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Original Research

The influence of the age of granite paving blocks in outdoor public spaces on the ambient temperature during the warm months affecting their users

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Abstract

In this research, we present the results from the comparison of temperature measurements that were made over different external points of public spaces in the old town of Xanthi. The area is located in northern Greece and is a protected settlement. All the points where the measurements were made are paved with dark gray granite blocks. This material has always been used to pave the open public spaces of the old town. Through the comparison of temperature measurements, it was found that the older paving materials develop higher temperatures compared to similar, but newer materials. Thus, it was concluded that the age of the paving materials affects the comfort of the users of the open public spaces. To test this, measurements were made during two months in spring and summer. During this period, the temperatures are higher and thus affect the users of the outdoor areas more; this results in a more useful comparison of the coating materials.

Keywords: granite; blocks; coating; outdoor; public area; temperature; thermal sensation

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1. Introduction

The aim of this work was to compare the responses of new materials with those of similar, but older materials that have been used and exposed for a longer period of time.

Long-term changes in the Earth's climate are one of the most serious environmental problems at present. Solar radiation is the primary energy source for physical processes and phenomena in the atmosphere [1]. A significant positive correlation between solar radiation and temperature was found principally from May to August [1].

This was further established by comparing the temperatures from measurements taken at fifteen different points in the old town of Xanthi from April to June as shown in the survey appendix from the table of measurements and the table with the annual climatological summary of 2022 in the city of Xanthi [2].

Solar radiation affects the temperature of materials. During the winter months the sunshine is limited and the differences in temperatures at several measurement points, and at points with new or old paving materials during this period are not significant.

Temperature is a measure of the thermal state of matter and represents the degree of hotness or coldness of a body. It is a widely measured variable of the change in weather because it influences or controls other elements of the weather, such as the dew point temperature, precipitation, humidity, clouds, and atmospheric pressure [3]. The impacts of temperature extremes on natural ecosystems and on human infrastructures are now widely recognized as being more important than changes in average values. Climatic variability is also important for the human perception of climate [4]. The total hours of sunshine are an important factor in determining solar radiation and air temperature [3].

The rate at which solar energy reaches the Earth's surface in any location depends on the season, time of day, cloudiness and the concentration of small aerosol particles in the atmosphere [5].

The sun is continuously emitting solar radiation in all directions. Sunlight that reaches the Earth's atmosphere is either absorbed or reflected. Absorbed energy gets re-radiated in the form of infrared, also known as longwave radiation. Infrared radiation is invisible to our eyes, but we feel it as heat [6].

The heat source for our planet is the sun. Energy from the sun is transferred through space and through the Earth's atmosphere to the earth's surface. Since this energy warms the Earth's surface and atmosphere, some of it becomes heat energy. There are three ways heat is transferred into and through the atmosphere: (1) radiation, (2) conduction, and (3) convection [7].

Heat transfer from a body with a high temperature to a body with a lower temperature, when bodies are not in direct physical contact with each other or when they are separated in space, is called heat radiation. All physical substances in solid, liquid, or gaseous states can emit energy via a process of electromagnetic radiation because of vibrational and rotational movement of their molecules and atoms. The intensity of such energy flux depends upon the temperature of the body and the nature of its surface. The radiation occurs at all temperatures, but the rate of emission increases with temperature [8].

The materials we use either as structural elements or as surface coatings are directly affected by the incidence of solar radiation. Solar radiation transfers heat to these materials, which in turn re-emit a part of it and store the rest, increasing their temperature. The stored heat is re-emitted to the environment when temperature conditions permit (energy flow conditions), increasing the temperature of the air in the immediate area [9].

By the term 'heat' we mean a form of energy that depends on the structure of matter and that can be transmitted to systems or bodies in various ways or converted into other forms of energy. The 'temperature' of a material is determined by the magnitude of its molecular motion in the form of heat. It is determined by the flow of heat from one system or body to another and is sensed or measured with the help of an instrument.

The forms in which thermal energy (heat) is perceived in the Earth's atmosphere are (a) sensible heat whose effect (sensible temperature) can be measured directly with the help of an instrument and (b) latent heat (corresponding effect: latent temperature) that is transported during physical processes such as evaporation, condensation, *etc*.).

As stated above, essentially the only source of heat for our planet is the Sun, because the energy both from the interior of the earth and from the surface is considered negligible. In fact, it was calculated that, if the amount of heat from the interior of our planet reaching its surface completely disappeared, the average temperature on the surface of the Earth would decrease by less than 0.1 °C. Therefore, solar radiation is the only factor that directly and indirectly regulates the temperature of the atmosphere and especially the temperature of its lower layers, thus keeping the huge Earth-atmosphere heat engine in continuous action. The short-wavelength radiation is considered as a direct effect, and the corresponding long-wavelength radiation (terrestrial radiation) is defined as indirect, depending on the intensity of the incident solar radiation on the ground surface.

The mechanisms of heat transmission to the atmosphere, resulting in heating of the air (mainly the lower atmospheric layers) are: (a) conduction, (b) convection (through vortices and mass transport) and

(c) radiation. Therefore, the most important factors that ultimately shape the thermometric conditions over a specific location are:

1. The radiation balance in the Earth-atmosphere system that exists at that location;
2. The possibility and frequency of transfer of amounts of heat to this location by horizontal and vertical movements of warm or cold air masses;
3. The amounts of heat released or absorbed during water vapor condensation or water evaporation;
4. The physicochemical characteristics of the soil surface that determine both soil reflectivity and plant cover; and
5. The sea currents that may flow near the area.

Because the solar radiation passes through it, the atmospheric air absorbs only very small amounts of heat and thus, the surface of the ground heats up much more. The layers of air near the surface are, therefore, heated more strongly than the upper ones [10].

We know that the heat absorbed from solar radiation by paving materials increases the temperature of the air in contact with them. In this way, the materials affect the users of these areas when they release their stored heat during the summer months, a period when solar radiation is more intense. If we can determine which materials, new or old, raise the air temperature less as they release their stored heat, we can find ways to deal with the warming of the areas covered with those materials.

Depending on the results of our research, we will choose those materials that perform best in controlling temperature. If the older paving materials increase the air temperature less, we should use the old materials in the renovations. If the newer materials raise the air temperature less, we should replace the old materials more often.

The old town of Xanthi is located at the northeastern edge of Greece in the homonymous prefecture and the region of eastern Macedonia and Thrace. After the catastrophic earthquake of 1829, which leveled the town of Xanthi, a new period of reconstruction began with particular prosperity due to the tobacco trade from 1870–1910. Reconstruction and economic prosperity stopped in 1912 with the start of the Balkan Wars. To this day, the traditional character of the old town of Xanthi has been preserved and it is considered a protected settlement. The streets of the old city have always used as paving material, the dark grey granite blocks that have been set in place with a special technique. Due to their great strength and durability, they have remained in very good condition for many years.

2. Methods

The difference in climatic conditions between the city and its periphery is greatly influenced by the amount of sunlight the area receives and how much is trapped by the ground, the paving blocks, and in the general constructions [3]. This response also depends on other factors concerning the paving materials of public areas. Atmospheric air is heated by the sun's rays passing through it and by the surface of the earth. Comparisons have been made between different points in the urban area of the old town of Xanthi, which is paved with grey granite cobblestones. These areas contain important road intersections and squares, but also include parking lots. These locations have been reconstructed over time, and we know the date because of an archive of the Municipality of Xanthi with projects carried out from 1992 until today. We know the points where the measurements were made, the exact date on which repairs were made from 1992 onwards or that they were older than 1992. During the day, some of the selected areas are exposed to the sun while others are in shadow caused by trees or buildings.

An effort has been made to demonstrate whether newer or older paving materials produce more comfortable temperature conditions for users. For this purpose, the temperatures were recorded at the height of a person, above specific areas that are covered with grey granite blocks, during the warm period of the year, and comparisons were made between the means of the temperature measurements recorded at each point. The measurements were made at those hours of the day when the sun most influenced the response of the materials--specifically at 12:00 pm, 15:00 pm and 18:00 pm.

2.1 Study Area

The study areas were in the old town of Xanthi, which occupies 380,000 square miles at the foot of the Achladovouno Mountains. The Kosynthos River passes next to the settlement, which has a southern orientation. It has retained its old road plan and its building stock due to its classification as a protected settlement. In the old town there are 1200 protected buildings listed. Of these, 140 are characterized as very remarkable, 130 as remarkable and 260 as interesting. Dark gray granite cobblestones are the main paving material of the external public common areas, which are the squares, streets, parking lots and other flat areas. At some locations, there are tall trees, but the buildings are relatively low and covered with tiled roofs. The presence of trees and grass in the outdoor public areas can help develop social bonds and the greenery also helps people relax, rejuvenate, and relieve stress [11].

Temperature measurements were made at fifteen different points throughout the urban area of the old town. These points are spaced relatively close together in groups of three in the same square (Figure 1). All fifteen points are in important outdoor public spaces of the old town (Figure 2). The measuring points are sometimes near trees or buildings, but at other times are exposed in open areas. Due to the information about when the replacement of the cobblestone paving was done at these points, it was possible to make comparisons between points that had been reconstructed in recent *vs*. older times.

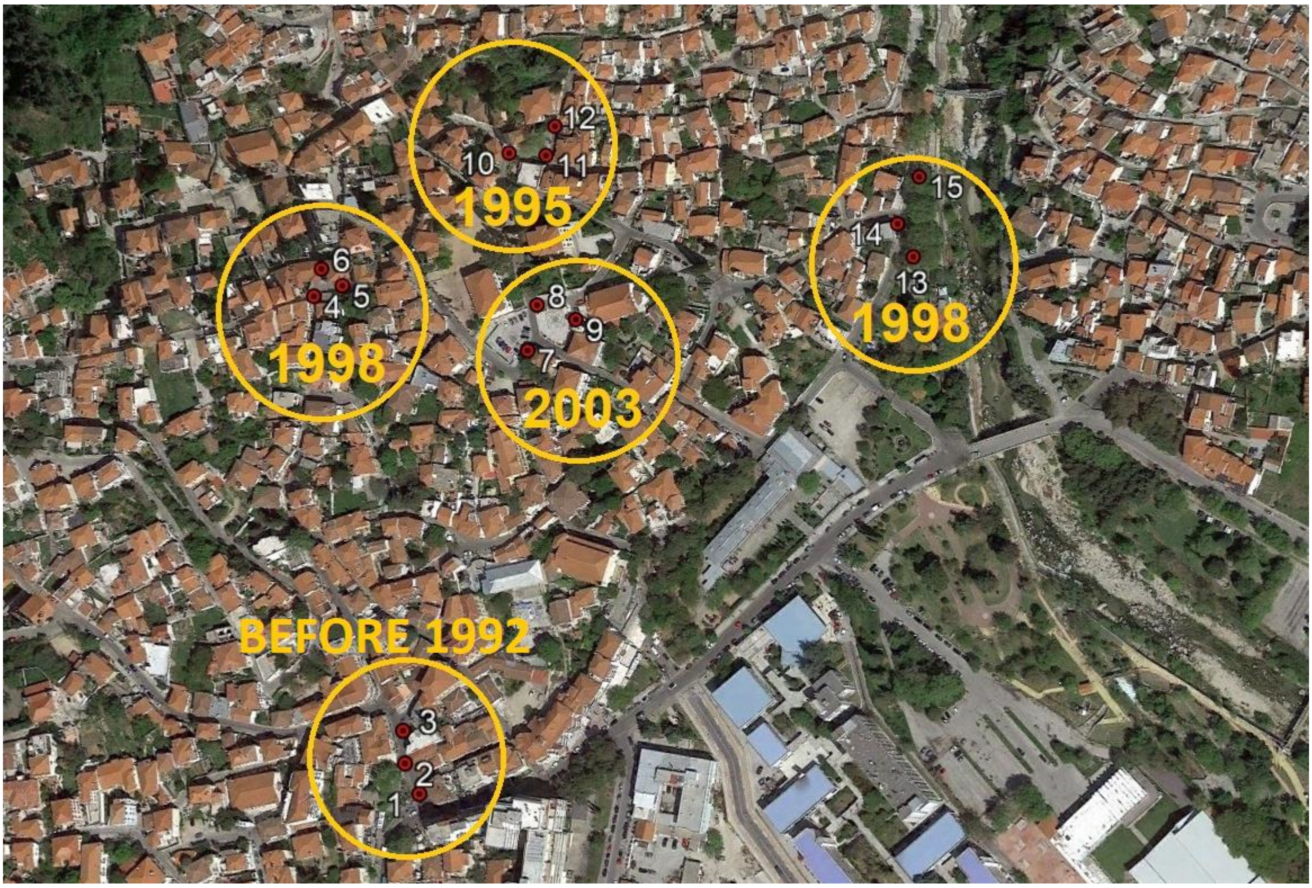

Figure 1. Measurement points and years of cobblestone reconstruction.

2.2 Methods

The device we used to make the measurements for the purpose of comparing temperatures was a digital thermometer. Air temperature is one of the most important meteorological and climatic elements and its change is of great importance for the study of weather and climate [12]. The black ball thermometer with which we made the measurements was connected to a digital hand measuring device (HD200, Kimo Instruments) (Figure 3). A hygrometer with a built-in thermometer was also connected to the digital device.

To make the measurements, we took the measuring device to the selected points at the selected times, and the device remained on for a period of time until the readings stabilized, at which time they were recorded and collected to compare their values.

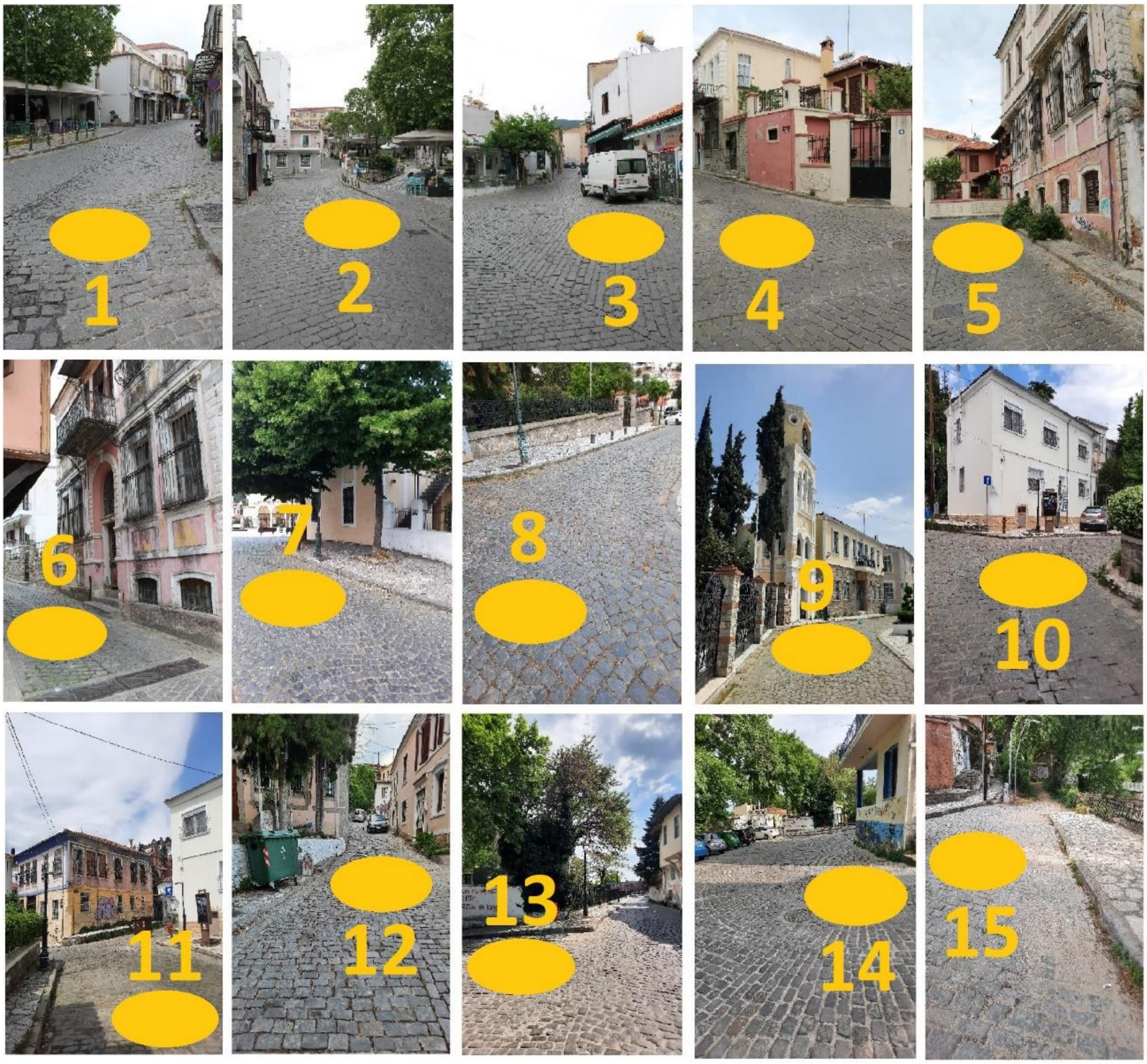

Figure 2. Pictures of the fifteen measurement points in old town of Xanthi.

The thermometer with which the ambient temperature was determined is of the black ball type as shown in Figure 3, which can measure temperatures from 0 °C to 60 °C with an error of 0.5 °C and temperature resistance up to 600 °C. These measurements are given in Table 1 as Tr2. This shows the great accuracy of the device, which is equal to ±0.417% of the reading.

We also measured the wet bulb globe temperature (WBGT), which is an indicator of the thermal stress to which a person is exposed in a very hot outdoor environment. This thermal stress is a function of the heat produced within the body due to the individual's physical activity and those parameters of the workplace that affect the heat exchange between the human body and the environment. The hygrometer measures % relative humidity, and the built-in thermometer has a range of −50 °C to +250 °C. The temperature measurements from this device are shown in Table 1 as Tr1. Therefore, in this study two temperature measurements were made, which were both used for comparison to increase the reliability of the results.

Figure 3. Digital measuring device, HD 200 by Kimo Instruments.

The temperatures were recorded at the fifteen points indicated on Figure 1, and these were selected for their importance in the urban areas of the old town. Readings were done three times each day, at 12:00, 15:00 and 18:00 in the afternoon, so that there was a set of measurements from noon until late in the afternoon. The measurements were carried out for two months, from April 14 to June 14, 2022, a period during which the sun is intense and significantly affects the comfort of the users of the outdoor public spaces that we examined.

The temperatures were recorded by a person with a height of 1.75 meters and the digital measuring device during the measurements was at a height of 1.10 meters from the ground (Figure 4). Of the measurements made at the 15 points, only Tr1 and Tr2 temperatures were used for the research.

Figure 4. Method of operation and temperature measurement using the handheld thermometer at a height of 1.10 meters from the ground.

A single handheld measuring device was carried from one point to the next, always starting the measurements at 12:00 pm, 15:00 pm and 18:00 pm. So, the measurements were not done at the same time, and the time between the first measurements and the last ones was about half an hour, and increased as the weather worsened due to the delay in stabilizing the measurements of the device. Measurements were always made in the same order as the points are numbered. So, at each point they were done every day at approximately the same time and the three measurements started at 12:00 pm, 15:00 pm and 18:00 pm, without a large time difference.

The daily measurements for the three time points at the fifteen measurement locations shown in Table 2. Comparisons were made between the temperatures obtained from the averages of the temperatures of all days at each location, and at one of the selected time points. The comparison between the points was performed twice. The first temperatures were recorded by the black ball thermometer (Tr2) and the second with the built-in dry type thermometer of the hygrometer (Tr1). Measurements were made at locations that were reconstructed recently and compared with those done at earlier periods. The comparisons allowed us to determine if the granite paving blocks performed differently depending on their age, and whether the newer or older materials performed better.

3. Results

A comparison was made between points that were reconstructed in the same year, specifically in 1998, such as points 4 and 14. In addition, the comparison was made between points that were reconstructed within a few years of each other, such as point 4 (1998) and point 10 (1995) (Figure 1 and Figure 2). Readings were made at the same time each day, as well as when the two points were exposed to sun or in shadow. This choice was necessary to prevent the worst case of sun exposure from skewing the outcome. The comparison for points 4 and 14 was made at 12:00 pm when they were exposed to the sun, while for points 4 and 10 the comparison during sun exposure had to be made at 15:00 pm (Table 1).

Table 1. Sun exposure and shadowing at the measurement points.

	SUN EXPOSURE TABLE & SHADOWING OF MEASUREMENT POINTS - PERIOD FROM 14/4 TO 14/06/2022																
			ANTIKA SQUARE			PYG. CHRISTIDI & FILIPPOU			METROPOLEOS SQUARE			MATSINI SQUARE			PINDAROU - WATERMILL		
DATE	HOURS	DATA	POINT 1	POINT 2	POINT 3	POINT 4	POINT 5	POINT 6	POINT 7	POINT 8	POINT 9	POINT 10	POINT 11	POINT 12	POINT 13	POINT 14	POINT 15
YEAR OF GRANITE CUBE COATING CONSTRUCTION			BEFORE 1992			1998			2003			1995			1998		
PERIOD FROM 14/04 TO 14/06 MEMORANDUM	12:00	SYMBOLISM OF SUN EXPOSURE & SHADOWING OF THE POINTS	●	●	●	●	●	■	■	●	■	●	●	●	■	●	■
SUN ●	15:00	SYMBOLISM OF SUN EXPOSURE & SHADOWING OF THE POINTS	●	■	●	●	●	■	●	●	●	●	●	●	●	■	●
SHADOW ■	18:00	SYMBOLISM OF SUN EXPOSURE & SHADOWING OF THE POINTS	■	■	■	■	■	■	●	■	■	●	■	■	■	■	■

During this comparison it was found that the temperatures measured at the two points were very close to each other. The differences were less than 1.00 °C between points 4 and 14, as well as between points 4 and 10 (Figure 5).

Figure 5. Measurement points 4 and 10 that were reconstructed within a few years and 1 and 7 that were reconstructed over a long interval between each other.

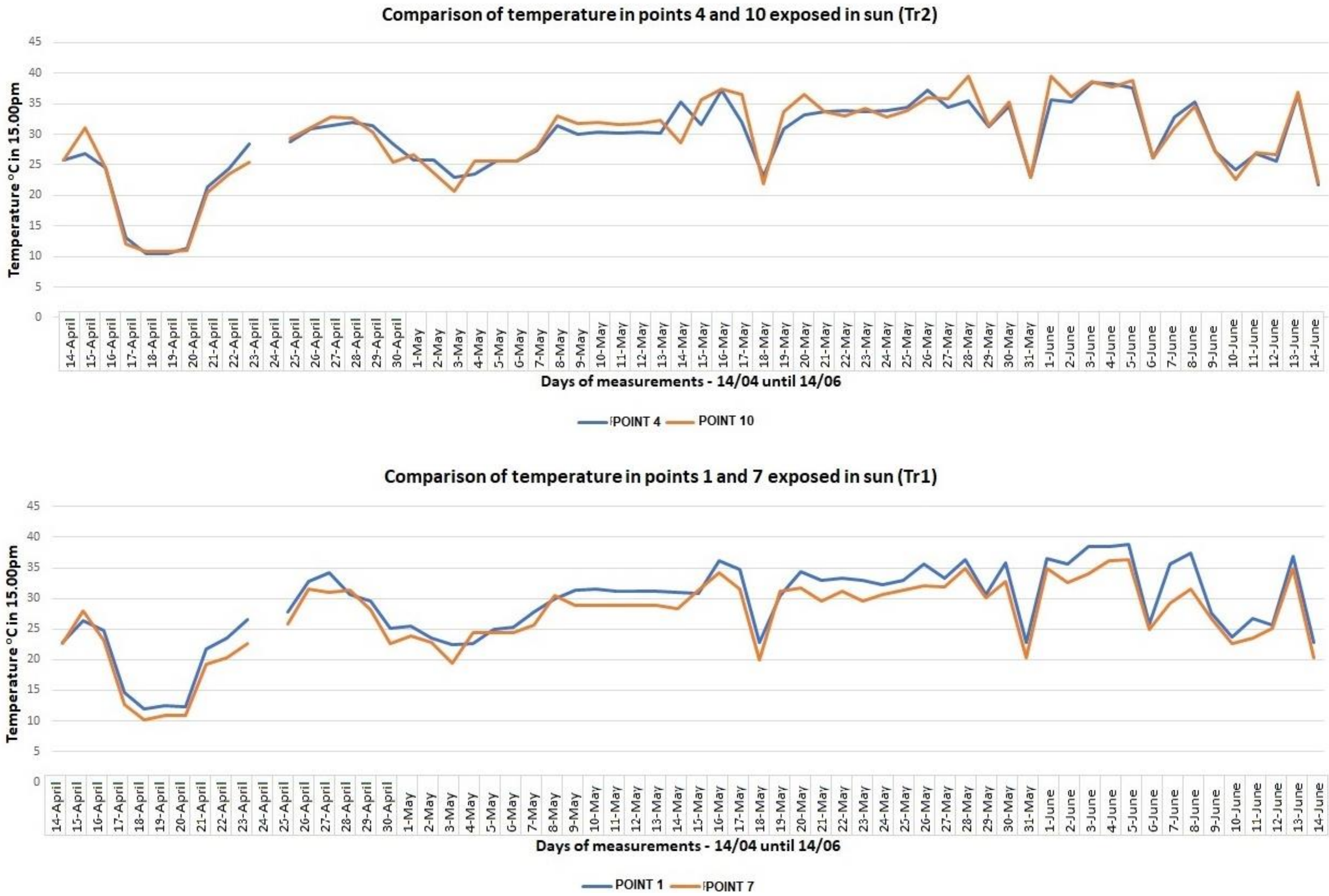

Figure 6. Linear graphs of temperature showing comparisons between two points.

The average temperatures recorded by the black ball thermometer for the 12:00 pm reading at point 4 was 28.92 °C and at point 14 it was 28.10 °C, with a difference of 0.82 °C. The average of the temperatures recorded by the built-in thermometer of the hygrometer for the 12:00 pm reading at point 4 was 26.99 °C and at point 14 was 26.40 °C, with a difference of 0.59 °C (Table 2).

Table 2. Two-day temperature measurements.

			INDICATIVE TABLE OF MEASUREMENTS																
			ANTIKA SQUARE			PYG. CHRISTIDI & FILIPPOU			METROPOLEOS SQUARE			MATSINI SQUARE			PINDAROU - WATERMILL				
DATE	HOURS	DATA	POINT 1	POINT 2	POINT 3	POINT 4	POINT 5	POINT 6	POINT 7	POINT 8	POINT 9	POINT 10	POINT 11	POINT 12	POINT 13	POINT 14	POINT 15	EMY	WEATHER
1/6/2022	12:00	RH %	22,70	24,40	23,40	28,80	26,20	28,10	30,20	28,10	26,10	26,80	26,80	30,10	28,90	27,90	29,60	36,00	
1/6/2022	12:00	WBGT ºC	25,90	26,40	26,50	26,10	25,90	26,00	25,30	26,10	26,00	25,80	25,90	25,60	25,40	25,10	25,10	<26,6	
1/6/2022	12:00	Tr1	37,00	37,10	37,60	35,30	35,90	35,40	33,80	36,20	36,40	35,70	36,20	34,40	34,40	34,50	34,20	29,00	
1/6/2022	12:00	Tr2	38,22	38,72	39,02	37,98	37,68	37,88	37,10	38,45	38,12	37,37	37,45	36,86	37,22	36,41	35,73		
1/6/2022	15:00	RH %	28,70	29,80	27,70	33,20	32,30	34,50	31,10	30,40	28,60	27,20	28,00	30,10	30,80	31,30	31,50	33,00	
1/6/2022	15:00	WBGT ºC	26,30	26,20	26,60	25,20	25,10	25,10	25,90	26,20	26,50	26,60	26,60	26,40	26,00	25,90	26,60	<26,6	
1/6/2022	15:00	Tr1	36,60	36,10	37,20	33,90	34,00	33,20	34,90	35,90	36,40	36,00	36,20	34,50	34,40	34,60	34,10	30,00	
1/6/2022	15:00	Tr2	37,51	37,88	38,83	35,62	35,68	35,13	35,63	37,32	38,03	39,48	39,64	39,27	37,53	38,03	37,87		
1/6/2022	18:00	RH %	29,70	30,50	28,30	35,00	34,20	35,50	33,10	31,50	28,70	28,30	29,10	30,60	31,70	32,40	32,60	31,00	
1/6/2022	18:00	WBGT ºC	26,40	26,50	26,80	25,50	25,50	25,60	26,10	26,40	26,60	26,50	26,50	26,40	26,00	25,90	26,30	<26,6	
1/6/2022	18:00	Tr1	36,70	36,50	37,20	34,10	34,40	33,60	35,40	34,20	34,30	35,10	34,20	34,40	33,10	33,30	33,10	31,00	
1/6/2022	18:00	Tr2	37,68	37,62	38,81	35,75	35,62	35,42	37,18	35,86	35,94	37,53	36,67	36,85	36,34	36,75	36,31		
2/6/2022	12:00	RH %	37,30	36,10	36,30	41,70	39,00	43,20	39,40	37,50	35,30	35,30	33,80	35,30	37,80	36,30	38,30	34,00	
2/6/2022	12:00	WBGT ºC	24,60	24,70	25,20	24,50	24,70	24,40	25,10	25,90	25,90	26,20	26,20	26,30	25,40	25,70	25,30	<26,6	
2/6/2022	12:00	Tr1	32,50	32,70	33,20	31,20	32,10	30,70	32,10	33,80	34,30	34,30	34,60	34,20	32,60	33,60	32,50	31,00	
2/6/2022	12:00	Tr2	32,43	32,85	33,84	32,72	32,57	32,61	34,51	34,40	34,68	36,36	36,48	36,88	35,53	35,07	35,10		
2/6/2022	15:00	RH %	32,60	33,70	30,90	36,50	35,30	37,70	33,20	32,30	31,70	30,40	30,90	31,60	34,10	34,30	34,60	27,00	
2/6/2022	15:00	WBGT ºC	26,20	26,00	26,30	24,90	25,00	24,80	25,70	25,90	26,20	26,30	26,30	26,20	25,10	25,10	25,00	<26,6	
2/6/2022	15:00	Tr1	35,70	35,30	36,10	32,70	32,00	31,80	32,60	33,40	33,20	33,90	33,50	33,80	33,20	31,70	32,80	33,00	
2/6/2022	15:00	Tr2	37,26	37,21	38,46	35,31	34,79	33,58	34,82	35,36	35,21	36,23	35,86	36,20	35,14	33,75	34,85		
2/6/2022	18:00	RH %	33,30	33,90	30,80	36,80	35,40	36,10	33,20	32,50	31,90	30,50	30,90	31,30	34,50	34,70	34,80	29,00	
2/6/2022	18:00	WBGT ºC	26,10	26,00	26,20	24,80	24,90	24,70	25,50	25,70	26,10	26,20	26,20	26,10	25,00	25,00	24,90	<26,6	
2/6/2022	18:00	Tr1	35,50	35,30	36,00	32,40	32,60	31,50	32,80	32,40	32,20	34,20	33,50	33,30	32,70	32,90	32,60	32,00	
2/6/2022	18:00	Tr2	37,13	37,24	38,38	35,14	34,79	33,58	35,14	34,79	34,62	36,41	35,46	35,35	35,47	35,57	35,64		

This can be explained by the riparian location of point 14 in comparison with point 4, which is located in the heart of the settlement with narrow streets and a large number of buildings. The average of the temperatures recorded by the black ball thermometer for 15:00 pm at point 4 was 29.00 °C and at point 10 was 29.32 °C with a difference of 0.32 °C. The average of the temperatures recorded by the built-in thermometer of the hygrometer for 15:00 pm at point 4 was 27.67 °C and at point 10 was 27.39 °C, with a difference of 0.28 °C (Table 2 and Figure 6).

In the comparison between points that were reconstructed at long intervals, between 1992 and 2003, the points selected were 3 to 8 and 1 to 7. Points 7 and 8 were reconstructed in 2003 and points 1 and 3 before 1992 (Figure 7). The measurements were made at the same time of day at 15:00 pm, while the areas were exposed to the sun (Table 1). As a result of this comparison, it was found that the two points had a large significant deviation in temperature (Figure 6).

Figure 7. Measurement points 1 and 3 with older granite cobbles and points 7 and 8 with newer granite cobbles.

There was a >1.0 °C difference in the averages of the temperatures of all days on which measurements were made, between points 3 and 8, and between points 1 and 7. The average temperatures recorded by the black ball thermometer at 15:00 pm for point 3 was 30.30 °C and at point 8 was 28.76 °C with a difference of 1.54 °C. The average of the temperatures recorded by the built-in thermometer of the hygrometer for 15:00 pm at point 3 was 29.00 °C and at point 8 was 27.16 °C, with a difference of 1.84 °C (Table 2).

Also, the average temperatures recorded by the black ball thermometer at 15:00 pm at point 1 was 29.81 °C and at point 7 was 28.52 °C with a difference of 1.29 °C. The average of the temperatures recorded by the built-in thermometer of the hygrometer at 15:00 pm for point 1 was 28.94 °C and at point 7 was 27.00 °C, with a difference of 1.94 °C (Table 2 and Figure 6). All four points are located in the old town of Xanthi in morphologically similar areas. The highest temperatures were measured above the older granite cobblestones.

4. Discussion

It has been found that the older granite blocks used for paving outdoor public spaces contributed to an increase in the air temperature above where they are located compared to newer granite blocks. The air temperature difference above older blocks compared to newer ones and in places with similar conditions in terms of orientation, building load *etc.*, reached 1.94 °C during the summer months when the measurements were made.

A significant positive correlation between solar radiation and temperature was found only from May to August [1]. For this reason, the measurements were made from April 14 to September 14, when solar radiation was expected to affect the results of the comparison.

The outcome of the comparison was not predictable, and measurements had to be compared to determine the change in air temperature above the older paved cobblestones in outdoor public spaces. The measurements were made at three times during the day, at 12:00 pm, 15:00 pm and 18:00 pm. These times were chosen because during the summer months the sun is at its highest point in the sky and its presence is felt most strongly. There were important reasons that the three time points were chosen for the measurements. The first was a practical reason. The handheld measurement device was taken from one point to another to make the measurements, and the process took about half an hour to complete the measurements at all 15 measurement locations in the old town of Xanthi. The order of measurements was always the same as that shown by the numbering in Figure 1. When there were clouds or the weather was not very good, the measurement time increased to as long as one hour, because there was a delay in the stabilization of the measurements of the handheld device. Another reason was that the measurements were chosen to be three hours apart in order to record any difference in temperatures due to the course of the sun. Even though the measurements were made with a single device and by the same person, it was not possible to make more measurement because of the time needed to move around the old city and complete the measurement process. Also, the time points before 12:00 noon and after 18:00 in the afternoon could not have a significant effect on the comparison of measurements, because in the morning and early evening, the path of the sun was low and the solar radiation was limited compared to midday hours.

Gray granite cobblestones are the main paving material and, with the slate slabs, are found in most of the public outdoor spaces of the preserved settlement of the old town of Xanthi. So, in the future we could measure the air temperatures above other paving materials with different ages, both traditional and modern and compare these to the granite paving stones.

Air temperature was found to be elevated during the summer months above outdoor public spaces paved with older granite cobblestones. So, this increase in temperature could potentially be reduced by replacing the older coated granite blocks with new ones.

5. Conclusions

The comparison was made between points that were reconstructed in the same year or in nearest years as well as between points that were reconstructed in distant years. Temperature readings were always made at the same time of day, 12:00 pm, 15:00 pm and 18:00 pm (Table 2). The measurements were made when the two points being compared were either both exposed to the sun or both in shadow.

The results of the comparison showed that the two locations with the nearest years of reconstruction, were very close in measured temperatures, with differences of 0.82 °C and 0.59 °C between points 4 and 14 and 0.32 °C and 0.28 °C between points 4 and 10. The comparison between points that were reconstructed in distant years showed a greater deviation in the measured temperatures, with differences of 1.54 °C and 1.84 °C between points 3 and 8 and 1.29 °C and 1.94 °C between points 1 and 7. Similar conclusions were found in the comparison of other points with corresponding conditions. Comparisons were made of temperatures recorded by both the black sphere thermometer and the built-in thermometer of the hygrometer.

As we have seen, the highest temperatures were measured above the older granite cobblestone pavers. This leads us to the conclusion, that the newer grey granite blocks respond better to summertime heat in creating comfortable conditions for users of the outdoor public areas where they have been placed. The temperature difference between the newer and the older granite blocks used for outdoor paving is >1.0 °C: respectively, 1.54 °C and 1.84 °C.

So, for environmental benefits especially in those areas where problems with increased summer temperatures have occurred, the replacement of the older granite blocks with new ones could be used to reduce the temperature to a more congenial level.

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