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Linear Parks along Urban Rivers: Perceptions of Thermal Comfort and Climate Change Adaptation in Cyprus

Elias Giannakis [1,*], Adriana Bruggeman [1], Dimitra Poulou [2], Christos Zoumides [1] and Marinos Eliades [1]

[1] The Cyprus Institute, Energy, Environment and Water Research Center, 20 Konstantinou Kavafi Street, Nicosia 2121, Cyprus; a.bruggeman@cyi.ac.cy (A.B.); c.zoumides@cyi.ac.cy (C.Z.); m.eliades@cyi.ac.cy (M.E.)

[2] Faculty of Early Childhood Education, National and Kapodistrian University of Athens, 13α Navarinou Street, Athens 10680, Greece; dimipoulou.1@gmail.com

* Correspondence: e.giannakis@cyi.ac.cy; Tel.: +357-22-208683

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Abstract: The development of green space along urban rivers could mitigate urban heat island effects, enhance the physical and mental well-being of city dwellers, and improve flood resilience. A linear park has been recently created along the ephemeral Pedieos River in the urban area of Nicosia, Cyprus. Questionnaire surveys and micrometeorological measurements were conducted to explore people's perceptions and satisfaction regarding the services of the urban park. People's main reasons to visit the park were physical activity and exercise (67%), nature (13%), and cooling (4%). The micrometeorological measurements in and near the park revealed a relatively low cooling effect (0.5 °C) of the park. However, the majority of the visitors (84%) were satisfied or very satisfied with the cooling effect of the park. Logistic regression analysis indicated that the odds of individuals feeling very comfortable under a projected 3 °C future increase in temperature would be 0.34 times lower than the odds of feeling less comfortable. The discrepancies between the observed thermal comfort index and people's perceptions revealed that people in semi-arid environments are adapted to the hot climatic conditions; 63% of the park visitors did not feel uncomfortable at temperatures between 27 °C and 37 °C. Further research is needed to assess other key ecosystems services of this urban green river corridor, such as flood protection, air quality regulation, and biodiversity conservation, to contribute to integrated climate change adaptation planning.

Keywords: nature-based solutions; linear parks; urban rivers; thermal comfort; urban heat island; micrometeorological measurements; field surveys; ordered logit model; urban planning

1. Introduction

More than half of the world's population lives today in urban areas, a proportion that is expected to increase to 66% by 2050 [1]. Urbanization is causing a myriad of problems, such as the loss of green space, increased surface runoff and flooding hazards, which have a negative effect on people's well-being. The changes in land use associated with urban development have increased storm runoff and have degraded riparian areas and natural flows of rivers and streams [2]. In the 19th and 20th centuries, many European cities channelled their streams into concrete sections or underground pipes [3]. These culverted rivers exhibit substantial flood risks due to the likelihood of blockages. The progressive surface cover modification of urban areas towards the predominance of non-evaporative surfaces, such as concrete and asphalt, has also contributed to the occurrence of the urban heat island (UHI) phenomenon [4]. Urban land uses with little vegetative cover are the most affected by the phenomenon [5].

The above problems are exacerbated by global climate change. Climate change projections indicate that summer heat waves in Europe will become more frequent and severe in the next decades [5] with substantially more adverse conditions prevailing in urban areas [6]. The number of extreme precipitation events is also expected to increase in a warmer future [7]. The Eastern Mediterranean region, where this study is located, is expected to be strongly affected by the continual and gradual future warming, with an increase of 3 degrees for Nicosia between 2010 and 2100 projected by the PRECIS regional climate model, which is based on the UK Hadley Centre HADRM3P model, for the IPCC SRES A1B emission scenario [8].

Nature-based solutions, including green roofs and walls, street trees, and green areas and corridors promote the green and blue spaces in cities and strengthen their capacity to better manage increased temperatures and flood hazards and adapt to climate change [9–11]. Urban green infrastructure is considered a major type of nature-based solutions and an important component of urban climate change adaptation strategies due to the multiple services and benefits it provides to city residents and urban ecosystems [12,13]. However, urban planning is constrained by the historical development of cities and towns, the multiple demands for space and the high value of urban land. Recognition of the hydrological, geomorphological, ecological, social, and cultural values of rivers and flood plains is an important step towards urban river restoration [2]. The importance of natural riparian areas in flood abatement is increasingly recognized [14]. Green areas along rivers promote the movement of plants and animals between habitat patches and support biodiversity conservation [15]. Urban parks can also contribute to air pollution attenuation [16,17]. The creation of green space around urban rivers and streams can improve environmental awareness and provide city dwellers with a convenient location for exercise and recreation.

The escalating pressures of urbanization and climate change and the increasing diversity of societal preferences create a variety of demands that urban parks should meet. Urban planners are increasingly stressing the need to take into account the perceptions of park users regarding the provided services in the design of urban green infrastructure [18]. The vegetation and design of parks can also have a strong effect on the cooling effects of urban parks [19]. A core challenge is to improve the quality and functionality of these spaces, which requires the assessment of the role of climatic conditions to individuals' thermal comfort and the identification of users' perceptions with urban park services. Although, several recent efforts have been conducted to reveal individual preferences for specific park services [20], very few studies apply an integrated and interdisciplinary approach that combines expertise from both natural and social sciences [21].

The largest increase of population will occur in urban areas of the developing countries of the world [1]. Cities in developing countries are also highly vulnerable to climate change threats [9–22]. Many of these cities are located in hot and dry climates with ephemeral streams that are sensitive to flash floods events. The narrowing of these streams, as a result of urbanization, will expose people to increased flood risks [23]. The rehabilitation and greening of urban streams has been studied mostly in the USA and Europe [24,25], while interest and appreciation for such green corridors has also been confirmed in recent studies in East Asian countries, e.g., China and Korea [26,27]. However, there is little scientific literature on the revitalization of ephemeral urban streams and the services of urban river parks in semi-arid environments.

The overall goal of this research is to contribute to the greening of ephemeral urban streams for the development of climate resilient cities in semi-arid areas. Our study is located on the semi-arid island of Cyprus, which is situated at the crossroads of Europe, the Middle East, and North Africa. A linear river park has been recently established along the ephemeral Pedieos River in the urban area of its capital city, Nicosia. This area has also been identified as an area of potentially significant flood risk, based on the assessments for the European Flood Directive (2007/60/EC). The specific objectives of this article are (a) to explore people's perceptions and satisfaction with the services and benefits of a linear river park at different vegetation cover locations; (b) to evaluate the thermal conditions that park users experience in summer, i.e., to explore how environmental parameters relate to park users'

thermal perceptions; and (c) to understand people's views on flood protection options in urban areas. Questionnaire surveys and micrometeorological measurements were used to assess people's opinions and perceptions about the services and benefits of nature in the city.

2. Methodology

2.1. Study Area

The ephemeral Pedieos River flows from an elevation of 1400 m above sea level in the Troodos mountains through the rural plains before it enters the urban areas of Nicosia (Figure 1). Flooding of the Pedieos River has been a recurrent phenomenon in the city's history [28]. A dam was constructed in the foothills of the mountains in 2002 to protect the downstream areas against flooding. However, the population of Nicosia city and its adjacent municipalities of Strovolos and Lakatameia has increased by 51% over the past 30 years [29], and storm water runoff from the growing urbanized area is increasing flooding hazards. The population of the three municipalities in 2011 was 161,263 inhabitants. Within the river basin, natural areas and cropland cover 8% of Nicosia, 10% of Strovolos, and 28% of Lakatameia, while the remainder is covered by built-up areas [30]. The built-up areas of all three municipalities are dominated by family houses and small apartment buildings (4–5 floors), with occasional blocks of flats (8–12 floors) and relatively little industry.

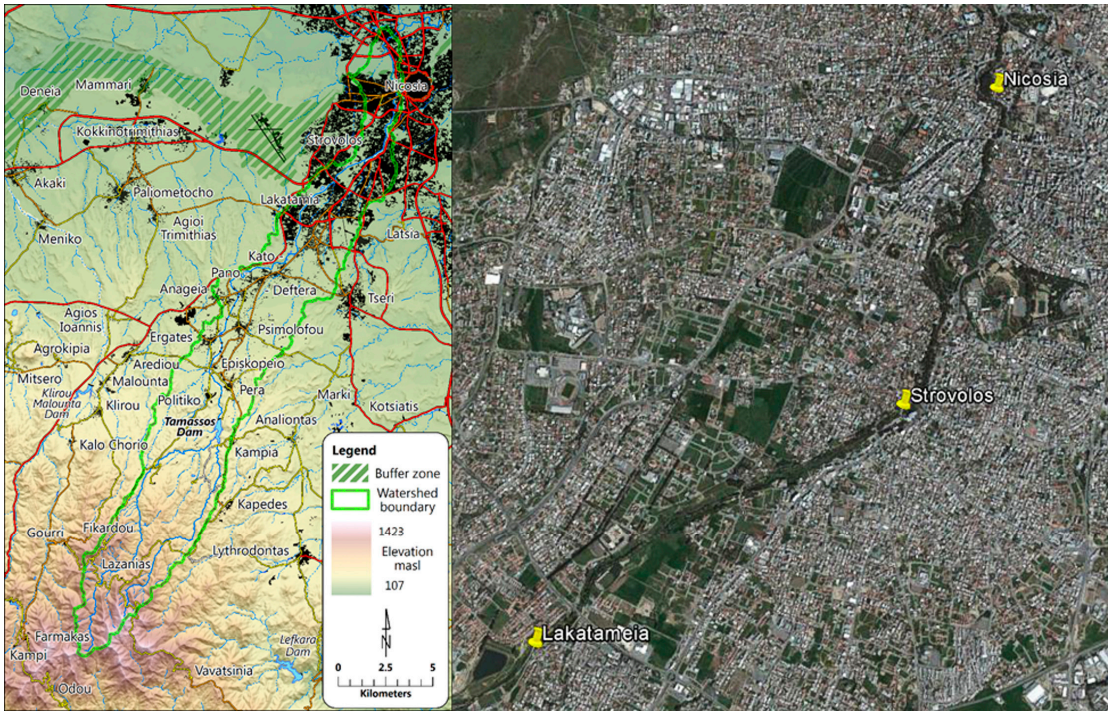

Figure 1. The Pedieos River Basin with the Tamassos Dam in the foothills and the urban area of Nicosia downstream (**left**); google earth image of the linear park in the urban areas of Nicosia and Strovolos (**right**).

Long-term average annual precipitation ranges between 670 mm on the top of the mountains to 360 mm in Nicosia (1980–2010). These low annual averages mask the extremes, which reached 196 mm/d in the mountains during this same period. Temperatures in the city are high with an average daily maximum temperature of 37 °C in July (1980–2010). Downscaled regional climate models indicate a hotter and drier Nicosia in the near future (2020–2050) [31].

The linear Pedieos Park, which was constructed between 1999 and 2014, runs for 9.5 km along the bed of the river. The park begins in the center of Nicosia city and passes through the

adjacent municipalities of Strovolos and Lakatameia. The park is narrow and shaded by large eucalyptus (*Eucalyptus camaldulensis* and *Eucalyptus gomphocephala*), pine (*Pinus brutia*), and palm trees (*Phoenix dactylifera* and *Washingtonia filifera*) along its first stretches in Nicosia (1.1 km), where it passes through a small forested area (1.4 ha) with a café. The path gains gradually in width in Strovolos, where it runs along the back of the gardens of the Presidential Palace. After about 3 km from its start in the city center, the path splits into a separate lane for walking and cycling. The river becomes wider and the path more open and less shaded. Suspended, steel-framed wooden pathways have been constructed at the narrowest parts of the river and inside the bridges that cross busy roads (Figure 2). Plans have been prepared to extend the park by 14.2 km, through the suburban and rural surroundings of Nicosia, all the way to the Tamassos dam at the foothills of the forested mountains (Figure 1).

Figure 2. Suspended pathways of the Pedieos Linear Park in Nicosia, showing the different heights of the built-up area next to the park.

2.2. Questionnaire Survey on Park Services and Thermal Comfort Perceptions

A questionnaire survey was designed to (a) elicit visitors' perceptions on Pedieos Park services and explore their overall satisfaction; (b) evaluate individuals' thermal comfort. The survey aimed to capture the views of a broad range of park visitors. Most questions used a five-point scale, namely, 1: "very dissatisfied"; 2: "dissatisfied"; 3: "neutral"; 4: "satisfied"; 5: "very satisfied". Similarly, visitors' thermal comfort assessment was based on the ISO 10551 [32] five-point scale affective evaluation, varying from "very uncomfortable" to "very comfortable".

The field survey was deployed for 28 days between 7:00 a.m. and 10:00 a.m. and 18:00 p.m. and 21:00 p.m., on both weekdays and weekends, during June and July 2014. At these times of the day, the park attracts most of its visitors. Government organizations and most businesses in Cyprus do not have long lunch breaks and people tend to remain indoors during the hottest parts of the day. As thermal comfort perceptions may be sensitive to vegetation cover [5,33], the field survey took place at three different locations in the linear park, representing high vegetation (Nicosia), medium vegetation (Strovolos), and low vegetation cover (Lakatameia) (see Figure 3). All passing park users were approached and invited for interviews, while anonymity and confidentiality was ensured. All respondents were older than 15 years old. In total, 305 questionnaires were completed.

Figure 3. Survey locations; **top left**: Nicosia (high vegetation cover); **top right**: Strovolos (medium vegetation cover); **down**: Lakatameia (low vegetation cover).

2.3. Micrometeorological Measurements and Human Discomfort Index

A small meteorological station was used to record the micrometeorological conditions that visitors experience in the park. The meteorological station was mounted on a bicycle and included temperature, relative humidity, and wind sensors. The data were recorded every 5 min, thus relating the response of each interviewee to specific temperature, humidity, and wind speed conditions. This allowed the assignment of a thermal comfort index value to each interview. The temperature measurements in the park were compared with those from a meteorological station in the built-up area of Strovolos, 180 m from the park.

Thermal comfort is defined as "the condition of mind that expresses satisfaction with the thermal environment" [34]. Several thermal comfort indices have been developed to evaluate human thermal comfort [35]. In this study, the Thom's Discomfort Index (DI) [36], a commonly used human bioclimatic index in urban climate studies [37–39], was used to evaluate discomfort conditions. The DI was calculated as follows:

$$\mathrm{DI} = T - 0.55\,(1 - 0.01RH)(T - 14.5) \quad (1)$$

where T: air temperature (°C), and RH: relative humidity (%).

2.4. Survey on Adaptation Options for Flood Protection

People's views on climate change adaptation options for flood protection were gauged in a follow-up survey in the linear park in October 2015. As part of the participatory development of a climate change adaptation plan for the Pedieos River Basin, a multidisciplinary group of expert stakeholders had identified flooding as the principal climate water challenge for the downstream urban areas. They suggested ten adaptation options for flood risk reduction, including nature-based solutions (green), hard engineering works (grey), as well as soft and managerial approaches [40].

These ten flood protection adaptation options were presented and explained to park users on two large colorful banners (Figure 4). Stakeholders were asked to evaluate the proposed options on a four-point scale, namely, 1: "not needed"; 2: "acceptable"; 3: "important"; 4: "very important".

Figure 4. Pedieos linear park users sharing their views on potential adaptation options for mitigating the impact of flooding.

2.5. Data analysis

Analysis of variance was employed to explore statistical significance between park users' responses and location. An ordered logit model was applied to assess if the relationship between the climatic conditions and people's thermal comfort perceptions was statistically significant. The dependent variable of the model represents the five thermal comfort perceptions of the park users. The highest category, i.e., very comfortable, is used as the reference category. The model estimates the cumulative probability of being in the chosen category versus all lower categories, i.e., comfortable, neutral, uncomfortable, very uncomfortable. All calculations were done in STATA 12 econometric software package.

3. Results

3.1. Descriptive Analysis

In total, 2659 visitors passed through the surveyed spots, of which 11% were interviewed. The average number of visitors per hour was 41. The maximum number of visitors per hour, that is 102, was observed at the high vegetation location during evening hours, while the minimum number of hourly visitors (10) was observed at the same location during a morning. It is interesting to mention that during weekdays the average number of visitors per hour (42) was substantially higher than during weekends (30). The individual characteristics and attitudes of park visitors along with some park characteristics are presented in Table 1. The majority of park visitors are aged between 41–60 years old, followed by the age group of 21–40 years. The sample was quite balanced in terms of gender, while the majority of the respondents visit the park more than once a week.

Table 1. Average number of visitors per hour at the three park locations and summary statistics of the characteristics and opinions of the 305 respondents.

Characteristics/Opinions	
Average number of visitors per hour	
high vegetation—morning	15
high vegetation—evening	63
medium vegetation—morning	20
medium vegetation—evening	42
low vegetation—morning	19
low vegetation—evening	62

Table 1. *Cont.*

Characteristics/Opinions	
Distribution of respondents	%
high vegetation	31
medium vegetation	30
low vegetation	38
Age	
less than 20 years old	6
21–40 years old	31
41–60 years old	44
older than 61 years old	20
Gender	
male	57
female	43
Frequency of visits	
first visit	4
more than once a week	94
few times a year	2
Climate change concerns	
yes	81
no	16
no opinion	3
Contributing to park maintenance	
yes	86
no	14
If yes, how:	
financially	12
voluntarily	58
both financially and voluntarily	28
other	2

3.2. Park Users' Perceptions of Urban Park Services and Satisfaction Levels

Respondents were asked in an open-ended manner to identify the three most important services of urban parks. All visitors specified at least one main service of urban parks, while 145 and 32 visitors identified a second and a third service, respectively (Figure 5). Enjoying nature had a significant place in the eyes of the park users since 43% mentioned this as the first service. Engagement in physical activities such as walking, jogging, and cycling, was considered the most important service by 34% of the visitors, while it was mentioned as a second or third benefit by 24% of the park users. The provision of a venue for socializing, interacting, and relaxing, including activities such as meeting friends and other people, was mentioned by 22% of park users as the first benefit of urban parks. Only 1% of the Pedieos Park visitors considered cooling as a primary benefit and 3% of the park users mentioned it as their second or third choice.

Respondents were then provided multiple choice options to indicate their reasons for visiting the Pedieos River Park. Respondents could select up to two choices. The major reason for visiting the park included physical activity and exercise (67%), enjoying nature (13%), cooling (4%), and socializing (3%), while close proximity was specified under the category "other" by 9% of the visitors. At the low vegetation cover location (Figure 3) only 1% of respondents visited the river park for observing nature, while at the high and medium vegetation cover locations the respective percentages were 22% and 21%. The low vegetation area, further from the city center, mainly attracted people interested in physical exercise (86%). The dominant physical exercise was walking, while 19 people were cycling and 15 people were jogging. The second most important reason for visiting the park, as specified by 177 responders, included observing nature (40%), physical activity (23%), cooling (15%), social interaction (12%), and other (10%).

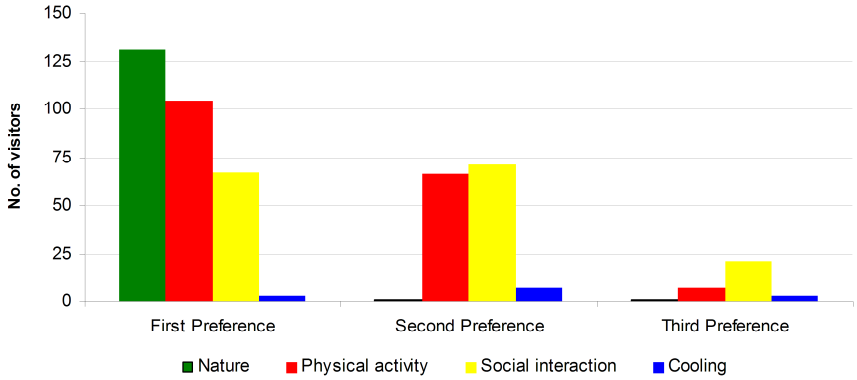

Figure 5. Users' perceptions of the most important services of urban parks (number of visitors).

It is interesting to note that users' own reasons for visiting the Pedieos Park did not always match their visions about urban park services. For example, of the 132 people who mentioned experiencing nature as the main service of urban parks, only 15 indicated this option as their first reason for visiting the Pedieos Park. Similarly, of the 40 people who mentioned cooling as their first or second reason for visiting the Pedieos Park, only seven had identified cooling as an important urban park service. Cooling was more often mentioned as a reason for visiting the park by responders in the more densely built-up urban area, with 45% of the 40 respondents in Nicosia and 40% in Strovolos, than by the visitors in the suburb of Lakatameia (15%). However, we have to note that open-ended questions were used for the general question on the services of urban parks, while close-ended questions were used for exploring the reasons for visiting the Pedieos Park.

Respondents were also asked to rate their satisfaction regarding the perceived park services. More than two-thirds of the respondents were satisfied or very satisfied with the facilities for physical activity and around 79% with the natural features of the park (Table 2). Similarly, the majority of respondents (84%) were satisfied or very satisfied with the cooling effect of the park, although only 11 people had reported this as their first reason for visiting the park. On the contrary, 37% of the visitors were dissatisfied or very dissatisfied with the park as a venue for social interaction. This relatively high level of users' dissatisfaction is reflected in their suggestions for improving the services associated with the park (Section 3.4). When considering only the people who had identified the respective service as their first reason for visiting the park, a slight increase was found for the mean satisfaction scores for socializing (3.4) and cooling (4.1), while scores for the other two services remained the same. It is also worth mentioning that none of the respondents at the high vegetation cover location were very dissatisfied with the "nature" and "cooling" services of the park.

Table 2. Satisfaction of park users to Pedieos Park services (% of 305 respondents and mean score).

Park Services	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied	Mean Score *
Nature	3	16	2	59	20	3.8
Physical activities	3	23	5	55	14	3.6
Social interaction	9	28	17	41	5	3.1
Cooling	1	11	3	69	15	3.9

* Five-point satisfaction scale ranging from 1 (very dissatisfied) to 5 (very satisfied).

3.3. Microclimatic Measurements and Thermal Comfort Perceptions

Ambient temperatures varied strongly throughout the June–July study period. However, our June survey days were hotter than usual. The average daily mean temperature at the meteorological station in Nicosia was 30 °C for both the June and the July survey periods, while the long-term daily mean temperatures for this station are 27 °C for June and 30 °C for July (1980–2010). Temperatures in August are nearly similar to July. Thus, our survey days were more representative for the July–August

period than for June. Analysis of variance indicated no significant differences between the temperature recorded halfway during the morning and evening interviews (8:30 a.m. and 19:30 p.m.) at the three locations (high, medium, low vegetation) and time slots (morning, evening). Evening questionnaire surveys were characterized by relatively higher air temperatures (29.2 °C vs. 28.1 °C, on average) and slightly higher wind speed (0.8 m/s vs. 0.3 m/s) compared to morning interviews. Similarly, average relative humidity was slightly higher in the evening compared to morning surveys (52% vs. 50%).

The measurements of the micrometeorological conditions in the park and in the built-up area near the park revealed a relatively low cooling effect of the urban park (0.5 °C). The highest differences were recorded in the park's medium vegetation location, which was close to the urban climate station (Figure 6). Here, temperatures were on average 1.5 °C cooler at 8:30 a.m. in the morning and 1.0 °C cooler at 19:30 p.m. in the evening, compared to the temperature in the built-up area. In the morning, temperatures at the low vegetation part of the park were on average 0.2 °C higher than at the urban station, while temperatures were 0.8 °C lower in the shaded, high vegetation location of the park. However, the evening temperatures were 0.4 °C lower at the low vegetation location in the less densely built-up suburbs than at the urban station, while they were the same at the densely vegetated location in the city center. The cooling effect of the park was highest on the hottest day, when the temperature in the park's medium vegetation location was 4.1 °C cooler at 8:30 a.m. in the morning (31.5 °C) than the temperature in the built-up area near the park (35.6 °C).

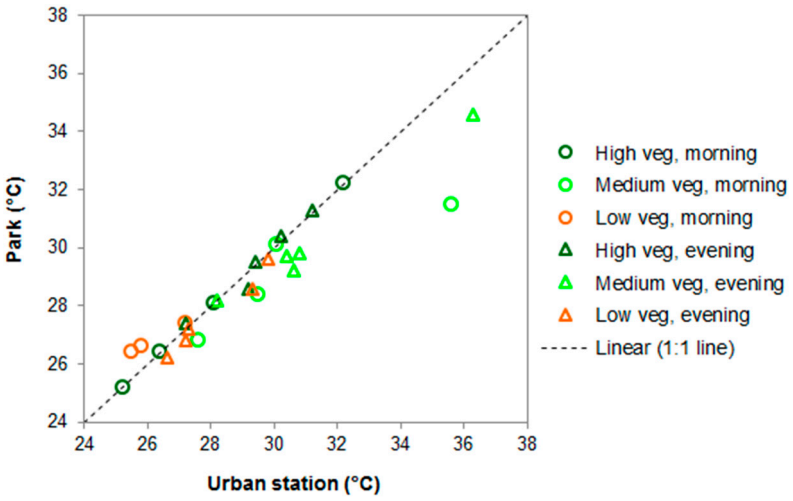

Figure 6. Temperature measurements at the three surveyed locations in Pedieos Linear Park and at the nearby urban station during morning (8:30 a.m.) and evening (19:30 p.m.).

The results of the ordered logistic model indicate that all three meteorological variables had a significant effect on the thermal comfort perceptions of the park users (Table 3). For a 1 °C increase in temperature, the odds of users feeling very comfortable versus the combined lower thermal comfort categories are 0.70 times lower, given that the other variables are held constant in the model. The odds of users feeling very comfortable would be 0.34 times lower than the odds of feeling either comfortable or neutral or uncomfortable or very uncomfortable for a projected increase of 3 °C between 2010 and 2100. On the contrary, the light wind speeds (WIND) observed, had a positive effect on the thermal comfort perception of park visitors. Individuals are 1.48 times more likely to feel very comfortable if wind speed increases. Finally, the effect of relative humidity (HUM) in the thermal perceptions of users is marginally negative. For a 1% increase in humidity, the odds of users feeling very comfortable versus the combined lower thermal comfort categories are 0.96 times lower. The variance inflation factor (VIF) was calculated to determine whether the explanatory variables are correlated. VIFs values ranged from 1.1 to 1.9, indicating a very low level of inter-correlation between the independent variables.

Table 3. Coefficient estimates of the ordered logistic regression model on park visitors' thermal perceptions.

Variables	Coefficients	Std. Error	*p* Value	Odds Ratio
TEMP	−0.363	0.063	0.000	0.70
HUM	−0.034	0.013	0.011	0.96
WIND	0.394	0.151	0.009	1.48

Thom's DI and the corresponding effects on human health can be classified into six classes ranging from DI values lower than 21 °C, which corresponds to no discomfort (class 1), to DI values equal or higher than 32 °C, which corresponds to state of medical emergency (class 6). In this study, the computed DI values fall into the classes 2, 3, and 4 (Table 4). The comparison of the subjective thermal comfort perceptions with the discomfort index values revealed great discrepancy between the two datasets. While the actual conditions of the linear park were at the "discomfort" level for more than the 50% of the population, only 19% of park users felt uncomfortable or very uncomfortable (Table 4). Similarly, while most of the people would suffer from discomfort according to the actual conditions, only 37% of visitors felt uncomfortable or very uncomfortable. These findings suggest that the park visitors in Nicosia are well adapted to the hot local climatic conditions.

Table 4. Thom's discomfort index (DI) classes [36], observed DI, and thermal perceptions of Pedieos Linear Park users.

Discomfort Index Conditions	DI Range	Number of Visitors	Park User Perceptions (%)				
			Very Uncomfortable	Uncomfortable	Neutral	Comfortable	Very Comfortable
Less than 50% of population feels discomfort	$21 \leq DI < 24$	63	0	3	8	57	32
More than 50% of population feels discomfort	$24 \leq DI < 27$	226	4	15	7	60	14
Most of the population suffers discomfort	$27 \leq DI < 29$	16	6	31	31	31	0

The results suggest that a maximum increase in temperature by 3 °C over the next 30 years would increase the average DI value from 25.1 to 27.2. This change of temperature could result in an increase of visitors feeling uncomfortable or very uncomfortable by 16% (DI 21–24) and 18% (DI 24–27).

3.4. Park Users' Suggestions for the Improvement of the River Park and Climate Change Adaptation

The riverbed has remained natural, except for a few small stone and concrete sections in Nicosia and at the crossing of roads. Almost all respondents (96%) agreed that the river park revealed the naturalness of the landscape. A similar number felt that the park's vegetation contributed to cooling. Half of the respondents considered the current vegetation fine. The other half suggested more or different vegetation, but no specific plant species were named. The percentage of park users that suggested planting more vegetation was higher at the low vegetation cover location (50%) than at the locations with medium (36%) and high (40%) vegetation cover, but these differences were not statistically significant. The majority of respondents (84%) were in favour of constructing a water body within the park, e.g., through the creation of a small dam, for cooling and aesthetic reasons.

Respondents' suggestions for improving the services associated with the park focused on improving infrastructure (43%) including more and better walking and cycling paths, and cleaning (30%). Specific suggestions included more water fountains (11%), more toilets (8%), more cafes (7%),

and more trees (6%). Respondents also mentioned the necessity of implementing regulations in terms of park aesthetics, e.g., dog faeces.

The majority of the park users (81%) were concerned about climate change. Respondents suggested various climate change adaptation actions including the use of renewable energy sources; in particular, they proposed the installation of solar panels and photovoltaics for the lighting of the park. They also highlighted the importance of protecting the environment by stressing the benefits of the trees and vegetation in the linear park. Some visitors suggested the installation of recycling bins in the park. A number of park users also mentioned the importance of water savings. However, nobody mentioned the role of the green area along the river for flood risk reduction.

It is interesting to note that the majority of park users (86%) stated that they are willing to contribute to the maintenance of the park either voluntarily or financially (Table 1). The average satisfaction score of the people who were willing to contribute was always slightly higher than that of the people who were not willing to contribute. The difference was greatest for physical activities (3.6 versus 3.2) and social interactions (3.1 versus 2.8). This finding indicates that satisfied park users are more inclined to contribute to the maintenance of the park.

3.5. Adaptation Options for Flood Risk Reduction

During the survey in October 2015, 84 users of the linear park, both women (56%) and men (44%), reviewed and scored ten climate change adaptation options for reducing flood risk. Even though the river was not flowing at the time, many people remembered the previous years' (2014) storm event, which flooded several parts of the cycling path. Nature-based solutions and managerial options were well perceived by park users as they received the highest score in terms of importance (Figure 7). Grey approaches to adaptation were also considered important but the overall average score was lower than the other two categories of options. The green option, restoration and maintenance of the riverbed, was the most important adaptation option according to park users' preferences (3.8), while the grey option, construction of technical flood protection works, was the least popular option (3).

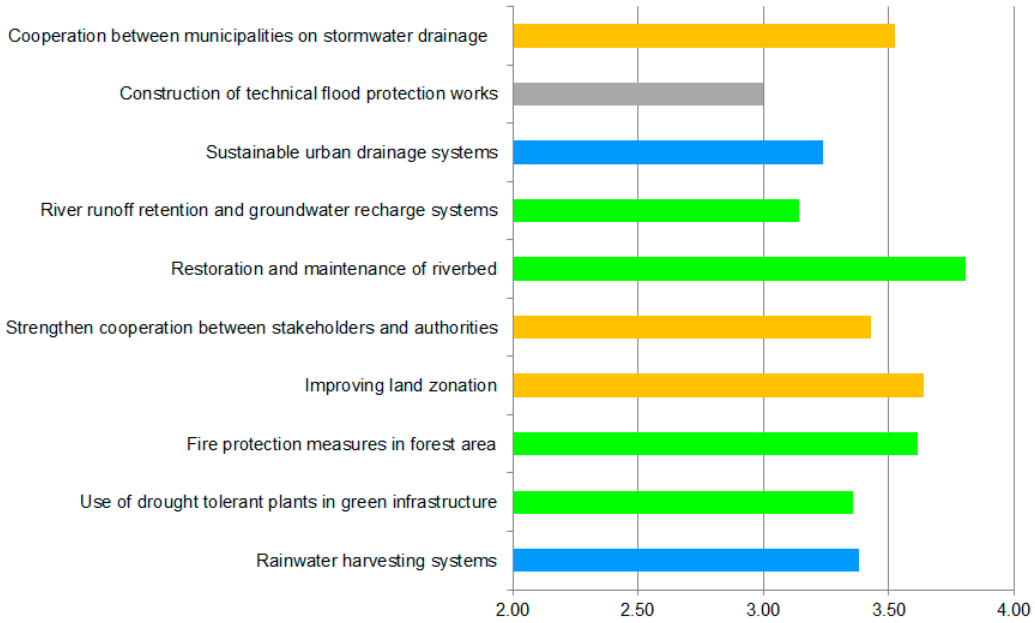

Figure 7. The average score of 84 park users' preferences on adaptation options for mitigating the impact of flooding. **Grey** options appear in **grey**, **green** options appear in **green**, managerial options appear in **orange**; options that can be both **grey** and **green** appear in **blue** (1 = not needed; 2 = acceptable; 3 = important; 4 = very important).

4. Discussion

Nicosia's Pedieos Park users primarily visit the park for physical activity and exercise. These responses are aligned with the findings of Irvine et al. [41], who found that physical activity and nature observation were the two main motives for visiting 13 public green spaces in Sheffield (UK). Similarly, Brown et al. [42] reported that linear parks tend to attract visitors for physical activities such as jogging, fast walking, and cycling. A meta-analysis of twenty-five studies provided evidence of the positive health benefits of a walk or run in a natural environment compared to a synthetic environment, including lower negative emotions such as anger, fatigue, and sadness [43]. Even though proximity was not included in the choices of the closed-ended question, 9% of the people mentioned it under other reasons for visiting the park. As Kaczynski and Henderson [44] point out, the proximity to parks is generally associated with increased physical activity levels.

Conversely, although the cooling effect of urban parks has been reported in several studies (e.g., [45,46]), only 4% of Pedieos linear park users visit it for cooling reasons. The micrometeorological measurements in and near the park revealed a relatively low cooling effect (0.5 °C) of the linear river park in the early morning and afternoon hours. The maximum cooling effect of the park (4.1 °C) was observed during the hottest day of the survey. Similarly, Oliveira et al. [47] found that a small green space (0.24 ha) in Lisbon was cooler than the surrounding areas, either in the sun or in the shade, with the highest difference in air temperature (6.9 °C) observed during the hotter days. Because of the ephemeral nature of the river and the upstream dam, as the Pedieos flows only during storm events, water remains standing in only in a few spots during part of the dry periods. The majority of the park visitors were interested in a small water body in the park. Sun and Chen [48] found a cooling effect with an average maximum temperature increase of 0.5 °C over 100 m for 197 water bodies in Beijing. On the contrary, a recent study in Rotterdam (The Netherlands) showed that water bodies could increase rather than decrease the UHI effect [49].

The differences between the park users' subjective thermal comfort perceptions and standard thermal comfort index values revealed that people are strongly adapted to the hot local climatic conditions. The adaptation of local residents to such hot and dry conditions may also influence their perceptions regarding the services and benefits of urban parks, i.e., the low preference for the cooling effect of urban parks, and the high preference for services such as experiencing nature, engagement in physical activities, and social interaction. Nikolopoulou and Lykoudis [50] provided similar evidence of adaptation to local climatic conditions in seven cities across Europe. Psychological mechanisms including parameters such as past experiences, expectations, preferences, and cultural processes may explain the variance between the objective and subjective assessment of thermal comfort [51].

Matzarakis et al. [52] applied the physiologically equivalent temperature (PET) thermal index, which is based on the energy balance of the human body, in various environments. They found that the PET within the trunk space of a forest in Freiburg was approximately 17 °C lower than at the grassland outside the forest at eight in the morning on a sunny day in June, while the PETs of the two locations were similar at eight in the evening. Interestingly in our study, no significant differences were found for the discomfort level during the morning and evening interviews and for the different vegetation cover locations. A future assessment of the newly developed universal thermal climate index (UTCI) [53] could provide more insights of the effects of different kinds of greenery on human thermal comfort.

The survey on climate change adaptation options for flood risk reduction revealed that park visitors understood the risk of flooding in the urban environment and they were more inclined towards green and managerial approaches to adaptation than grey approaches such as the construction of flood protection works. As Derkzen et al. [12] point out, understanding people's views on climate change and adaptation options is vital for prioritizing policy responses for climate adaptation. However, both Geneletti et al. [9] and Derkzen et al. [12] indicate the need for assessments and stronger evidence of the benefits and co-benefits of nature-based solutions versus other options. In addition,

Geneletti et al. [9] also points at the importance of mainstreaming and integrating nature-based climate adaptation measures in the urban planning process.

5. Conclusions

Questionnaire surveys and in-situ micrometeorological measurements were conducted in the Pedieos River Park in Nicosia, Cyprus, to explore visitors' perceptions and satisfaction with river park services and to assess the role of climatic conditions on human thermal comfort. Although urban river parks may only have space for narrow multi-use pathways, they can still attract a large number of visitors and urban residents. We recorded a maximum of 102 visitors per hour during the evening hours at the high vegetation cover location near the city center. Park visitors identified physical exercise as the main service of the linear park, followed by nature, cooling, and socializing. People also specified the close proximity of the park as a service. In the low vegetation cover location, exercise was the dominant park service. Park users' suggestions for climate adaptation options included environmental and nature protection, recycling, and energy and water savings, while the flood mitigating functions of the river park were not recognized. A follow-up survey on flood protection measures showed that park users opinions inclined towards green solutions.

Temperatures during the survey in the park ranged between 26 and 35 °C, with discomfort indices ranging between 21 and 29. However, 75% of the visitors rated their thermal comfort as comfortable or very comfortable. The thermal comfort assessment indicated that residents in cities in semi-arid environments, like Nicosia, may be adapted to the hot local conditions. Projected temperature increases due to climate change may, however, start affecting peoples' thermal comfort conditions.

Climate change threats provide a rationale for encompassing nature-based solutions into urban planning. There is a need to analyze and optimize the provision of all services of the greening of ephemeral streams in an integrated manner. To overcome the prevailing institutional barriers for urban river parks, which typically cross many municipalities and involve various sectors, cooperation of all competent authorities and organisations at national and local level, e.g., urban planners and municipal authorities, and water and environment authorities, is needed.

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