amounts of HDD and CDD recorded at 28 meteorological stations in northwest Iran for the period 1984–2003, using data provided by the Information and Statistics Center of the Meteorology Organization of Iran.

In choosing the meteorological stations to include in our analysis, we took account of data availability and connectivity. Because of the influence of altitude on climate, we also selected stations located close to each other but with contrasting altitudes (e.g., the stations at Hamedan (airport) and Hamedan (Nojeh) occur in the same geographical area, but are located at altitudes of 1749 and 1679 m above sea level, respectively). The selected stations are also those with appropriate data for our analysis.

Some stations lacked data for certain years; consequently, we reconstructed the data required to calculate HDD and CDD values using the method of differences, as temperature

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series show little variability. In this approach, missing data were replaced based on data from the closest stations with similar climate.

Before analyzing the data, we assessed the data quality using the Run Test method. The tests demonstrated the congruency of annual HDD and CDD data for all stations. Maps of cooling and heating needs were compiled using SURFER software, and regionalization maps were compiled using ARCVIEW software.

Results and Discussion

We used statistical methods to calculate and examine the cooling and heating needs of the areas represented by 28 meteorology stations in northwest Iran, and analyzed the spatial distribution of the needs. The study area was divided into sub-regions via a climatic classification scheme based on environmental cooling and heating needs, and we compiled a GIS-based map of cooling and heating needs throughout the study area.

The average monthly cooling and heating needs of the stations revealed the greatest need of heating energy during January and the greatest need of cooling during July. Ardebil is the coldest site, requiring heating energy throughout the year; Sarpolzahab is the warmest.

A comparison of the spatial distribution of annual average cooling and heating degree-days with altitude reveals that areas at 1600–1700 m elevation have heating needs of 3300–3500 degree-days (the highest values among the stations) and cooling needs of 50–150 degree-days (the lowest among the stations).

Also, a comparison of cooling and heating needs revealed that the mountainous nature and high altitude of the stations means that heating needs are dominant; i.e., most of the energy consumed in the region is used for providing heat.

A regression analysis revealed that with increasing altitude, heating needs increase and cooling needs decrease. Although coastal stations benefit from their proximity to the Caspian Sea, according to the hierarchical classification (which assigns the stations of Rasht, Bandar Anzali, Astara, and Parsabad in the same climatic class), the sea has relatively little effect on the cooling and heating needs of the region overall.

During the second decade of the study period, the heating needs of high-altitude stations decreased by an average of 317 degree-days compared with the first decade.

The effect of latitude on cooling needs was examined by cubic (bivariate regression). To limit the influence of altitude, stations located above 1500 m were excluded from analysis. The heating needs of the region increased by 0.622 degree-days for each degree increase in latitude, and cooling needs decreased by 0.651 degree-days for each degree increase in latitude. The same trends are apparent in the spatial distribution of heating and cooling needs relative to latitude. The combined data demonstrate that cooling needs in northwest Iran are reduced with increasing latitude.

Conclusion

An analysis of the effects of independent factors on the cooling and heating needs of the area revealed that the Caspian Sea influences only the coastal land adjacent to the sea; latitude and altitude affect the cooling and heating needs throughout the region. For each degree of increase in latitude, the heating needs increase by 0.662 degree-days and the cooling needs decrease by

0.651 degree-days. Over the second decade of the study period, the heating needs of highland regions decreased by an average of 317 degree-days relative to the first decade. The conditions that affect cooling and heating needs throughout the study region are heterogeneous. Our regionalization analysis demonstrates the existence of 11 different climatic classes in terms of cooling and heating needs.

Keywords: Cooling, Heating, Degree-day, Regionalization, Northwest Iran.