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Sustainable Proposal for Utilization of a University's Park and the Contribution of Different Types' of GPS for an Architecture Landscape Plan

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Abstract: Urbanization has brought city dwellers under stress; resulting in the renewal and development of open spaces to create urban green areas or remodeling existing ones; gives a breath of renewal in the wider area of an urban area. The aim of this paper is to demonstrate the appropriateness' of using handheld GPS for mapping urban green for developing regeneration proposals. Two different types of GPS and various topographic methods were used for comparing the results of field measurements with the "true value" - in our case was that of the KTIMATOLOGIO AE - because it gives acceptable by the State surveying quotes. The utilization of the park was based on the method of mild and low regeneration cost. The results of this research are given in two stages; the surveying and the planning. The surveying results from comparing measurements between two types of GPS and the Ktimatologio AE are within the industrial error of each instrument. As far as urban park planning and utilization in the campus of AUTH a reconstruction plan is proposed based on low cost in intervention on urban green.

Keywords: Sustainability, Utilization, GPS Types, Methods of Surveying Floss, Architecture Landscape Urban Plan

1. Introduction

The decade of 1960s, the development of the system Transit started, ancestor of the current GPS systems (Global Positioning System), by US government's organizations, including the military and NASA. In the beginning the reasons for the development of the system were for military applications (even today the operational control belongs to the USAF-United States Air Force). However in recent decades, political and geodetic applications have been developed. GPS is a global satellite system providing positioning in global coverage, all-weather and with high accuracy.

The purposes of this paper are: 1) to show how useful GPS surveying systems can be in topographical mapping of urban green 2) whether the differences in positioning are within the limit of topological errors and 3) if GPS systems can be used to plan reconstruction proposals of urban parks.

The creation of green areas and parks within urban spaces is necessary in our time, due to climate change, the greenhouse effect and the crowding of the population in urban centers. The reconstruction and development of these sites is very beneficial, because it gives a sense of renewal and alternation for both aesthetic and environmental reasons. This study aims to reflect the current situation of the park of the Observatory of AUTH and recommend gentle low-cost regeneration measures, because the rotation of planted links in urban green spaces, gives impetus to renewal within the urban centers.

2. Literature Review

The NAVSTAR / G.P.S. (Navigation Satellite Timing and Ranging - Global Positioning System) or simply GPS is a satellite-based global positioning system that uses coordinates of time and speed, anywhere on the Earth's surface or below it, in any time and regardless of the weather conditions. The system was designed in the 1970s, developed in the 1980s and is constantly under the control of the US Department of Defense (Department of Defense) (Fotiou and Pikridas, 2006).

The GPS belongs to the GNSS systems (Global Navigation Satellite Systems), such as the similar Russian system GLONASS (GLObal Navigation Satellite Systems) and promising purely political European GALILEO system.

Fixed points for creating topographic charts is a method used since ancient times. The use of geodetic, photogrammetric, satellite and other methods to capture and map an area are necessary to achieve the field measurements. (Papadimitriou and others, 2007, Doukas, 2002) makes reference to the necessity of land registration processes in forest cadastre. As "Urban Green" is mainly characterized the urban tissue space which is planned or is in development process of the city and has been evolved to remain without buildings and host some form of vegetation. The built-up areas have now flooded the surface of large cities, especially of megacities. The urban green is limited in parks or in rows on both sides of major roads, while the suburban green spaces have also declined dramatically with the continuous expansion of the building (mainly arbitrary) (Kassios, 2003). The importance of urban and suburban green is a climate forming factor of the city, which provides constant source of renewal of air, and a filter for large amounts of air pollutants (Dafis, 2001, Karameris 2009). The benefits of urban green range from physical and psychological in social cohesion and ecological balance, and conserve biodiversity (Fuller and Gaston, 2009).

The urban green, in the current times and in the conditions of big cities, should provide possibility of escape from the man densely built up environment in an area with other colors, shapes and sounds, cleaner air, milder noises, in a cool room, shady or simply sunny with blue sky or panoramic views. Stergiadou (2001) said that the development of space is a way of creative expression. It is a social necessity, economic and environmental, leading to the fulfillment of human needs. The combination of cartographic surveying of an urban green area using low-cost GPS and the redevelopment proposals of mild and low cost is required in our times, because in the present time of economic crisis it will also cover the socio-economic needs of the city inhabitants.

3. Research Area

As research area was chosen the Observatory Park on the campus of AUTH. The choice of the area was such because it is not only one of the busiest and popular areas of the University campus but also of the city of Thessaloniki generally. The site occupies an area of 19629, 29 m^2. The perimeter of the park of the Observatory, as it was measured by this study, is 513,1m. In the area stands the building of the Observatory, as well as the Jewish monument. There are two internal main streets, as well as two others that lead to the main entrance of the main building of the Observatory (fig. 1).

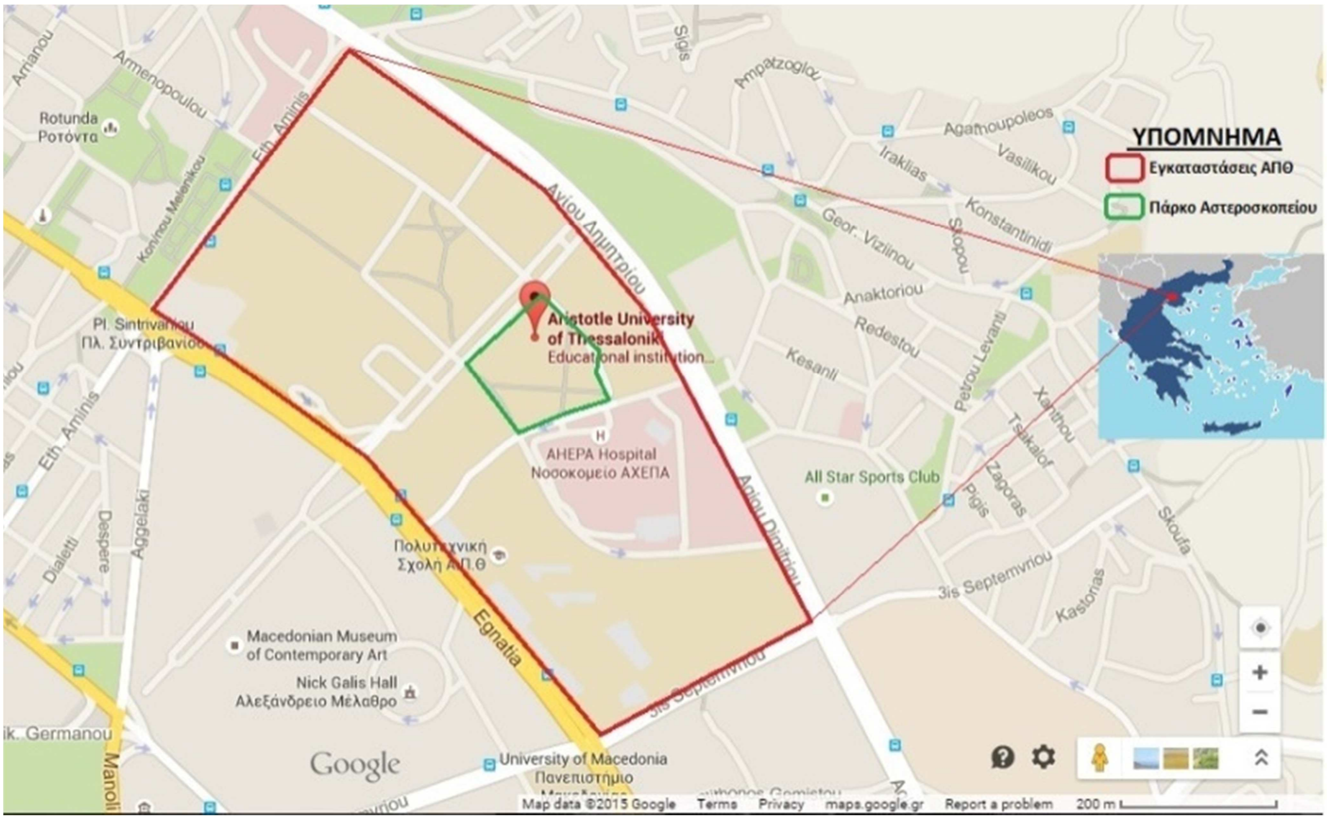


Figure 1. Location of Observatory Park on campus of AUTH (source: Google Map).

The vegetation consists of forest species (*Pinus nigra, Pinus Radiata, Cupressus Sempervirens* etc.) and rangeland vegetation (*Hordeum, Dactylis Glomerata, Lolium, Brumus, Poa,* etc.). The Park of Observatory represents the 13% of the total green campus of AUTH (Tab.1 & 2 and Fig.2 & 3).

Table 1. Green Park areas in the campus of AUTH.

TOTAL AREA OF AUTH CAMPUS	332388,94m^2	100%
GREEN AREA OF AUTH CAMPUS	151799,50m^2	45,67%

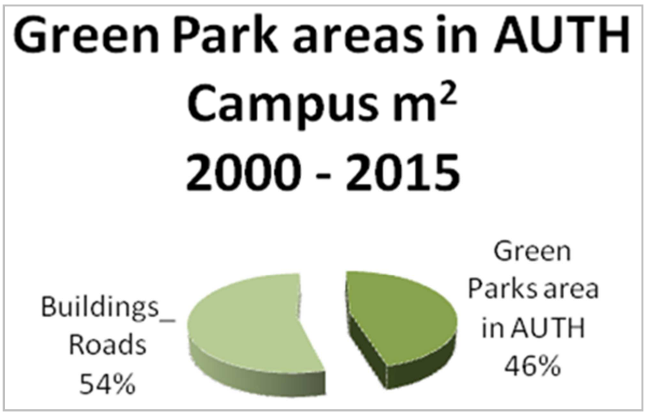


Figure 2. Green Ratio relative to the total area of AUTH Campus.

Table 2. Green Parks in AUTH Campus.

PARK NAME	GREEN AREA (m^2)
OBSERVATORY	19629,3
THEOLOGICAL SCHOOL	8915,088257
LIBRALY	1611,563232
METEOROSKOPIO	26962,27954
MEDICAL ACADEMY	6191,908691
PHILOSOPHY SCHOOL	8596,597627
UNIVERISTY GYM	66630,39698
FREE SPACES – SQUARE OF CHIMIO	13262,37525
TOTAL GREEN AREA	151799,5096

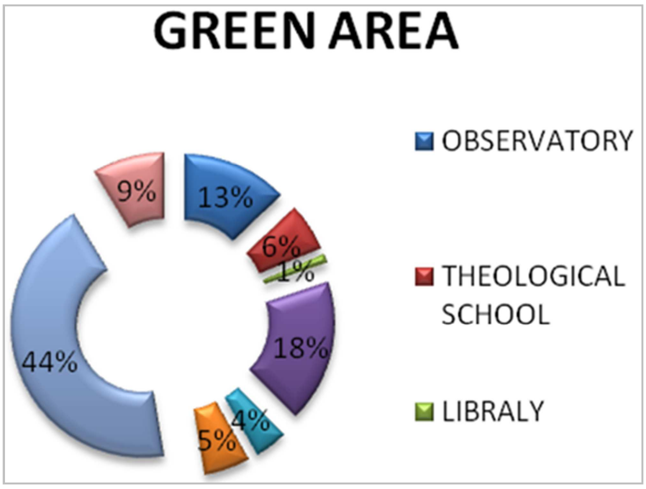


Figure 3. Green area's in the AUTH Campus.

4. Materials and Methods

Our research consists of two levels and therefore uses different materials and methods for completion of both studies, given in detail below:

4.1. Materials and Methods for Capturing the Park Observatory of AUTH Campus

The measurements were performed with: 1) GPS handheld Garmin eTrex Vista mapping and 2) with GPS for Android EGSA '87. Both two devices are in Class Handheld GPS, low cost, which is the issue in our times. The area was captured with the GPS perimeter initially and then inside with emphasis on key points (specific places-buildings) and internal roads. Also the area was measured using a measuring tape to calculate the length of the perimeter and internal roads.

Measurements took place at midday, with good weather, so we could avoid the error of multi-reflection, and in positions that do not impede the signal reception from the plants or by the existence of buildings in the area. To accept measurements within the factory errors of each instrument we have given each measure the necessary time to allow for the greatest possible number of satellites in each position. Thus higher accuracy was achieved, because of the resolution phase of satellites.

The measurement procedure was surveying each point as: X (East - C), Y (north - N) and Z (altitude - elevation). Also recorded the deviation of each position based on the measurements of each institution and the satellite geometry (Stergiadou et all, 2003).

The "true values" for comparison of differences between GPS handheld and preparing the topographic plan was received by KTIMATOLOGIO AE. All the measurements are in the coordinate system EGSA'87 (Greek Geodetic System 1987).

The purpose of the mapping was the cartographic representation of the terrain and the record of the accuracy of measurements based on Forest Cadastre (urban green) using suitable electro and satellite bodies (GPS). The method of comparison of measurement results with various handheld GPS was based on geodetic methods, particularly in the theory of errors by calculating the mean square error and the average squared error in order to find the deviations of measurements of the "true values" (Doukas K., 2004).

4.2. Materials and Methods for Proposing Redevelopment of Observatory Park

In urban centers there are three types of arrangement of green areas for optimum use of their potential: linear, radial and concentric. By Law no. 2508/1997 three basic types of urban renewal are provided depending on the intensity of urban and intervention: reconstruction, renewal and improvement.

Based on Legislation and also the type of users who visit the Observatory Park, we chose an intervention refreshing combination between linear and radial defining centered design the building of the Observatory. With this combination of landscape architecture we aim to achieve redevelopment of the park and the creation of recreational areas and relaxation for students, teachers and companions of hospitalized in adjoining AHEPAN's hospital.

5. Results

The results of this study are divided into two levels: 1) The reliability of handheld GPS measurements to capture urban green areas, and 2) The recreation landscape architectural plan of the Observatory Park.

5.1. Results for Imprinting with Two Types of Low-Cost Handheld GPS

Table 3. *Surveying perimeter points with GPS Garmin eTrex Vista mapping.*

POINT	X	Y	Accuracy AC (m)	ELAVATION	Distance from previous point (m)
P1	411829	4498070	5	52	0
P2	411817	4498057	6	51	15
P3	411811	4498048	5	50	15
P4	411800	4498034	5	50	15
P5	411789	4498025	5	48	15
P6	411785	4498016	5	47	7,7
P7	411785	4498015	6	46	2,1
P8	411771	4498002	6	46	15,5
P9	411769	4498001	5	46	2,2
P10	411762	4497996	5	45	15
P11	411747	4497981	7	44	12,9
P12	411747	4497983	6	43	3,1
P13	411745	4497982	6	42	1,9
P14	411757	4497967	6	44	15
P15	411769	4497959	8	45	15
P16	411775	4497954	7	44	8,1
P17	411773	4497954	6	42	6,6
P18	411786	4497939	6	43	15
P19	411804	4497916	7	43	15
P20	411810	4497907	5	44	15
P21	411810	4497898	5	45	13,3
P22	411810	4497905	8	44	2,4
P23	411817	4497909	6	45	2,4
P24	411834	4497902	6	46	15
P25	411836	4497912	7	48	15
P26	411850	4497915	7	49	15
P27	411869	4497915	6	49	15
P28	411884	4497923	5	50	15
P29	411896	4497927	6	50	18
P30	411914	4497935	6	52	15,4
P31	411923	4497934	6	54	6,8
P32	411922	4497943	7	49	6,3
P33	411919	4497940	7	47	5,6
P34	411922	4497951	7	43	15
P35	411913	4497968	7	44	15
P36	411911	4497979	5	45	15
P37	411911	4497989	8	45	15
P38	411895	4498011	5	47	15
P39	411877	4498033	6	47	19,2
P40	411877	4498029	7	48	3,8
P41	411872	4498024	5	49	15
P42	411854	4498056	5	50	15
P43	411852	4498062	5	50	15
P44-P1	411830	4498070	6	52	14,8

Based on GPS handheld Garmin eTrex Vista mapping was depicted originally forty four (44) points of the perimeter of the park Observatory (Table 3). Table 3 with bright color displays brand GPS-handheld points Garmin e-Trex Vista mapping, which are common with those of surveying with GPS android EGSA'87 (Table 4) and the KTIMATOLOGIO AE (Table 5).

The surveying results of GPS android EGSA'87 are given in details at Table 4 and also for the same points are given the coordinates from the official webpage of KTIMATOLOGIO AE in the Table 5.

Table 4. *Surveying points by applying Android «EGSA'87".*

POINT	X	Y	Accuracy (m)
A1	411831,672	4498069,596	1,07
A2	411746,692	4497979,239	1,13
A3	411807,981	4497899,158	1,03
A4	411926,187	4497932,895	1,51
A5	411919,105	4497932,879	1,39
A6	411931,789	4497952,415	1,69
A7	411898,324	4497997,910	1,33
A8	411878,154	4498031,797	1,55
A9	411833,456	4498072,987	1,31

Table 5. *"True values" KTIMATOLOGIO AE.*

POINTS	X	Y
K1	0411830,51	4498073,02
K2	0411740,55	4497980,41
K3	0411810,67	4497891,78
K4	0411926,42	4497930,14
K5	0411625,10	4497936,75
K6	0411928,41	4497947,34
K7	0411902,61	4497998,93
K8	0411876,15	4498025,39
K9	0411832,50	4498073,68

Within the Observatory Park in order to geo-referenced we counted another three points given in Table 6.

Table 6. *Mapping of specific internal points with GPS Garmin eTrex Vista mapping.*

POINTS	X	Y	Accurasy (m)	ELEVATION (m)
Observatory Park	0411782	4497977	6	38
Israeli Monument	0411820	498037	8	43
Proposed Park's Position 0	0411825	4497931	6	37

We worked the field measurements by the method of the theory of errors, involving comparison between field measurements and the "true value" which led us to the following tables (7, 8, 9), the corresponding diagrams (3, 4, 5) and of course the appropriate conclusions in each case.

Initially we compared each GPS handheld with the "true value" of the KTIMATOLOGIO AE and then all together to find the differences and decide what is the most suitable for low-cost surveys in the urban fabric.

Table 7. *Mean square error of measurement between KTHMATOLOGIO AE & GPS Android EGSA'87.*

points	KTIMATOLOGIO Coordinates		GPS Android EGSA '87 Coordinates		Difference U		Average Square Error $\mu\tau = \pm ((\upsilon\upsilon)/(n-1))^{0,5}$	
	E_{Θ}	N_{Θ}	E_{GPS}	N_{GPS}	E_{Θ}- E_{GPS}	N_{Θ} - N_{GPS}	E	N
K1-A1	411830	4498073	411831,67	4498069,6	-1,672	3,404		
K2-A2	411740	4497980	411746,69	4497979,24	-6,692	0,761		
K3-A3	411810	4497891	411807,98	4497899,16	2,019	-8,158		
K4-A4	411926	4497930	411926,19	4497932,9	-0,187	-2,895		
K5-A5	411925	4497936	411919,11	4497932,88	5,895	3,121	$\mu_{\tau E} = 0,738$	$\mu_{\tau N} = 1,408$
K6-A6	411928	4497947	411931,79	4497952,42	-3,789	-5,415		
K7-A7	411902	4497998	411898,32	4497997,91	3,676	0,09		
K8-A8	411876	4498025	411878,15	4498031,8	-2,154	-6,797		
K9-A9	411832	4498073	411833,46	4498072,99	-1,456	0,013		
					-4,36	-15,876		

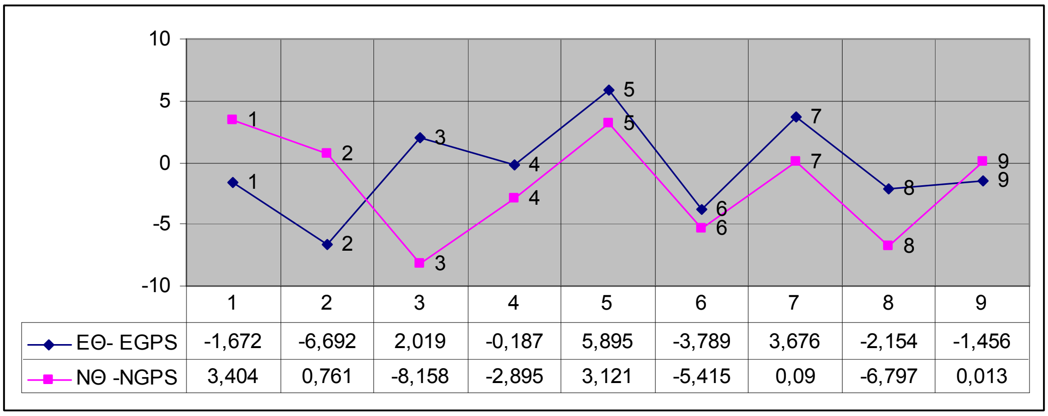


Figure 4. *Evaluation of accuracy of E and N coordination for GPS Android EGSA'87.*

Table 8. *Mean square error of measurement between KTHMATOLOGIO AE & GPS Garmin eTrex Vista mapping.*

Points	KTIMATOLOGIO Coordinates		GPS GARMIN-eTrex Vista Mapping Coordinates		Difference U		Average Square Error $\mu\tau = \pm ((\upsilon\upsilon)/(n-1))^{0,5}$	
	E_{Θ}	N_{Θ}	E_{GPS}	N_{GPS}	E_{Θ}-E_{GPS}	N_{Θ} -N_{GPS}	E	N
K1-P1	411830	4498073	411829	4498070	1	3		
K2-P12	411740	4497980	411747	4497983	-7	-3		
K3-P22	411810	4497891	411810	4497905	0	-14		
K4-P31	411926	4497930	411923	4497934	3	-4		
K5-P32	411925	4497936	411922	4497943	3	-7	$\mu_{\tau E} = 0,353$	$\mu_{\tau N} = -1,118$
K6-P33	411928	4497947	411919	4497940	9	7		
K7-P37	411902	4497998	411911	4497989	-9	9		
K8-P40	411876	4498025	411877	4498029	-1	-4		
K9-P44	411832	4498073	411830	4498070	2	3		
					1	-10		

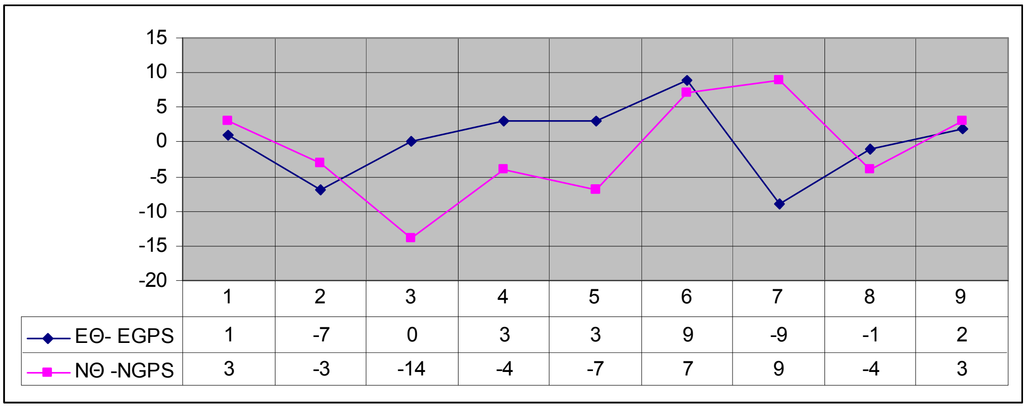


Figure 5. *Evaluation of accuracy between E & N coordinates GPS Garmin eTrex Vista.*

The gaps between the field measurements with GPS Android EGSA'87 per location and the corresponding "true values" of KTIMATOLOGIO AE, do not exceed the acceptable error factory 5 meters relative to East, but as to the north we have two points diverge significantly. The first gap was at point: K3 ~ A3; due to canopy cover and the second (K8 ~ A8) due to the phenomenon of multi-reflection, because it is between the buildings of AHEPA's Hospital and the Faculty of Engineering.

The gaps between the field measurements of GPS Garmin eTrex Vista mapping and the corresponding "true values" from KTIMATOLOGIO AE, mostly do not exceed acceptable factory error of 5 meters to the East as in most respects except one (K7 ~ P37) because it is located between the buildings of AHEPAN's Hospital and the Polytechnic School and because of the phenomenon of multi-reflection. In the North we have two points diverge significantly. The first gap was at point K3 ~ A22 due to the canopy cover and the second gap was at point K7 ~ P37 due to the phenomenon of multi-reflection; because it is located between the buildings of AHEPA's Hospital and the Polytechnic School, and also due to the symmetry of satellites.

Table 9. *Comparison between field measurement of GPS Garmin eTrex Vista mapping & GPS Android EGSA'87 & KTHMATOLOGIO AE in East.*

$E_{GPS-EGSA'87}$	$E_{GPS-GARMIN\ eTrex}$	X KTHMATOLGIO AE
411831,672	411829	411830,51
411746,692	411747	411740,55
411807,981	411810	411810,67
411926,187	411923	411926,42
411919,105	411922	411625,1
411931,789	411919	411928,41
411898,324	411911	411902,61
411878,154	411877	411876,15
411833,456	411830	411832,5

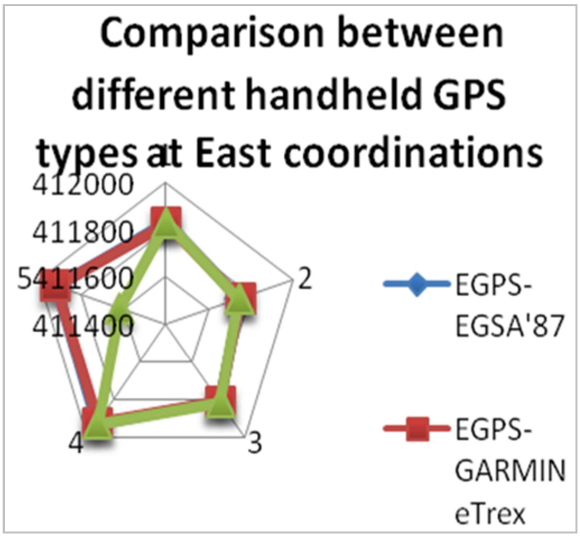


Figure 6. *Deviations between field measurements of two different types of handheld GPS and KTIMATOLOGIO AE (East).*

In Table 9 which is expressed in Figure 6, we observe price differentials relative to E or X, of the two GPS and with that of the KTIMATOLOGIO. We realize that differences are minimal except point 5.

Table 10. *Comparison between field measurment of GPS Garmin eTrex Vista mapping & GPS Android EGSA'87 & KTHMATOLOGIO AE in North.*

$N_{GPS-GARMIN}$	$N_{GPS-Android}$	$N_{Θ}$
4498070	4498069,596	4498073
4497983	4497979,239	4497980
4497905	4497899,158	4497891
4497934	4497932,895	4497930
4497943	4497932,879	4497936
4497940	4497952,415	4497947
4497989	4497997,91	4497998
4498029	4498031,797	4498025
4498070	4498072,987	4498073

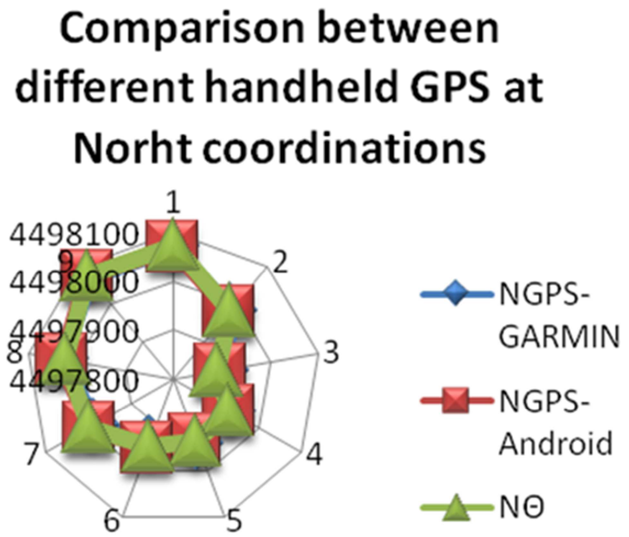


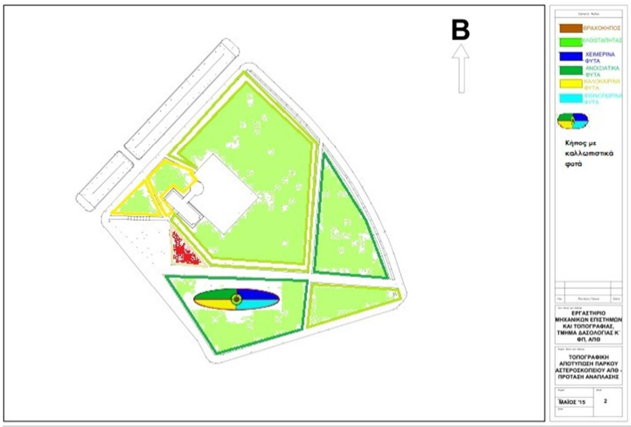
Figure 7. *Deviations between field measurements of two different types of handheld GPS and KTIMATOLOGIO AE (North).*

Observing Table 10, which is expressed by the Figure 7, and where field measurements are captured between the two GPS handheld with that of the KTIMATOLOGIO AE as a northwards (N or Y), we find that deviations are not displayed.

Based on the above diagrams and tables we find that there are no significant deviations from the true value of the KTIMATOLOGIO AE. However, differences were shown in the mean squared error of both GPS handheld with the KTIMATOLOGIO AE, which does not exceed 0.75 with respect to E and 1.5 regarding N. Therefore we can say that both handheld GPS are acceptable to be used for mapping urban green when variations of measurements' are within the factory errors organs.

5.2. Observatory Park Redevelopment Study

The sustainable proposal was based on a combination of methods related to urban green in order to achieve a recovery of the Park Observatory with minimal interventions and low cost. The general concept was to design an architectural plan based on Greek aromatic plants and painted rocks in order to recreate the landscape and designe a galactic realistic depiction of our planetary system. The construction of that kind of park will give the opportunity to the students of Physics but also to the visitors of the AHEPA's Hospital to have an educational time with not many lectures. The next architectural plan gives all our sustainable proposals concerning the Observatory Park in AUTH Campus.



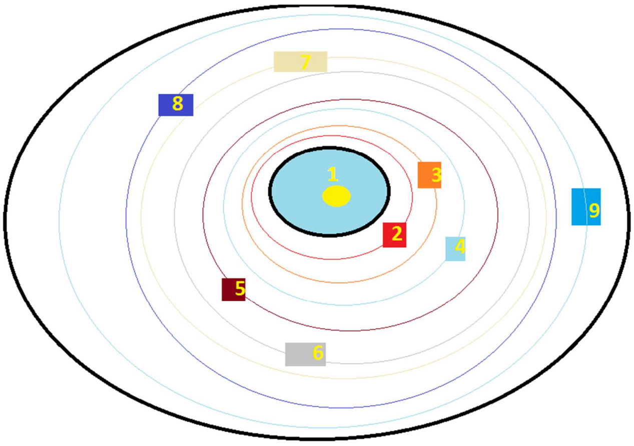


Figure 8. *The Order of rocks by the orbit of the planets of our solar system around the sun.*

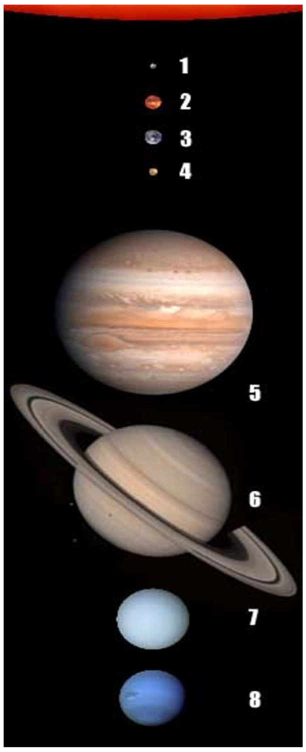
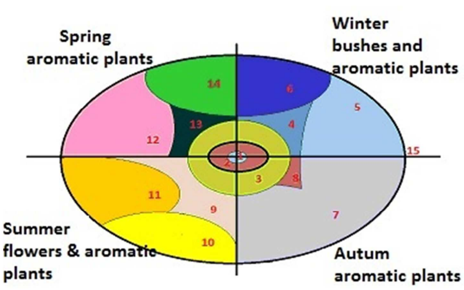


Figure 9. *Colors and sizes which are corresponding to the planets, as they will be placed into rock garden.*

The sustainable redevelopment proposal concerns: 1) the construction of a rock garden which is with the solar system and where we put rocks painted in matching colors of the planets and in positions similar to their actual orbit around the sun. In the following images (5 & 6), the formation is given analytically.

The proposed "Four Season Garden" (Fig. 10), located in the Northeast side of the Park, is proposed to import plants to bloom in all four seasons and edible shrubs like lavender, thyme, mint and herbs like lemongrass, evening primrose, jasmine, honeysuckle, etc, so that the rotation of colors, aromas and flowering creates a calm atmosphere for the students, employees teachers of Aristotle University, and also patients and their companions in the adjacent hospital AHEPA. The plan following indicates the details of the proposed garden.



LEGEND

No	TYPE	BLOOMING PERIOD
1	FOUNTAIN	
2	ROCK-GARDEN	
3	GRASS-MATTERIAL	
4	WINTER FLOWERS	WINTER
5	CAMELIA	WINTER
6	GIASMEN	WINTER
7	CYCLAMEN	AUTUM
8	CHRYSANTHEMUM	AUTUM
9	ANTIRRHINUM MAJUS	SUMMER
10	HELIANTHUS	SUMMER
11	PETOUNIA	SUMMER
12	DIANTHUS	SPRING
13	VIOLA	SPRING
14	HYAKINTHUS	SPRING
15	LEILAND BUSHES	ALL SEASON

Figure 10. *The "Four Season Garden".*

6. Discussion and Conclusions

This research was initiated in two levels, the use of low cost handheld GPS for mapping apark within the urban fabric, and field measurements were evaluated based on the "true value", as given by the KTIMATOLOGIO AE and upon this surveying we proposed a Sustainable Architecture Landscape Study based on a Mild Regenerating and renewing the existing part and creating educational rock- and four seasons garden.

The results of comparisons between fields measurements with two different handheld GPS and true values, were found satisfactory and acceptable, since it was within the organ factory errors. So the use of low cost handheld GPS is suggested for the architectural landscape design in the urban fabric.

The Observatory Park redevelopment proposals is based on the use of shrubs and herbs that can be purchased from the Departments of Agriculture, Forestry and Natural Environment, and therefore the construction cost will be lower and the species proposed are available and have many requirements in water and planting operations (pruning, fertilization, etc.).

At a time when the cost - benefit analysis will be shown that is more relevant than ever we believe that such architectural landscape study is easy to be implemented and the results are going to be shown within a decade. In any case a renewal sustainable proposal of utilization a university park is always an educational statement.

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