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Factors affecting the use of urban forests in Turkey

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Abstract: The aim of this paper is to find drivers behind visitor's participation in the use of urban forests and to explain the differences in co-operation in urban forest management with the help of game theoretic modeling. For this purpose, data regarding public urban forests of Turkey were collected and analyzed by various statistical methods. According to the principal component analysis, leading factors affecting the use of urban forest were, ordered from the most important to the least important: (1) forest versatility, (2) management intensity, (3) visitor services, (4) forest tranquility, and (5) forest activities. These five factors accounted for 71% of the total variance among the variables. Furthermore, multiple regression analyses showed that, especially in cities with an abundance of forests, the use of urban forests was not widespread, whereas urban forests were visited more in the settlements having a high number of young population and a large family size. The estimated game theoretic model on participation indicated that the availability of forest services among visitors was generally harmonious. It could be concluded that urban forestry has to focus, not only on increasing the number and size of urban forests, but also on educating all relevant social groups in society on how to use urban forests in a sustainable and responsible manner.
Keywords: Green infrastructure, Management, Urbanization, Recreation

Türkiye'de kent ormanlarının kullanımını etkileyen faktörler

Özet: Bu makalenin amacı, kent ormanlarının kullanımında ziyaretçilerin katılımını etkileyen faktörleri ortaya koymak ve kent ormanı yönetimindeki farklılıkları oyun teorisi modellemesi yardımıyla açıklamaktır. Bu amaçla, Türkiye'deki kent ormanları ile ilgili veriler toplanmış ve bu veriler farklı istatistik yöntemlerle analiz edilmiştir. Temel Bileşenler Analizi'ne göre, kent ormanlarının kullanımını etkileyen başlıca faktörler en önemliden en aza doğru (1) orman çok yönlülüğü, (2) yönetim gücü, (3) ziyaretçi hizmetleri, (4) orman rekreasyonu ve (5) orman aktiviteleri olarak sıralanmıştır. Bu beş faktör değişkenler arasındaki toplam varyansın %71'ini açıklamaktadır. Bundan başka, çoklu regresyon analizi özellikle ormanların çok olduğu şehirlerde kent ormanlarının çok kullanılmadığını buna karşılık genç nüfus ve aile birey sayısının fazla olduğu yerleşim yerlerinde kent ormanlarının daha çok ziyaret edildiğini göstermiştir. Katılımcı üzerine yürütülen tahmini oyun teorisi modeli ise ziyaretçiler arasındaki orman hizmetlerinden yararlanmanın genellikle uyumlu olduğunu göstermiştir. Bu çalışmayla, kent ormancılığının sadece kent ormanlarının sayısını ve büyüklüğünü artırmaya değil, aynı zamanda kent ormanlarının sürdürülebilir ve sorumlu bir şekilde nasıl kullanılacağı konusunda bütün ilgi gruplarını eğitmeye odaklanması gerektiği sonucuna ulaşılmıştır.
Anahtar kelimeler: Yeşil altyapı, Yönetim, Kentleşme, Rekreasyon

1. Introduction

Green areas have been an essential component of town and city planning over the last century (Ignatieva et al., 2011).Hence, urban forests are an important part of the green areas and provide various services, such as the reduction of carbon emission, amelioration of the microclimate, mitigation of air pollution and a number of intangible recreation possibilities (Jim and Chen, 2009). Besides, they also provide other benefits beyond aesthetics, namely limiting runoff, absorbing urban noise, improving human health, and providing wildlife habitat (Mansfield et al., 2005). The ecological role of urban forests has been considered more important than that of most other green spaces in cities, as they have always represented a nearby nature, a 'wilderness' at the urban fringe (Konijnendijk, 2008).

Since the 1950s, the urban population in Turkey began to increase. Today, 92.1% of population is living in metropolitan areas, cities, and towns. Public expectations from forest resources have changed together with the migration of people from rural to urban centers (Atmiş, 2004; Atmiş et al., 2007, 2012). The General Directorate of Forestry (GDF) began to consider urban forests from 2003 onwards, following the worldwide popularity of research on urban forestry. GDF initiated "the Project of Urban Forests" to meet the demand of city people from urban forests. The goals and criteria for establishing urban forests were explained via the booklet entitled the "New Approach in our Forestry: Urban Forestry".

Yet, there was no legal or administrative basis for urban forestry, due to the spontaneous start of GDF to work for the establishment of urban forests without sufficient consideration of scientific data (Çağlar, 2004).

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Subsequently, and rather suddenly, new directives were launched to establish urban forests in all provinces. Various authors observed that problems arose from poor planning, a rather random selection of urban forest locations and insufficient funding for attracting the right personnel. For instance, according to Coşkun and Velioğlu (2004) urban forests have remained mainly a "concept on paper" and it was not part of the planning process supported by legal regulations. Therefore, the criteria for establishing urban forests were inadequate (Elvan and Velioğlu, 2004). The basic needs and demands of those living in the city were not considered. Uncertainties among authorities were blocking the way to obtain a common vision among relevant stakeholders (Çağlar, 2004; Atmiş et al., 2012).

In fact, most of the research conducted on urban forests has not yet led to generally accepted practical guidelines and criteria, or into other types of policy and management instruments. Consequently, urban forest managers should have a basic knowledge of the forest structure and functions. Moreover, appropriate guidelines and criteria for effective urban forest management are needed. Assessing successful urban forest management also requires clearly defined targets, or criteria, and specific performance indicators of success (Kenney et al., 2011). In order to improve the management of urban forests, GDF registered the number of existing plants and available equipment in urban forests. Furthermore, open fires during picnics were banned in the "Picnic Spot Regulation" published in the Official Gazette dated 30 September 2006. However, this regulation alone was an insufficient legal and administrative basis for urban forests. In a recent regulation dated 2013 open fires during picnics were no longer restricted. In the "Promenade Application Notification" it has been stated that the regional directorates of forestry that have urban forests, may allow for open fires, taking into account visitor demands.

Academic studies on urban forestry in Turkey already began in the 1980s, even though these studies were quite rare. So far, a variety of scientific studies are either elaborating on a conceptual framework for urban forestry or study what has been done in Turkey on urban forests (Atay, 1988; Coşkun and Velioğlu, 2004; Gül et al., 2006; Gezer and Gül, 2009; Atmiş et al., 2011; Kurdoğlu et al., 2011). Besides these studies, Atmiş et al. (2007) showed that rapid urbanization increased the pressures on forests in Turkey and these pressures caused considerable adverse effects on the forests. The same article concludes that urbanites' interest in and knowledge of the forests should be increased, forest legislation should be developed to respond to expectations of urbanites from forests and to decrease urban pressures on the forests. New recreation areas should be developed to decrease the urbanites' recreation-oriented pressures on the forests. Likewise, Bekiroğlu et al., (2015) stressed that forest recreation areas played an important role in urban sustainability. It was also found that urban forests, established by the Forestry Ministry in all cities in Turkey in the early 2000s, should be well-planned and the users' profiles and needs to be taken into consideration. The aim of this paper is to find drivers behind visitor's participation in urban forest management with their determinants and explaining the differences in co-operation in urban forest management with the help of game theoretic modelling.

2. Material and methods

Population size of the study consisted of 64 urban forests established in Turkey as from 2010. In the current study full sampling was planned but taking into account that some urban forests are not open to the public, whereas other urban forests lack information, this study could only compile sufficient information on 52 out of the urban forests. Today, Turkey had more than 133 urban forests (GDF, 2015; Figure 1).

In order to provide an overall knowledge about urban forests in Turkey and contribute to the improvement of variables created in this study, we interviewed people from the forestry organization and representatives at the central and provincial level and examined various documents related to urban forests in the GDF archive in detail (covering a period from 2003 to 2010).

A part of the data has been obtained from other state organizations such as municipalities and Forest Regional Directorates through GDF. For this purpose, GDF assisted in the data collection process by sharing data from 27 Forest Regional Directorates. In this way, quantitative data has been collected with a form including the created variables between May and October 2010.

In total, 37 variables were derived from the available literature and interviews. These variables were grouped into six categories, namely (1) urban forest planning variables, (2) urban forest services, (3) urban forest administration, (4) urban forest general characteristics, (5) socio-economic characteristics and (6) usage of urban forests.

The variables in Table 1 can be further divided into the following categories:

- #1–15: variables describing the key decision factors in urban forest management. These variables will be interpreted as indicators of urban forest management (I). These will be aggregated (see below) into the main dependent variables.
- #16–35: explanatory variables that will explain the variation in the derived indicators of urban forest management (the hypothesised and expected sign in the regression analysis is shown in the brackets) and visitor numbers (see #36–37).
  - #17: Distance to the urban forest. The further the distance, the lower would be the level of participation (negative sign).

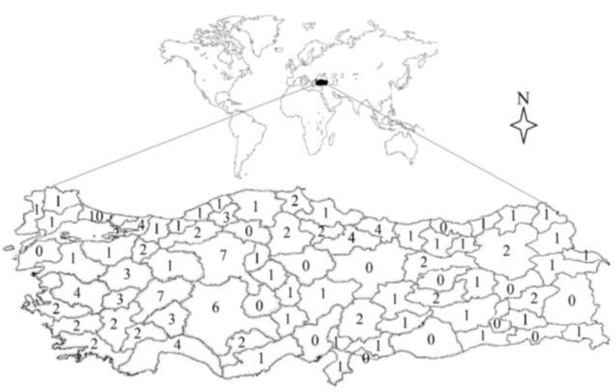

Figure 1. Location of Turkey and number of urban forests by provinces (Atmiş, 2016)

- #18 and #24 and #25: Size of the urban forest. The larger the size of the urban forest, the more visitors it would attract and a higher participation (positive sign).
- #19: Is the forest artificial (one) or natural (two). A higher number would attract less visitors and lower participation, due to protection status of natural forests (negative sign).
- #20: Number of limiting factors. A higher number would lead to a lower participation (negative sign).
- #21: Number of transport alternatives. A higher number would increase the number of visitors (positive sign).
- #22: Forest land not steep. More steepness decreases the access possibilities and would lead to less participation (negative sign).
- #26: Altitude of the forest. Forests at higher altitudes would be less accessible and lower participation (negative sign).
- #27 and #28: Temperature and number of rainy days. A higher temperature and more rain would it make more difficult to visit the forest and lead to lower participation (negative sign).
- #29: Population. A higher population number would lead to more visitors, but could lead to less participation (mixed sign).
- #30: Income. This variable influences the budget of the family. It is not a priori clear what the effect of a higher income would be on participation (mixed sign).
- #31: Education level. Higher education would lead to more participation (positive sign).
- #32: Age. Younger people tend to be more environmental conscious and therefore more participative (negative sign).
- #33: Household size. Larger families will be more negligent and less participative (negative sign).
- #34: Level of urbanisation. The impact on level of urbanisation on participation is unclear (mixed sign).

- #36–37: dependent variables explaining the demand for visitors to urban forests.

In this study the resulting data has been analyzed using principle component analysis (PCA) and multiple regression analysis (OLS). PCA has been employed to determine which factors describe the use of urban forest and also applied to reduce the number of variables into a few new representative uncorrelated integrated decision variables. Furthermore, an OLS has been undertaken to explain the drivers behind the decision variables obtained from the PCA. In this analysis, the usage level and average annual number of visitors of urban forests have been used as dependent variables too. These two dependents are included to study which variables increase/decrease the use rate of urban forests. This will show ways to promote and encourage urban forest use. These analyses were performed by using the SPSS program (SPSS Inc., 2011).

For studying the opportunities of local people to voluntarily participate in the management of urban forests adjacent to their cities, we propose a general non-cooperative game model, without specifying this game beforehand. The strategy is to choose the level of participation in urban forest management. Here participation measures how an urbanite perceives the organization in the city to manage an urban forest. A participating urbanite adheres to rules and codes of conduct that are prevalent in the city for urban forest management. This participation is awarded with the right of access to the urban forest from which they can reap benefits (=their net payoff). We refer to this situation as the participation game.

In order to formalize possible conflicts, which can emerge between urbanites, we will focus on the case with n urbanites contesting for access to the urban forest. Then we can distinguish between urbanite 1, the challenger, and urbanite 2, the contender, which is composed of all other urbanites contesting for the same urban forest. For that we need to assume that the challenger interprets the actions of other urbanites as a simultaneous move. Hence, we are dealing with a 1 versus n–1 person game (see also Lise, 2007).

The simplest form of such a game consists of only two persons, who have a choice between two alternatives: to participate or not. When both urbanites participate they obtain x. When one urbanite participates, while the other does not, the single participant keeps the urban forest rules, obtaining b, while the other does not follow the set rules, reducing the protection of the urban forest, obtaining a. This ‘cheating’ can be detected and deterred through ‘social fencing’, where the rule-abiding urbanite spots cheating. Finally, when both deviate, rules are not adhered to by both urbanites, obtaining y. Table 2 shows the resulting payoff matrix.

A possible outcome of this game is a prisoner's dilemma, where the dominating strategy is to not participate and deplete the forest, while it would lead to collective better results when both villagers would participate, keeping the regeneration rate of the forest optimal. Hence, the following inequality could hold:

$$a>x>y>b \tag{1}$$

It is also possible that there are other types of games.

For estimating the participation game we need to construct a triplet (π_i,θ_i,ϑ_i), where π_i is the payoff for urbanite i, measured as the use level urban forests (the variable LEVELUSE is shown in Table 1). Next, θ_i is the strategy for urbanite i, measured as the level of participation (chosen as the second factor as derived in the Section Factor Analysis). The strategy of the contenders, ϑ_i, which is the strategy of all other urbanites as perceived by the challenger, can be derived by taking the perception of forestry attributes, which is the first, third, fourth and fifth factor, as derived in Section Factor Analysis. The first, third, fourth and fifth factor is in a way the perception of the urbanites of the joint action of all other urbanites.

To interpret the value of the strategy, it is useful to normalise the strategy of the challenger θ_i and the strategy of the contender ϑ_i can be converted into a fraction between 0 and 1.

It is possible to assign the payoffs into four payoff groups by taking the average level of participation as the threshold value. We define values of θ_i and ϑ_i above the average as participative behaviour in the sense that an urbanite has a participatory attitude, while values of θ_i and ϑ_i below the average indicates that an urbanite is not participating. This simple way of splitting the payoffs can be referred to as the Mean Threshold Method. Assigning the payoffs is done as shown in Table 3.

Table 1. Names, labels, and units of the quantitative variables

No	Type	Names of variables	Label	Scale	Unit
Urban forest planning variables					
1	I	Number of tree species distributing in the urban forest	FLORA[2]	1 – 25	number
2	I	Number of coniferous tree species distributing in the urban forest	GYMNO[2]	0 – 9	number
3	I	Number of broad-leaved tree species distributing in the urban forest	ANGIO[2]	0 – 16	number
4	I	Number of animal species living in the urban forest	FAUNA[2]	1 – 12	number
Urban forest services					
5	I	Number of resting place types in the urban forest: bench, camellia or rain shelter	CHAIR	0 – 3	number
6	I	Number of observation place types in the urban forest: observation tower, observation deck	TERRACE	0 – 2	number
7	I	Number of sport service types in the urban forest: sports area, walking path, climbing path, bicycle path, children's playground	SPOR	0 – 5	number
8	I	Number of general service types in the urban forest: toilet, fountain, parking place, buffet	SERVICE	0 – 4	number
9	I	Number of information service types in the urban forest: information center, routing signs	INFORM	0 – 2	number
10	I	Functionalities of urban forest: health, recreation, aesthetics, flora and fauna info, sports	FUNCTION	1 – 5	number
Urban forest administration					
11	I	Number of personnel working in the urban forest	STAFF[1]	0 – 60	number
12	I	Number of technical personnel working in the urban forest	TSTAFF[1]	0 – 10	number
13	I	Management plan of urban forest	MANAGE	1 = no, 2 = yes	-
14	I	Number of protected areas outside urban forest used for recreation	PROTECT[5]	0 – 8	number
15	I	Number of picnic areas	PICNIC[5]	1 – 165	number
Urban forest general characteristics					
16	E	Time (year) since the establishment of urban forest	TIME[1]	1 – 6	years
17	E	Distance between urban forest and city center	DISTANCE[2]	1 – 40	km
18	E	Size of the urban forest	URFOREST[1]	8 – 1025	ha
19	E	Urban forest structural type (formerly or subsequently woody) of the area where the urban forest is established	STRUCT	1 = artificial 2 = natural	-
20	E	Limiting factors within the forest, like settlements, industries, highways	LIMIT	0 – 3	number
21	E	Number of transport alternatives from city center to urban forest	TRANSPOR	1 – 4	number
22	E	Average slope of the urban forest	SLOPE	1 = steep, 2 = partial steep, 3 = flat	-
23	E	Urban forest area per capita	PERURBAN[3]	0.11 - 105.87	m^2
24	E	The ratio of total forest area in the city to city area	FOREST[1]	0.5 – 68	%
25	E	Forest area per capita in the city	GREEN	0.01 - 35.96	m^2
26	E	Average altitude of province/county	ALTITUDE	2 – 1418	m
27	E	Average temperature	TEMPERAT[4]	8.86 - 19.23	^oC
28	E	Number of rainy days	RAINYDAY[4]	6.02 - 12.66	number
Socio-economic characteristics					
29	E	Province/county population	CENSUS[3]	0.01 - 12.92	number
30	E	Income per capita	GDPPC[6]	0.69 - 3.72	TL
31	E	Education level (share of educated people in the region)	EDUCA[3]	0.39 - 0.60	-
32	E	Average age of urban population	AGE[3]	23.16 - 39.12	number
33	E	Household size	FAMILY[3]	3.47 - 6.93	number
34	E	Urbanization ratio	URBANZTN[3]	0.43 - 0.99	%
35	E	Net migration rate	MOVE[3]	-35.23 - 12.84	%
Usage of urban forests					
36	D	The average number of visitors in urban forests	VISITOR[1]	100 – 20000	number
37	D	Usage level (annual average urban forest visitors as ratio of population)	LEVELUSE[1]	0 - 216.5	%

I = indicators of urban forest management for PCA, E = explanatory variables and D = dependent variables. The colored rows indicate variables that have been excluded from the analysis due to statistical reasons as explained in the text.
Variables with [1], [2], [3], [4], [5] and [6] codes in table are provided from GDF archives, GDF (2015), ABPRS (2010), TSMS (2010), MEF (2011) and SPO (2010), respectively. The non-code data are collected through forms and interviews.

Finally, the payoffs can be calculated by applying formula (2), where |X| denotes the number of observations in payoff-group X:

$$a = \frac{1}{|A|}\sum_{i\in A}\pi_i; b = \frac{1}{|B|}\sum_{i\in B}\pi_i; x = \frac{1}{|X|}\sum_{i\in X}\pi_i; y = \frac{1}{|Y|}\sum_{i\in Y}\pi_i \qquad (2)$$

Table 2. Payoff matrix of the participation game

		Urbanite 2: (contender)	
		Participate	Do not participate
Urbanite 1:	Participate	*x,x*	*b,a*
(challenger)	Do not participate	*a,b*	*y,y*

Table 3. Assigning the level of participation

Level of participation of challenger (θ)	Level of participation of contender (ϑ)	Payoff group
'participate'	'participate'	*X*
'participate'	'do not participate'	*B*
'do not participate'	'participate'	*A*
'do not participate'	'do not participate'	*Y*

3. Results and discussion

3.1. Principal component analysis

To study factors that influence the use of urban forest in terms of various aspects, a PCA is undertaken on thirteen indicators, namely FLORA, ANGIO, FAUNA, TERRACE, SPOR, SERVICE, INFORM, FUNCTION, STAFF, TSTAFF, MANAGE, PROTECT and PICNIC (see Table 4). These variables are selected for the PCA, because they represent three dimensions of urban forests, namely planning, services, and administration. And they are all decision variables.

The first five factors turn out to have eigenvalues with a value greater than one, leading to five factors. These five factors explain 71% of urban forest management. Variables GYMNO and CHAIR were included in the initial set of indicators, but were excluded later on, due to two reasons: (1) these indicators had no dominant factor loading in any of the five factors, and (2) the set of indicators was singular with these two variables present and became orthogonal after excluding them.

Interpretation of the results in Table 4 yields that the most important component of urban forests is related to *Forest Versatility*, in terms of tree species, picnic areas, functionality and number of protected areas, explaining 27% of the variance. There are six dominant indicators (factor loading larger than 0.5 in absolute terms). The first factor consists of both the number of tree species, broadleaved tree species, picnic areas, protected areas, functionalities of the urban forest and technical personnel working in the urban forest. Hence, the variety in tree species is part of the most important factor for managing the urban forest. This is not surprising, because the first item coming to mind when considered forests is their natural wealth. Plants are important elements of open-green areas in the urban space and perception of the environment (Eroğlu et al., 2012). It has been reported that visitors often prefer urban forests with a higher diversity of tree species over natural forests around the city (Clark et al., 1997; Nowak et al., 2006). In addition, it is stressed that species composition of urban forests is generally highly variable (Kenney et al., 2011; Peckham et al., 2013).

The second factor is considerably less important than the first factor, explaining 13% of the variance, and represents the *Management Intensity*, in terms of staff numbers and the presence of a management plan. There are three dominant indicators here, namely whether there is a management plan of the urban forest, the number of personnel and technical personnel working in the urban forest. Hence, having a well-staffed administrative unit (second factor), will certainly help to improve the management of urban forests. Likewise, a study that Gül et al. (2013) have conducted on urban forestry in Isparta of Turkey has shown that there were significant challenges because of the insufficient staff in urban forestry practices. Kenney et al. (2011) have also indicated that the optimal number of urban forestry personnel would vary among communities and a better criterion would address the training, skill, and experience of the staff. Again, they have suggested that a sustainable and optimally managed urban forest requires a broader range of skills and experience than taking care of trees. Likewise, Clark et al. (1997) have reported that an optimal indicator of success for sustainable forest management is a community that recognizes the environmental and economic contributions offered by the urban forest.

Visitor Services, in terms of general and information services forms the third factor, explaining 12% of the variation. There are two dominant indicators of participation in this factor. A high value in the third factor indicates a higher number of information and general services in the urban forest. Here urban forests with an adequate number of qualified information and orientation points, places such as toilets, fountains, parking places and small shops show that the needs of visitors are considered by the urban forest administration. This will also be a signal that the urban forest is managed well.

Forest Tranquility, in terms of lack of sport facilities and variety in number of animal species, would best describe the fourth factor explaining 10% of the variation. There is a positive factor loading to the number of animal species living in the urban forest, whereas there is a negative factor loading for the number of sport service types in the urban forest, which will generally be lower in a more 'tranquil' forest. Here, the number of available transport options to reach the urban forest would be lower for remote forests. The literature shows a negative relation between visitor frequency and distance (Schipperijn et al., 2010). However, the attractiveness of urban forests as a recreational environment is considered more important than the distance people need to visit an urban forest (Tyrväinen et al., 2004).

The fifth factor can be called *Forest Activities*, in terms of sport facilities and terrace viewing platforms and explains 9% of the variation. There are two factor loadings, namely the number of sport service types in the urban forest and observation place types. An urban forest having various activities is expected to attract more visitors. In addition, urban forests with a sufficient number and qualified sport areas, walking, climbing and bicycle paths, children's play area and observation points may be managed well too. Residents use urban forests for a variety of activities, such as recreation, exercise and playing (Lehvävirta et al., 2014). Urban forests in cities, where the ratio of forest area is high, have numerous forest activities (qualified sport areas, climbing, etc.) according to the results from the multiple regression analysis (see below).

Table 4. Principal component analysis based on thirteen indicators of urban forest management

	Factor 1 Forest Versatility	Factor 2 Management Intensity	Factor 3 Visitor Services	Factor 4 Forest Tranquillity	Factor 5 Forest Activities
FLORA	**0.880**	-0.008	0.265	0.167	0.044
ANGIO	**0.867**	-0.025	0.182	0.206	0.017
PICNIC	**0.642**	0.371	0.189	-0.138	-0.030
PROTECT	**0.578**	0.184	-0.226	0.079	0.210
FUNCTION	**0.564**	-0.001	-0.343	-0.409	0.064
TSTAFF	***0.547***	**0.655**	0.143	-0.162	-0.214
STAFF	0.107	**0.820**	-0.069	-0.060	-0.168
MANAGE	-0.031	**0.789**	-0.003	0.287	0.278
INFORM	0.014	0.136	**0.856**	0.095	0.030
SERVICE	0.203	-0.140	**0.700**	-0.158	0.028
FAUNA	0.234	0.124	-0.109	**0.778**	0.067
SPOR	0.069	0.139	-0.058	***-0.630***	**0.531**
TERRACE	0.089	-0.094	0.070	-0.019	**0.882**
Variance Explained	26.8%	13.1%	12.2%	10.3%	8.7%

Table 5. Multiple regression analysis results for ten dependent variables of urban forests

		Dependent Variables						
		Visitor	Leveluse	Factor 1 Forest Versatility	Factor 2 Management Intensity	Factor 3 Visitor Services	Factor 4 Forest Tranquillity	Factor 5 Forest Activities
	(Constant)	742013***	289	0.948	7.003	5.928	-8.489	-1.609
		(261941)	(240)	(5.956)	(7.460)	(7.594)	(7.523)	(7.274)
Independent Variables	DISTANCE	-683	-1.418**	0.006	-0.011	-0.003	0.025	-0.012
		(705)	(0.645)	(0.016)	(0.020)	(0.020)	(0.020)	(0.020)
	URFOREST (x 1000)	29962	5.207	0.069	-0.708	2.095**	-0.058	-0.049
		(34455)	(49.744)	(1.364)	(1.702)	(1.739)	(1.656)	(1.638)
	STRUCT	-10138	-10.708	0.238	0.466	-0.527†	-0.189	0.227
		(13087)	(11.972)	(0.298)	(0.373)	(0.379)	(0.376)	(0.363)
	LIMIT	3599	-4.488	0.221	0.255	0.21	-0.493*	0.111
		(9876)	(9.034)	(0.225)	(0.281)	(0.286)	(0.284)	(0.274)
	TRANSPOR	1230	-7.479†	-0.091	0.092	-0.260†	0.271†	-0.229†
		(5955)	(5.447)	(0.135)	(0.170)	(0.173)	(0.171)	(0.165)
	SLOPE	10735	7.492	-0.395*	0.172	0.221	0.125	-0.396†
		(9868)	(9.027)	(0.224)	(0.281)	(0.286)	(0.283)	(0.274)
	FOREST	-327	-0.482	0.013	0.002	0.016	0.015	0.032**
		(538)	(0.492)	(0.012)	(0.015)	(0.016)	(0.015)	(0.015)
	GREEN	1938†	2.563**	-0.017	0.017	0.015	-0.023	-0.024
		(1306)	(1.195)	(0.030)	(0.037)	(0.038)	(0.038)	(0.036)
	ALTITUDE (x 1000)	-50005†	-12.199	-1.085†	0.134	-0.261	0.006	1.269†
		(33106)	(30.284)	(0.753)	(0.943)	(0.960)	(0.951)	(0.919)
	TEMPERAT	-13643**	-3.479	-0.152	0.047	-0.029	0.033	0.054
		(6403)	(5.857)	(0.146)	(0.182)	(0.186)	(0.184)	(0.178)
	RAINYDAY	-9322	1.164	-0.329*	0.026	0.137	-0.25	0.044
		(7810)	(7.144)	(0.178)	(0.222)	(0.226)	(0.224)	(0.217)
	CENSUS (x 1000 000)	9947**	-6.188*	0.379***	0.02	-0.164†	0.025	-0.096
		(4000)	(3.659)	(0.091)	(0.114)	(0.116)	(0.115)	(0.111)
	GDPPC (x 1000 000)	7972	15.475†	-0.199	-0.275	-0.589*	0.039	-0.261
		(11675)	(3.378)	(0.093)	(0.116)	(0.118)	(0.112)	(0.111)
	EDUCA	96994	310.44†	5.475	1.936	-2.096	1.382	1.879
		(223066)	(10.276)	(0.282)	(0.352)	(0.359)	(0.342)	(0.338)
	AGE	-11352**	-9.637**	0.072	-0.235*	-0.159	0.179†	-0.084
		(4409)	(4.033)	(0.100)	(0.126)	(0.128)	(0.127)	(0.122)
	FAMILY	-25377†	-17.338	0.162	-0.671†	-0.53	0.674†	0.103
		(16725)	(15.300)	(0.380)	(0.476)	(0.485)	(0.480)	(0.464)
	URBANZTN	-28285	28.767	-1.791	0.943	4.235**	-0.131	2.08
		(65637)	(60.042)	(1.493)	(1.869)	(1.903)	(1.885)	(1.823)
R^2		0.543	0.383	0.563	0.314	0.289	0.302	0.348

The value in the brackets denotes the Standard Error; † $p < 0.20$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3.2. Multiple regression analysis

To explain the drivers behind the five factors describing urban forests in Turkey, we also undertake a multiple regression analysis. The following models are estimated by using Ordinary Least Squares (OLS):

$$\left.\begin{array}{l}\text{VISITOR}\\ \text{LEVELUSE}\\ \text{Factor}_i\end{array}\right\}\begin{array}{l} = \text{Constant} + \beta_1\,\text{DISTANCE} + \beta_2\,\text{URFOREST}\\ + \beta_3\,\text{STRUCT} + \beta_4\,\text{LIMIT} + \beta_5\,\text{TRANSPOR}\\ + \beta_6\,\text{SLOPE} + \beta_7\,\text{FOREST} + \beta_8\,\text{GREEN}\\ + \beta_9\,\text{ALTITUDE} + \beta_{10}\,\text{TEMPERAT} +\\ \beta_{11}\,\text{RAINYDAY} + \beta_{12}\,\text{CENSUS} + \beta_{13}\,\text{GDPPC}\\ + \beta_{14}\,\text{EDUCA} + \beta_{15}\,\text{AGE} + \beta_{16}\,\text{FAMILY}\\ + \beta_{17}\,\text{URBANZTN} + \text{error}\end{array} \qquad (3)$$

The above Equation shows that the five factors, which were found with the PCA, and two more variables (VISITOR and LEVELUSE) are used as dependent variables, because they are also good indicators for the pressures on urban forests. Equation (1) also shows the 17 variables used to explain the variation in (the use of) urban forests. These are descriptive variables, which cannot be changed by management decisions. These drivers consist of urban general characteristics and socio-economic characteristics. All variables in this group of seventeen variables turn out to be significant at least once in the seven estimated regression equations. Three more descriptive variables were considered, namely TIME (Year since the establishment of urban forest), PERURBAN (Urban forest area per capita) and MOVE (Net migration rate), however, these were never significant and therefore excluded from the regression analysis. The results of multiple regression analyses are presented in Table 5.

After giving an interpretation of Table 3 above, we discuss these results and compare with what could logically be expected, and also with other findings in the literature below.

1. Three variables are significant in explaining the variation in visitor numbers, namely, the average temperature (–), the population number (+) and the average age (–). The signs of these variables are given in the brackets.
2. It was found that the forest area per capita (+), the population number (–), distance from city center (-) and the average age (–) were significant to explain the variation in intensity of the urban forest use.
3. The slope of the urban forest (–), the number of rainy days (–) and the population number (+) were found

significant in explaining the variation in forest versatility.
4. The average age (–) is found to be significant in explaining the variation in management intensity of urban forests.
5. The size of the urban forest (+), the income per capita (–) and the level of urbanization (+) were found to be significant in explaining the variation in visitor services. In other words, in cities where the income per capita is high, urban forests have fewer visitor services.
6. The variation in forest tranquility can be explained by the number of limiting factors in the forest (–).
7. The ratio of forest area is the only significant variable to explain the variation in forest activities.

Multiple regression analyses have exhibited that the distance to the forest (DISTANCE), the number of limiting factors (LIMIT), the average slope of the forest (SLOPE), the average temperature (TEMPERAT), the number of rainy days (RAINYDAY), and the average age (AGE) have a negative sign when significant. This shows that especially in cities with an abundance of forests the use of urban forests is not widespread, whereas urban forests are visited more frequently in settlements having a large young population and immediate family. This is an intuitive result and therefore the included statistically significant variables have the expected sign. On the other hand, urban forests are used much more intensively in cities where the forest area per capita is lower. In places with various forests, the public can easily reach different green areas in addition to urban forests.

The forest area per capita (GREEN), urban forest per capita (UFOREST), and the total forest area (FOREST) all have positive signs. Hence, the number of tree species is higher in the regions where the forest area per capita is low and the number of protected areas used for recreation is high. Variability in urban forests is greatly appreciated by urban visitors, due not only to mixtures with other types of trees, but also due to the combination of trees with fields, meadows and, in particular, water bodies (Schmithüsen et al., 1997). Likewise, Ja-Choon et al. (2013) stated that among the six urban forest attributes, biodiversity was the most influential among Korean urban dwellers in their choice of urban forest recreation. Gundersen and Frivold (2008) also pointed out that visitor preferences for a forest are affected positively by increasing tree size and a more advanced stage of tree species development.

In cities where the income per capita (GDPPC) is high, urban forests are generally established in areas with formerly woody rather than those with subsequently woody. General sites with fresh logs (in terms of having natural characteristics) are considered more aesthetically appealing than sites with old or no logs (Hauru et al., 2014). Most visitors appreciate the idea of the naturalness of an urban forest, and the importance of ecological management has increased during the past decade (Tyrväinen et al., 2003). Moreover, Eroğlu et al. (2012) stated that socio-economic difference among people also results in different visual preferences.

Fragmentation of urban forests by roads, agriculture, urbanization, industries and other development may effect negatively their management. Small remaining fragments having the removal of original species from the system may result in extensive changes in the community structure, in the microclimate, in trophic associations and all other inter-specific relationships such as pollination, dispersion and competition, and result in biodiversity deterioration, both in terms of species and processes (Dislich and Pivello, 2002). In addition, Thomson (2014) has reported that the forest fragmentation process reduces the forest's function as a habitat for many plant and animal species. Furthermore, Tyrväinen et al.(2004) have stated that the more the urban forests become fragmented in a city structure, the more difficult it will be to reach the ecological objectives. Also, connectivity management of fragmented urban forest patches would be helpful to improve the habitats of forest birds (Song and Kim, 2016).In contrast, Lehvavirta et al. (2014) have announced that fragmentation effects might increase tree species richness in urban spruce dominated forests. Likewise, multiple regression analysis has shown that tranquil forests tend to be unfragmented due to a lack of roads, industries and urbanization.

3.3. Game estimation

The Mean Threshold Method as explained in the previous Section is applied to derive the participation games. In order to obtain insight in the assignment of payoffs to payoff groups, the choices of the challenger and the contender are plotted in Figures 2–5. The choice of the challenger, θ, represents the management intensity (factor 2). The choice of the contender, ϑ, represents the forest versatility (factor 1), visitor services (factor 3), forest tranquility (factor 4) and forest activities (factor 5); a high ϑ or θ is a positive perception, while a low ϑ or θ means a negative perception. Figures 2-5 show the result for the Mean Threshold Method where a division into four payoff groups is indicated by the thick lines.

Interpretation of Figures 2-5 already leads to an interesting outcome, namely that the most frequent occurrence of mutual participation is found with respect to management intensity and visitor services. This is shown in the figures by the concentration of data at the upper-right cell (= *X*) in Figure 3. *B* is the right lower cell, *A* is the left upper cell and *Y* is the left lower cell (this is also indicated in the figures by putting an upper-case letters in the four cells).

In a Pareto game it is optimal for the players to both participate (Lise, 2007). A battle-of-sexes game for the game on management intensity and forest tranquility implies that the optimal strategy of the challenger is to choose the opposite of the strategy of the contender (Table 6).

4. Conclusions

In this study, the PCA indicated that the most leading factors affecting the use of urban forests in Turkey were as follows: (1) *forest versatility*, (2) *management intensity*, (3) *visitor services*, (4) *forest tranquility*, and (5) *forest activities*. These five factors explained 71% of the variation among the indicators of urban forestry in Turkey. In addition, multiple regression analyses have shown that especially in regions with an abundance of forests the use of urban forests is not widespread, whereas visitors of urban forest tend to consist of young people and small families. The estimated game theoretic model on participation indicates that the availability of forest services among visitors is generally harmonious.

As the usage of recreational areas in cities with a large number of picnic areas and a large young population became institutionalized, urban forest management became more successful in those cities. This result stresses that experience with previous open-air recreation is needed to improve management of urban forests. Moreover, a newly established urban forest which includes a wide variety of tree species would better meet the needs of urban residents. In this respect, improvement of urban forests is needed in order to be able to provide sufficient services in terms of health, happiness, and success of urban population that is having more stressful social life and tired owing to the rise of technological innovations. In addition, it would be beneficial to establish and manage urban forests that provide multi-purpose services.

It can also be concluded that the General Directorate of Forestry has to focus, not only on rapidly increasing the number of urban forests, but also on instructing how to use urban forests to all relevant social groups in society in order to achieve a balanced result. For this purpose, awareness programs based on audiovisual methods, trainings, and workshops can be used.

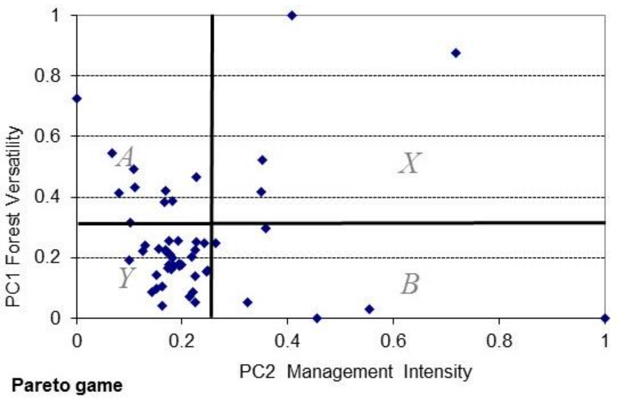

Figure 2. Scatter plot of the strategies forest versatility versus management intensity

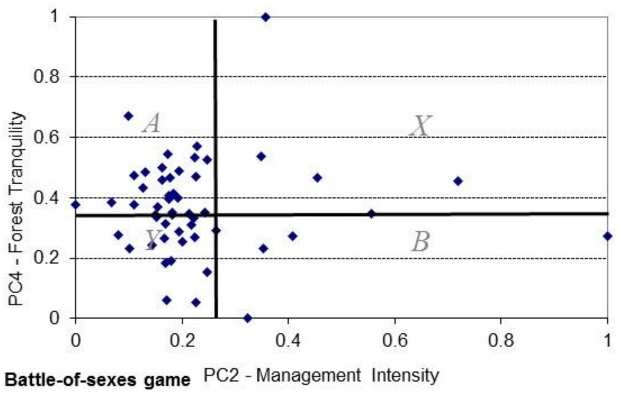

Figure 4. Scatter plot of the strategies forest tranquility versus management intensity

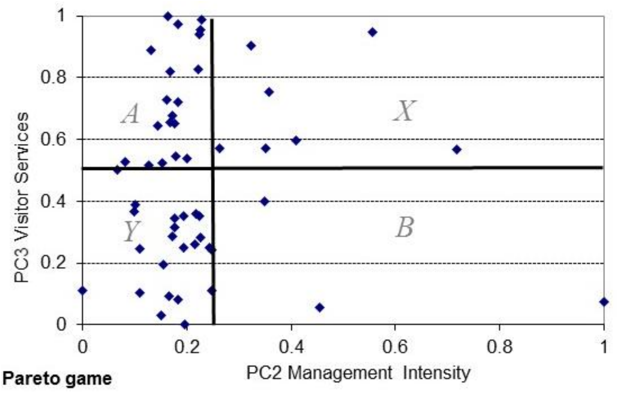

Figure 3. Scatter plot of the strategies visitor services versus management intensity

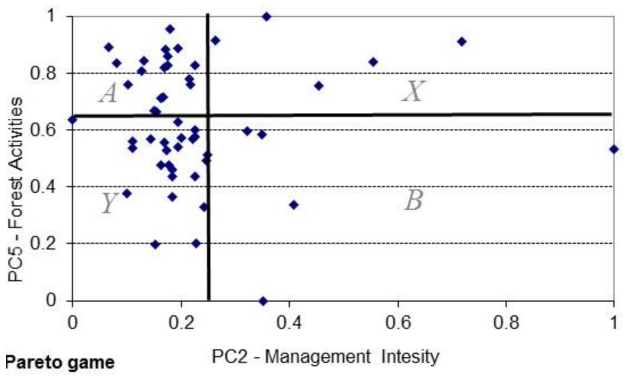

Figure 5. Scatter plot of the strategies forest activities versus management intensity

Table 6. Estimated urban forest games

	a	*b*	*x*	*y*	Payoff order	Name of the game
Management Intensity	8.5	37	23.9	12.3	*b>x>y>a*	Pareto game
Forest Versatility	(10)	(8)	(5)	(29)		
Management Intensity	7.6	20.7	41.6	15.2	*x>b>y>a*	Pareto game
Visitor Services	(20)	(6)	(7)	(19)		
Management Intensity	15.3	44.7	11.6	7.1	*b>a>x>y*	Battle of Sexes game
Forest Tranquillity	(20)	(8)	(5)	(19)		
Management Intensity	8.7	23.3	45.9	13.8	*x>b>y>a*	Pareto game
Forest Activities	(19)	(8)	(5)	(20)		

In conclusion, this study has drawn some preliminary management implications that highlight the need for developing a policy framework for urban forests in Turkey. Future work is required to better understand the complex relationship between urban people and urban forests. This need is apparent, in the urbanizing world, from which Turkey is no exception.

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