

ANALYSIS OF HUMAN THERMAL CONDITIONS IN WINTER FOR DIFFERENT URBAN STRUCTURES IN ERZURUM

Prof. Dr. Hasan Yılmaz
Assist. Prof. Dr. Nalan D.
Yıldız
Assist. Prof. Dr. Ugur
Avdan
Res. Assist. Ahmet Koç
Prof. Dr. Andreas
Matzarakis

ABSTRACT

Healthy urban planning and modelling are necessary for sustainable urbanization. This study was carried out in the city of Erzurum, which is located at a 2000 – m altitude and the coldest city in Turkey and where urban transformation projects have been implemented in the last few years. Four different parts of the urban areas are decided for the case study to be (1) Erzurum city center, (2) Botanic garden of Ataturk University, (3) Yenisehir and (4) Dadaskent. PET and SVF were measured in these areas and measurements were conducted at 9:00, 12:00, 15:00 and 18:00, peak hours in which people are using outdoor in winter months (December- January - February). Life comfort, which is the issue tried to be measured in this study, is extremely important the cities facing long winter period. In addition to PET and SVF, Landsat satellite images are used for the measurement and in this process; different categories are defined for the determination of alteration in the heat islands. In conclusion, related to the structural and plant design in urban areas, design based suggestions are made to increase urban comfort.

Keywords: urban design, PET, Winter comfort, SVF, Thermal Band

INTRODUCTION

New approaches for healthy and sustainable environment have been experienced in urban areas in the scope of landscape planning and design. Among such approaches, climate balanced planning includes thermal comfort studies even though they are new for Turkey. Climatic change and UHI may change local, regional, national and global scale climatic parameters.

The overall importance of the PET in outdoor thermal comfort has been given special attention in this process. There are so many studies in the literature using PET values. The number of studies carried out to determine the causes and effects of urban land - uses on urban microclimate and ecosystem is quite limited in Erzurum. The SVF values are used in different studies for the thermal comfort analysis. Urban outdoor thermal environment is impacted by trees and man made objects, streets (w/h), heating and street orientation. SVF is used in urban areas.

The aim of present study is to plan healthier, more liveable and thermally more comfortable areas for urban people and produce data for the same aim. It is targeted to gain experience to take the advantages of urban transformation works in Erzurum. In Erzurum, chosen to be study area, present location areas were evaluated and SVF measurements were conducted at the points on main arteries thought to represent the areas best. Roads are the areas making accessibility possible for urban people in urban areas in daily life. For people using these areas security and thermal comfort are extremely important. Winter season PET calculations were conducted in December, January and February in 2013 and 2014. It was emphasized that climate and its effects should be taken into consideration for planning roads in addition to other factors. It was also targeted to attract planners and designers' attention to bioclimatic comfort in order to create more comfortable areas. Importance of thermal comfort is emphasized in urban planning. Data obtained from Erzurum Meteorology Service for the study period were used to calculate PET through RayMan model.

MATERIAL AND METHOD

MATERIAL

Material of the study includes the roads used most densely in Erzurum city centre. For this aim, measurements were conducted at four different road axes in Erzurum.

Study area is located in the eastern part of Turkey at an elevation of 1850 m. In the city, a harsh continental climate is prevalent, which means winters are long and extremely cold. This station (at an elevation of 1758m and a location of 39°.57N and 41°.10E), considered as the representative of a rural area, is in the Airbase area lying about 7 km from the city. The Airbase is surrounded by the vast open area in all directions. There are no buildings or human activities around the station except for the cultivated area which is 4km from the station and where plants that do not need watering are grown. Data obtained from Erzurum Meteorology Service for the study period were used to calculate PET through RayMan model. Winter season PET calculations were conducted in December, January and February in 2013 and 2014. The location of the measurement stations and SVF points for the data used in this study is shown in Figure 1.

METHOD

In this study, Erzurum city centre are decided for climatic analysis. For those areas, Sky View Factors (SVF) and PET values are calculated and compared with the data obtained from Meteorological Station. The location of the measurement stations and SVF points for the data used in this study is shown in Figure 1.

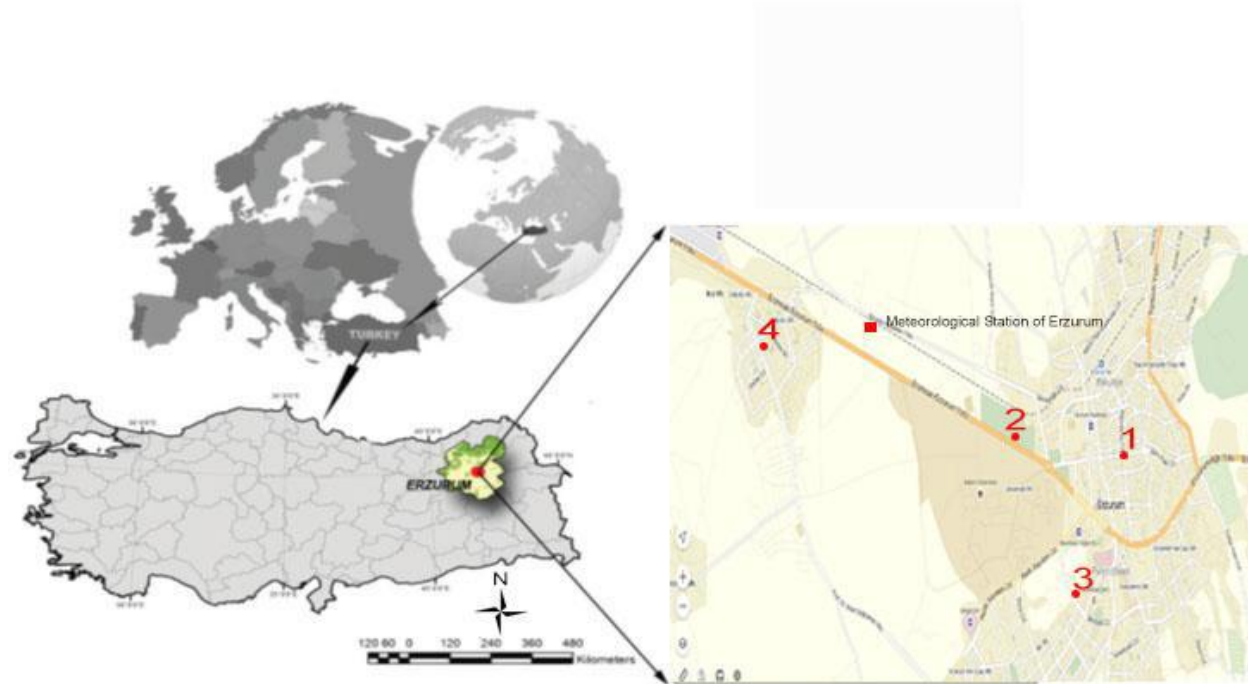


Figure 1. Study areas (1) Erzurum city center, (2) Botanic garden of Ataturk University, (3) Yenisehirand (4) Dadaskent and meteorology station

SVF Analysis:

The sky view factor (SVF), expresses the ratio between radiation received by a planar surface and that from the entire hemispheric radiating. The SVF is a dimensionless value between 0 and 1 and approaches unity in perfectly flat terrain, whereas locations with obstructions such as buildings and trees will cause the SVF to decrease proportionally. The SVF is, in this sense, a measure of the openness of the sky to radiative transport in relation to a specific location, where a value of 0 (complete obstruction) means that all outgoing radiation will be intercepted by obstacles and a value of 1 (no obstruction) means that all radiation will propagate freely to the sky. Four different main road and pavement have been chosen, fish-eye photos were taken about 1.5 m above of each point by high-definition camera integrated with fisheye lens by three repetitions in different four stations. The relation between the variables was evaluated by the method of ordination analysis via the computer program CANOCO version 4.5. The relation between Sky view factors (SVF) and data for height and diameter of plant trends near-linear. When there is such this trend, RDE (Redundancy Analysis) analysis method is preferred in the ordination analysis, so these techniques were used in this study

RayMan;

Bioclimatic comfort is the climatic conditions where people consume less energy and feel themselves healthy and dynamic. Winter season data (December, January and February) of 2013 and 2014 were used for the study and calculation considering the most densely active hours for people 9, 12, 15 and 18. Rayman 2.1 pro model was used for the calculation of PET considering thermophysiological conditions; age, gender, height, weight clothing insulation, physical activity and position and air temperature (T_a -°C), wind velocity V (m/s), relative humidity (RH-%), cloudiness (N-octas) or radiation (W/m^2). Wind was used in the calculations by reducing data from 2 m to 1.1m.

RESULTS

In the present study, thermal comfort conditions were evaluated over pedestrian sidewalks. Pedestrian comfort and security may be lessened due to the icing on the roads in winter. SVF measurements were conducted on the road axes densely used in Erzurum city centre. Axes were chosen among the most densely used roads. Three different points were selected to make measurements. Photos tried to be taken from the empty points on main axis including building and tree. Results are presented below.

Station 1 is Cumhuriyet Street most densely used main-street of the city centre. Since it is the commercial centre of the city, it is used most densely by youths and other people on foot or by car. Measurements were taken from the points with two side buildings, one tree and one building and empty. Width of the road is between 17 and 28 m (Figure 2). At the point with coniferous tree SVF was found to be the largest with 0.052.

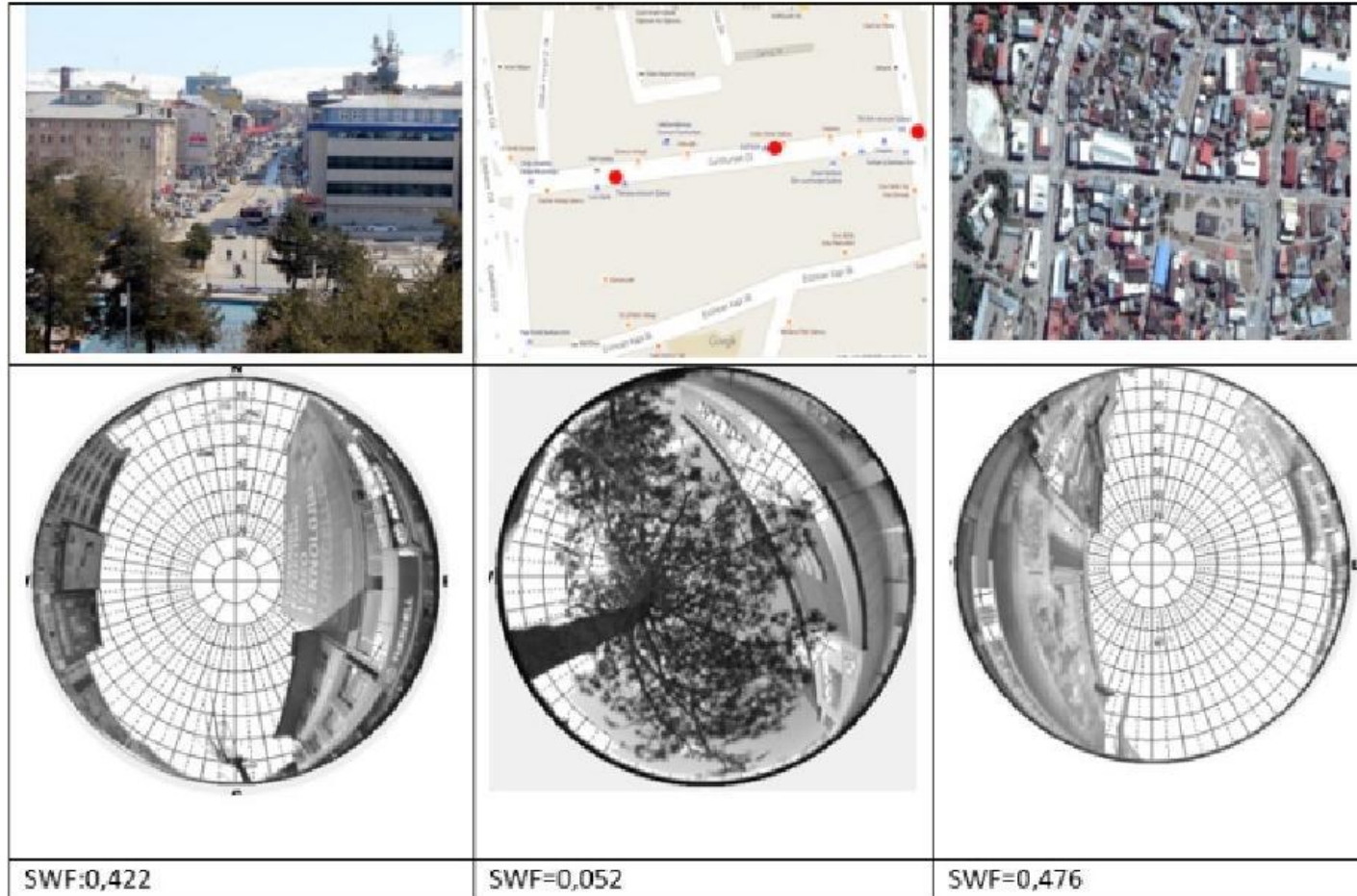
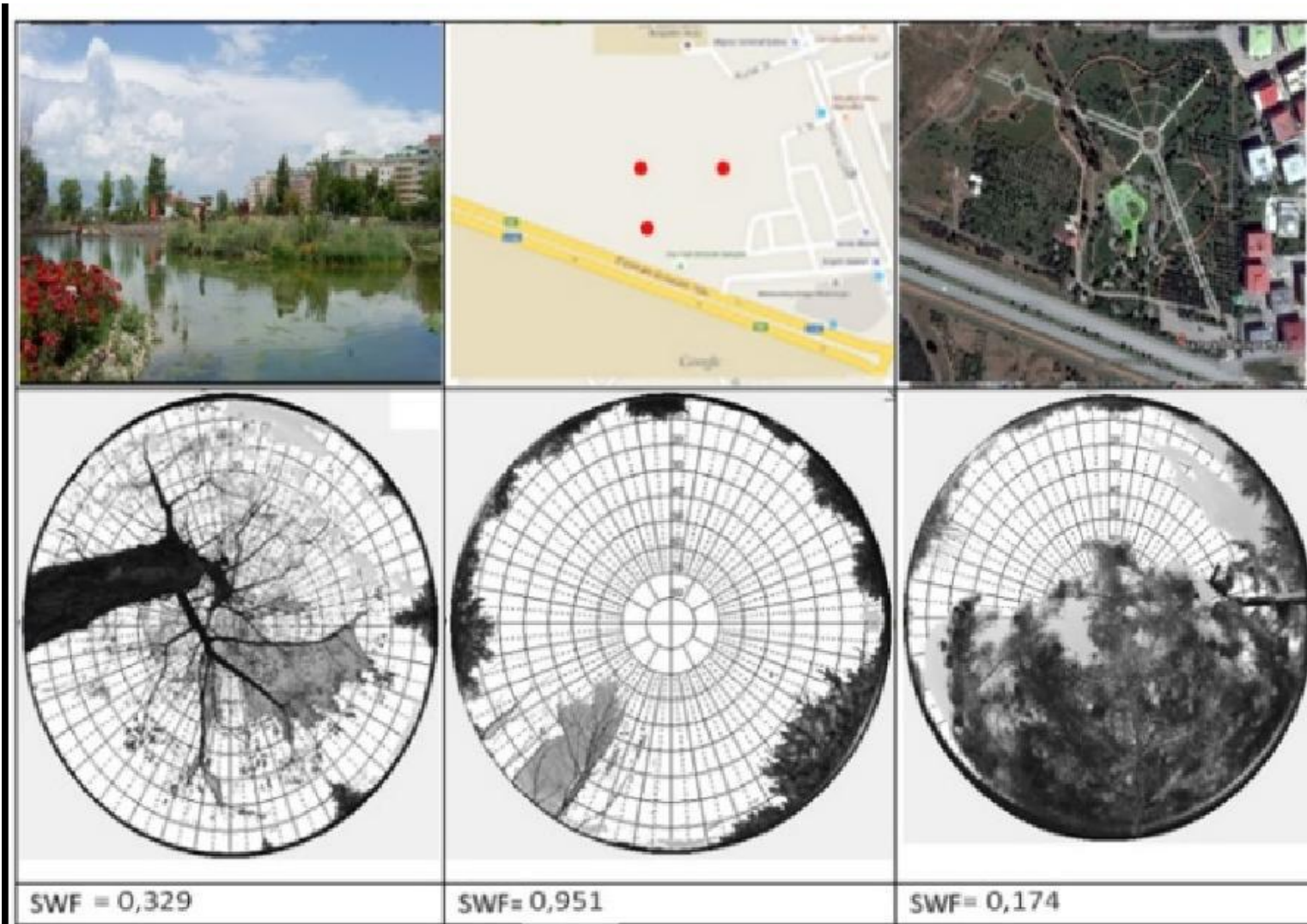
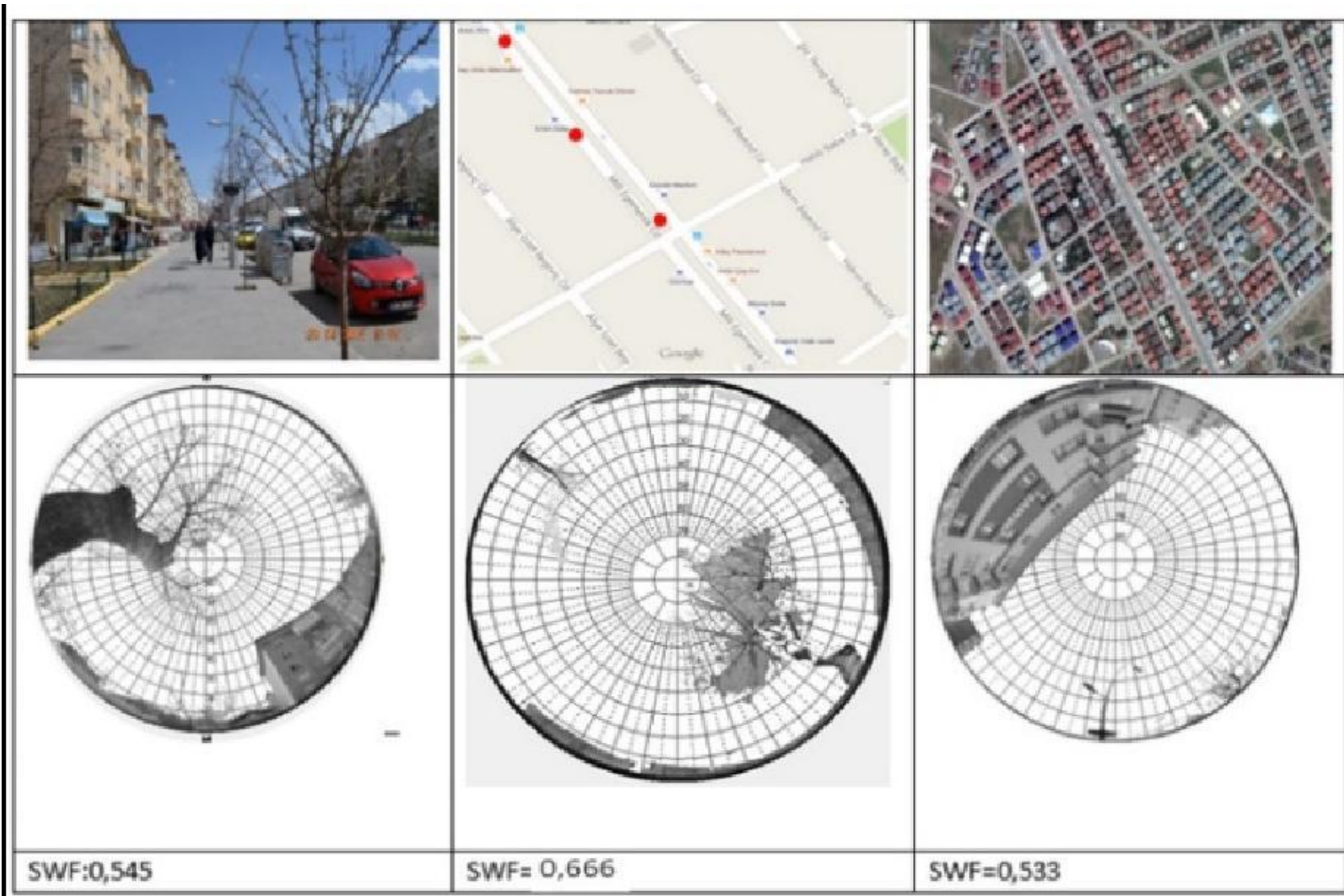


Figure 2. SVF on Cumhuriyet Street



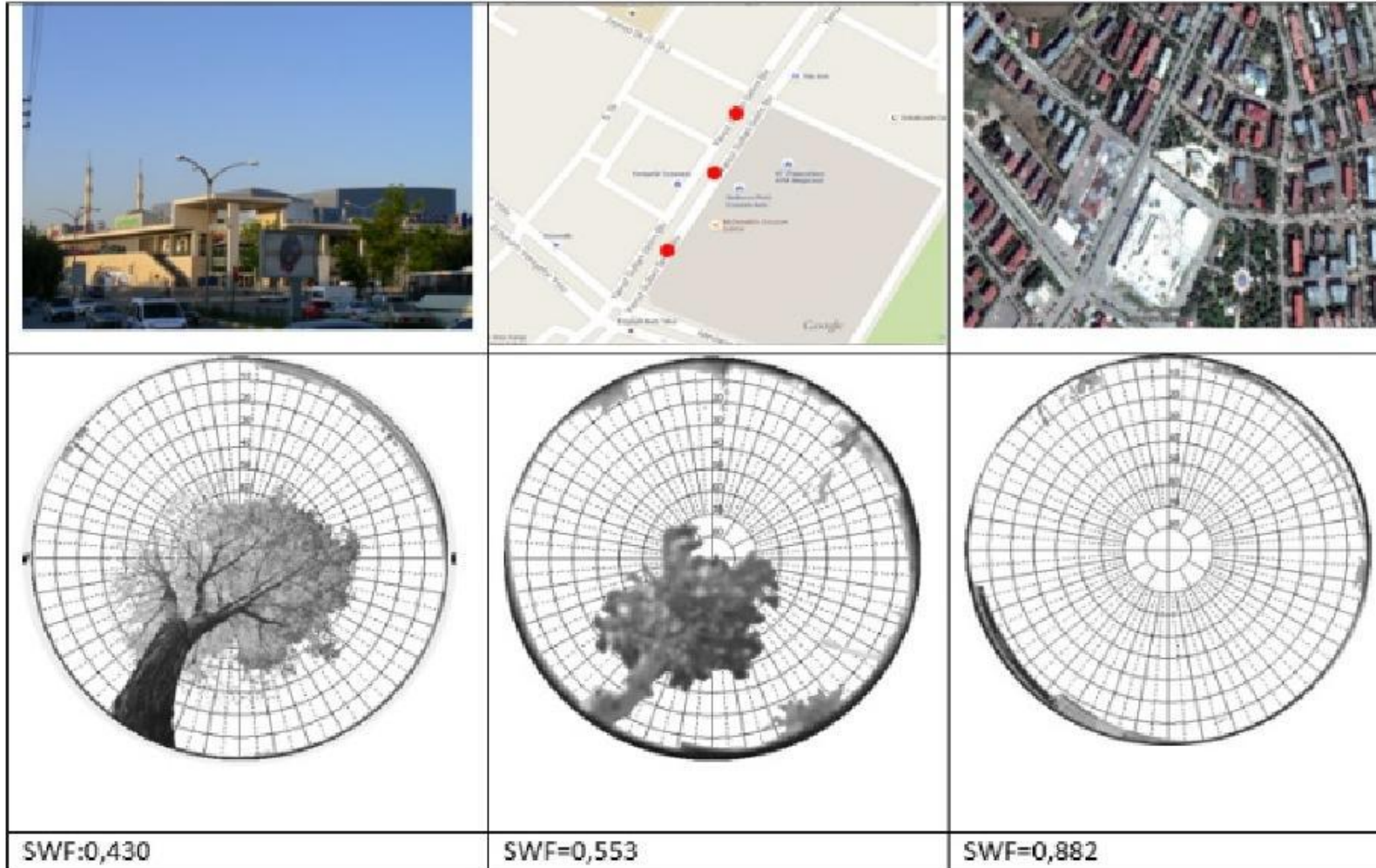
Station 2 is on the main axis at Ata Botanical Garden of Atatürk University, 2 km away from city centre and functioning as green heart. Measurements were taken from three different points. The highest SVF value was found at this point with 0.951. At the point covered with coniferous trees, SVF is lower with 0.174 (Figure 3).

Figure 3. Atatürk University Ata Botanical Garden



Station 3 is on the main axis of Dadaskent neighbourhood constructed in 1990s functioning as a satellite city. Width of the road is 40 m. SVF values are very close to each other (Figure 4).

Figure 4. Dadaskent neighbourhood and measurements on main axis



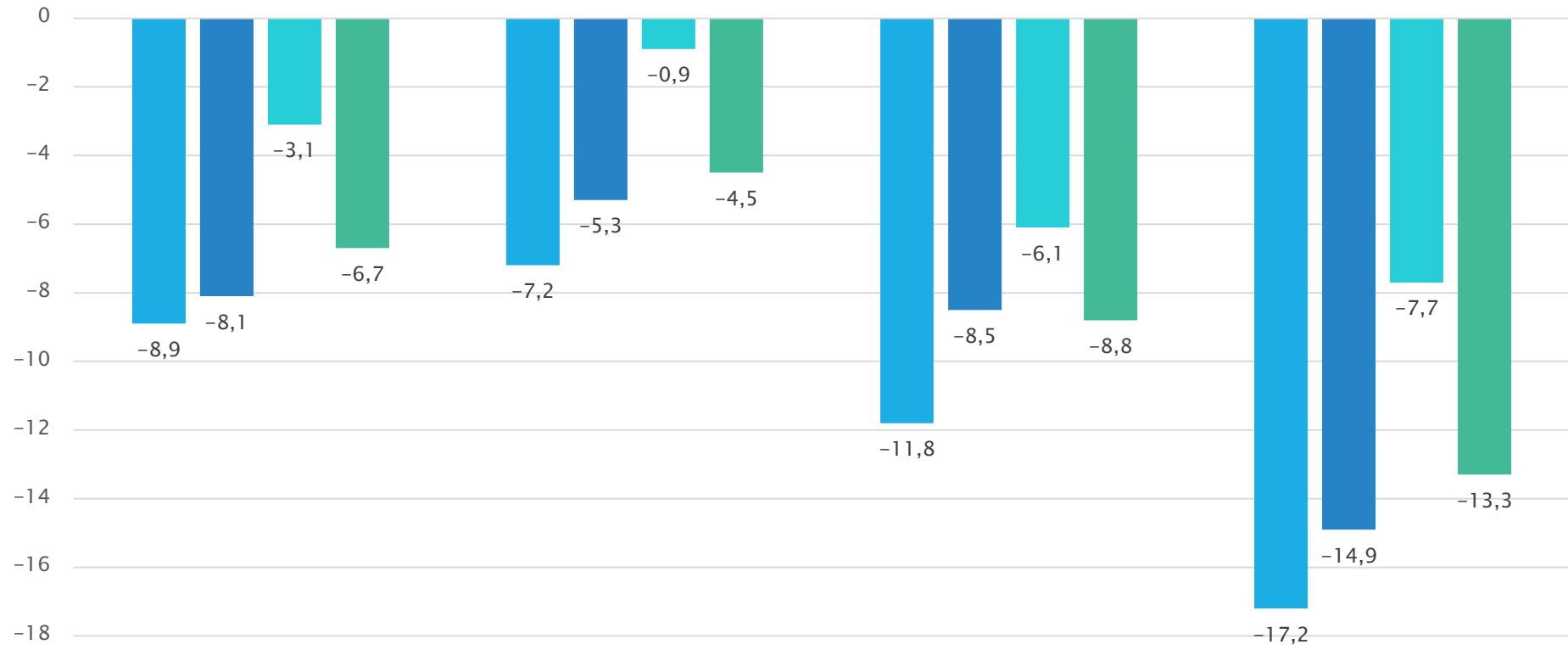
Station 4 is Yenisehir neighbourhood constructed in 1980s and measurement points are given in Figure 5. Both the settlement area and the sidewalks where measurement points are located have been designed conveniently design and planning principles. SVF values are between 0.430 and 0.882 (Figure 5). Width of the road is 40 m.

Figure 5. Yenisehir neighbourhood SVF analysis



All climate parameters were obtained from the General Directorate of Meteorology Airport Station in Erzurum which is also the reference station of this study. Erzurum city winter data for 2013 and 2014 were used to compute daily PET values.

2014



	09:00	12:00	15:00	18:00
■ January/2014-PET (°C)	-8,9	-7,2	-11,8	-17,2
■ February/2014-PET (°C)	-8,1	-5,3	-8,5	-14,9
■ December/2014-PET (°C)	-3,1	-0,9	-6,1	-7,7
■ Mean PET(°C)	-6,7	-4,5	-8,8	-13,3

■ January/2014-PET (°C) ■ February/2014-PET (°C) ■ December/2014-PET (°C) ■ Mean PET(°C)

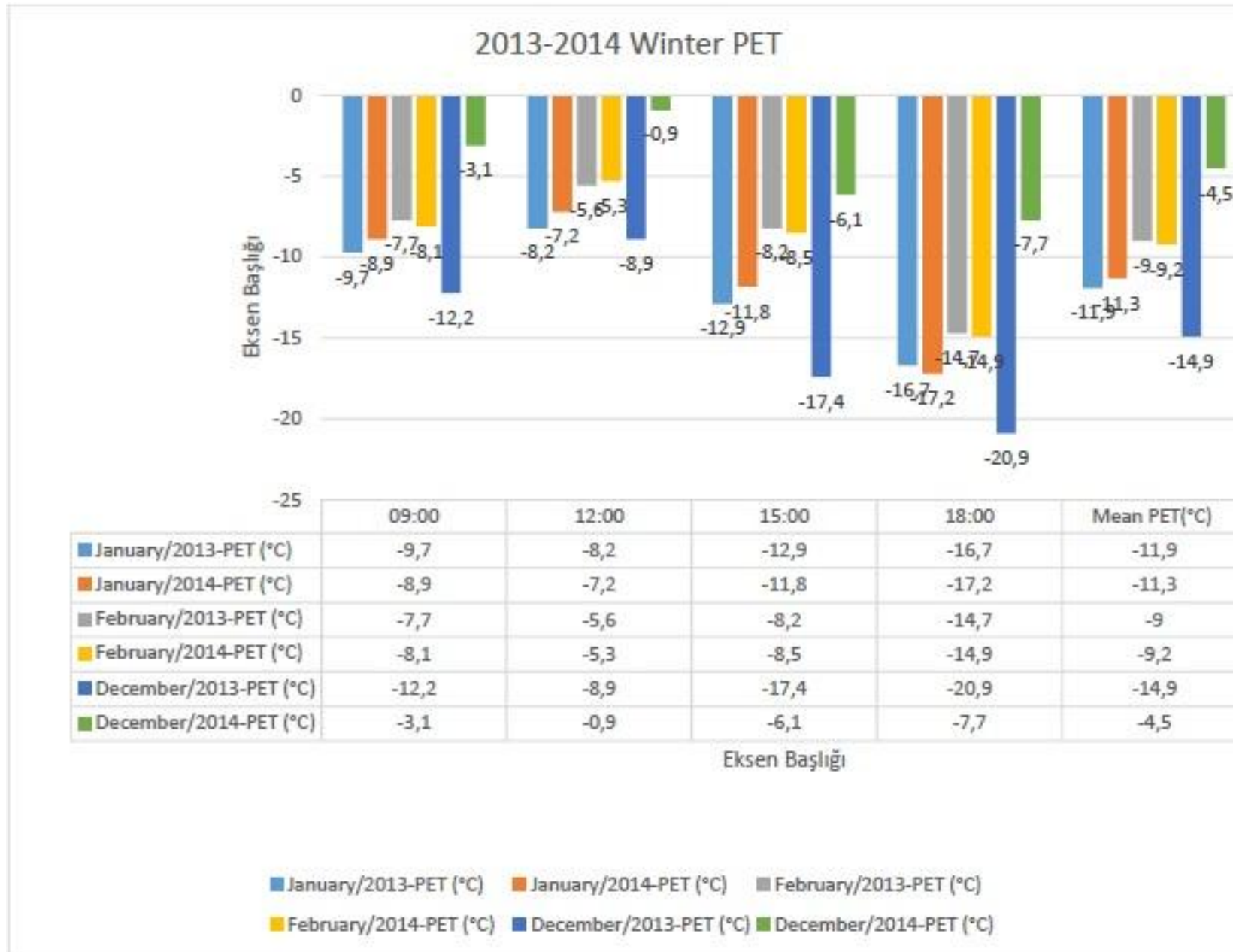


Figure 6. PET values for winter months 2013-2014.

CONCLUSION

Landscape architecture aims to provide physically and psychologically comfortable environment for people. In this respect, creating thermally comfortable areas is an important feature of landscape design and planning. Among the subjects that landscape architecture discipline interested are bioclimatic comfort and nature protection which are directly and strongly affected by the changes in climatic elements.

It was emphasized in the present study that climatic factors should be taken into account in the planning of cities and roads. The aim was to attract the attention of planners and designers to thermal comfort. SVF analysis shows that trees contribute to the sky openness.

SVF values change between 0.422 and 0.951 in the present study from the photos taken from the roads with plants, buildings and open sides. When the street widens SVF increases.

The largest SVF close to 1 was measured at Ata Botanical Garden in the city centre of Erzurum. This axis and its environment are rich in green area and trees.

Pedestrian walks should be evaluated in details for their security and comfort for liveable cities. In especially the cities like Erzurum, where cold and long winter conditions are prevalent, coniferous trees should not be used densely. They should be planted away from roads due to their lower branching characteristics and since they cause icing. Upper branching deciduous trees should be preferred since they offer shadow in summer and sunlight in winter.

Life quality can be increased through relocation, development and expansion of cities to comfortable areas or increasing comfort conditions in the areas with low comfortable conditions intervening them. Such a project to be carried out for Erzurum may serve as sample for new studies for other cold region cities.

Thank You Very Much