

2006

Unification and Planning of Urban Public Spaces with Bioclimatic Conditions. Case Study Drama, Greece.

Georgi, Neratzia Julia

WSEAS (World Scientific and Engineering Academy and Society)

<http://hdl.handle.net/11728/7531>

Downloaded from HEPHAESTUS Repository, Neapolis University institutional repository

UNIFICATION AND PLANNING OF URBAN PUBLIC SPACES IN DRAMA, GREECE WITH BIOCLIMATIC CRITERIA

Julia N. Georgi * & Sophia Sarikou **

* Dr. Landscape Architect, Hellenic Open University
Spec. Scientist of Ministry of the Environment Planning and Public Works
P.O.BOX. 13680, 10310 Athens, e-mail: jgeorgi@tee.gr

** Landscape Architect MSc,
Department of Architecture
Aristotelian University of Thessaloniki
P.O.BOX. 50019, 54013 Thessaloniki, e-mail: ssarikou@tee.gr

Abstract

The green spaces in the urban environment facilitate the movement of air masses that act as air refreshment in the wider region. The unification of urban open spaces and their enrichment with vegetation affect the micro-climate positively and act as a decisive factor for the increasing of urban thermal comfort, via the shading and the phenomenon of evapotranspiration.

The planning of urban public spaces can support a habitat network encouraging the connectivity of the man-made environments with the surrounding natural ecosystems. The following paper aims to promote the unification of urban open spaces, with bioclimatic criteria by emphasizing the role of vegetation aiming the enhancement of living conditions in settlements. In particular are analysed the data collection like the proportion of building height with road width H/W, the road orientation and the solar access, the paving materials, the existent vegetation and concludes to an urban unification in a central part of Drama city in Northern Greece, by creating walkways and green corridors. The issue of solar access outdoors has been briefly discussed as an additional criterion in landscape designing the street. Design recommendations are also outlined for designing comfortable urban spaces.

Keywords: Unification of urban spaces, Green-ways, urban microclimate, street design

1.Introduction

In sustainable cities, accordingly to the maps of Aalborg [1] and to the maps of Athens [2], the Open Public Spaces should work as a consistent network and not as separated pieces of land. The design strategy should allow the walking from the suburban areas to the small areas of green and to the small pieces of land, connecting the city parks with the city squares and with the paving even though with the archaeological sites [3][4]. The human interference to the environment should encourage the wise and the precise management of the natural resources, adjusted to the urbanization and to the cities development. The concept of sustainability and versatility of landscapes, defined as follows: “The Landscape should be managed in a way such as to endure its mobility, to offer its services to future generations in to the biggest amount” [5]. In regard to the designing, most European countries the last thirty years have adapted an ecological approach which encourages the penetration of the natural elements into the Urban Sites, aimed the unification of the areas of green, with the suburban green and with the surrounding natural ecosystem. The piercing of the natural elements in cities should work as a very well organised network, which

encourages the biodiversity into the cities, providing to the flora and fauna guest environments [6][7]. In the following research is encouraged the penetration of the natural elements into the cities, providing the probe unification of the existing areas of green in the urban web, examining a case study in a part of the city of Drama in North Greece, gathering to useful conclusions that could be applied to similar cases.

2 Literature review

2.1 Green ways - Green networks

The tradition of the Green networks has started very early from the beginning of the 20th century, when Schmidt the 1912 [8], suggested the city land - planning, identifying the value of the green networks in urban sites. The creation of the greenways synoptically can offer:

1. Connectivity and versatility of urban spaces and urban usages [9]. Possibilities of recreation [8]. Possibilities for creation of different walking tours through out the cities [10] and inspire the citizens to move by feet.
2. Encouragement of the biodiversity in urban cities [7][8] and the facilitation of new habitats settlements [11]
3. Improvement of the Thermal comfort in cities and of the urban microclimate [12] [13].

The Urban wasteland exists anyway in urban sites so instead of remaining a blank space, with simple techniques can be transformed to a safe and welcoming environment for flora and fauna. Even if these sites are ignored, wildlife habitation will take place; opportunistic weeds will colonize; which in time will be replaced by tougher perennials, which in turn will give space to shrubs and trees, while in the meantime animals will move in [7][14].

“The rough and untreated ground, the derelict housing, the obsolete spaces that the city ignores is the places which provide inspiration for creative and formative experience. Ecologists tell us that the richest variety of life-forms is to be found where different living conditions meet” [14].

All these places with the city parks and the city squares, with the streets and the roads and with the paving, all can comprise spaces of unification of green. The most important prerequisite is the appropriate plant choice. According to the different conditions the planting design in urban environments premises plants with low demands, high resistant to the temperature, and to the solar heating, adjustable, with less management demands [7][15]. The irrigation in the first two years, even though to the dry plants, should be regular and ordinary, whereas the next years, it depends on the depth of the water horizon and on the annual waterfall [7]. The management plan of the urban green, premise weed control and constrain of the most competitive plants so to avoid the creation of one specie populations. Additionally should be scheduled enrichment techniques and conservation of the biodiversity [7][14][16].

Eventually for the unification of the Urban open spaces should be taken in ccount the Bioclimatic Design theories.

2.2 The Bioclimatic Design Theories

The Bioclimatic Design of Urban Open Spaces presupposes the adaptation of the total aggregation to the microclimate and to the natural environment and aims to provide suitable thermal comfort conditions making the most of the solar radiation and of the natural resources like sun, wind, ground, water vegetation, so as to minimise the energy consumption [17].

The advantages of the Bioclimatic Design in general are: Energy consumption, financial benefits, environmental benefits, social benefits [18].

The Bioclimatic Design aims to offer [12][18]:

1. Natural refreshing techniques with the usage of vegetation, or with special constructions or with devices and systems of passive refreshment.
2. The facilitation of the airstreams that it depends on the orientation, on the height, on the shape and on the setting of the buildings.
3. The conservation or the restoration of the ground levels
4. The natural water flow
5. The usage of nature friendly materials and the ground ventilation
6. The recycling
7. The ensuring of thermal comfort

Thermal comfort [17] is the situation that allows the conservation of the thermal comfort of the human body and makes you feel amiable. The thermal comfort conditions are affected by the solar radiation, the temperature, the air movement and the air humidity.

The thermal comfort in cities and urban environments [19][20][21][22] is affected by:

- The structural density and the geometry of the buildings
- The proportion of the building height with the streets width (H/W)
- The streets usage and the percentage of the Hard landscape with the Soft landscape
- The solar radiation, the timing, the enduring and the season
- The street orientation
- The existence or not of vegetation
- The air temperature and the air humidity
- The existence of open spaces
- The speed and the air orientation
- The paving materials [26]

Researches on the City Thermal Comfort [23] showed that the microclimate is affected and getting improved significantly by the usage of treerows.

2.3 The flora contribution in the Bioclimatic Design

The existence of vegetation affects the city microclimatic conditions. Researches have shown 2.8⁰C difference between a structural city centers with an open space [24]. The microclimate improvement is succeeded with the enrichment of vegetation and with the water elements that work like refreshmnets elements, because of the evapotraspiration that causes reduction of the ground temperature, balances the air humidity, improves the lighting conditions, commits the dust and the air pollution and controls the air circulation.

Vegetation improves the microclimate as follows [13][15]:

- Minimizes the extreme temperatures
- Via evapotraspiration, plants causes the maximize of the air humidity conditions, which during summer can reach to 5-8%
- Because of the light diffusion from the leafs is getting improved the lighting conditions
- Works against air pollution by keeping and absorbing dust and polluting elements.
- Refreshes the air oxygen (It's well known that a Picea excelsa tree produces 1-3 gr Oxygen).

- Offer wind protection and minimizes the dangers of frost in a site.
- Affects the air circulation, creating the air refreshment
- Absorbs less radiant heating during the summer months
- Via the shadow improves the city thermal comfort.

3. Methodology

3.1 Methods of microclimate improvement in cities and urban environments

Via the different methodologies that are applied in the improvement of the Streets Thermal Comfort, the dominant was the one that is been used in the following research, and in which Ali Toudert Fazia [25] has adapted to her similar case study, where the Streets Thermal Comfort is affected by the different proportions of the building heights and of the streets width (H/W), by the streets orientation, and by the usage of vegetation (see foto 1,2,3).

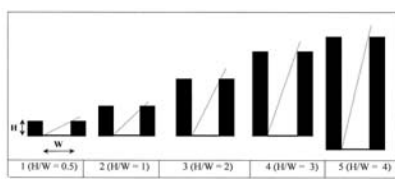


Foto1 The Geometry of Urban Streets with different proportions of building heights and street width (H/W)

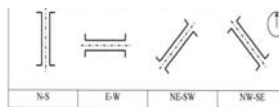


Foto2 Street orientation.

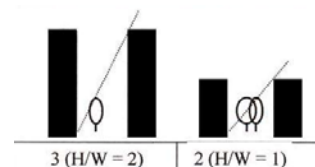


Foto3 The proportion of building heights and street width (H/W) with the usage of vegetation

According to the methodology it has to be done presentation of streets with different width, with different building heights (see foto 1), with different streets orientation (see Foto 2) and with different planting (see foto 3).

From the above sketches arise the following observations:

- Narrow streets with E-W orientation with high buildings perform better thermal comfort conditions than wide streets with low buildings in both orientations E-W and N-S (see foto 1).
- Wide streets with low buildings are cooler especially during the summer nights because the sun during summer is higher (see foto1).
- The usage of planting is more effective as lower as the buildings are (see foto3).
- Streets with orientation N-S are much more preferable than those with orientation E-W which are extremely discomfort at the evenings during summer time (see foto 2)
- During summer in wide streets the wind moves higher so it's much cooler.

In order to understand and facilitate the method it has to be applied to a case study in a part of the city of Drama in North Greece.

3.2 Case study

The case study is in the city center of Drama which is in the North part of Greece. Drama is a city which is built in the south part of Falakro Mountain in the height elevation 110m, veritably above water, the springs of Agia Barbara and the stream Kallifito. Both of them are crossing the city from one side to side. Its name comes from the word Drama ► Idrama ► Idor ► which in Greek means water. The lowest hill of the Falakro Mountain called Korilovos and touches the city from the North East. The climate is continental with cold and moist winters with minimum

temperatures -18.5°C (in December 2001), and high temperatures during summer with maximum $+44^{\circ}\text{C}$ (in July 2001). The rainfall is increased the last years especially during autumn and spring with medium annual rainfall between 362.4mm (2000) and 982.90mm (1966). The relative humidity is high with medium annual rate the 66.3%. The insolation is extreme high during April till October, whereas the wind tension is low, no more than 2.5 Beaufort.

According to the history Drama was a city that from 1930 was suffering from the millions refugees. In order to tide up is setting up a rectangular canvas with orientation North-East and South –West. Nowadays is valid the same Design planning with small alterations, with structural factor 2 and max allowable height the 21metres. The whole area has lost its physiognomy and the less traditional old houses are covered by the new seven-floor tower blocks.

The case study concerns the unification of three existing urban green areas: Firstly the springs of Agia Barbara and the recreational park that exists along it. It's a place that combines perfectly the water, with the natural environment, with the traditional old buildings, in a heavy urbanized area. Secondly the Civil Garden which characterized by the native *Platanus orientalis* species, with human made waterfalls and constructions and lastly the Elefterias Square which as in all over Greece is a paved square with sectional areas of green (see foto4).

3.3 Methodology

In order to achieve the aims of this study which are the Unification of these three areas of green, with vegetation enrichment and with the creation of walking tours via the city, have been used the following:

- Mapping out all the characteristics of the existing situation of the imposed roads that exist between the three areas, like: existing vegetation, street orientation, street width, building height, paving materials.
- Application of the Method of a relevant survey of Ali's Toudert Fazia [25].
- Record of the existing ecosystems.

According all the above elements and the Methodology, the survey concludes to a Unification Design Proposal.

4. Results

4.1 The record results

Aim of this study is the unification of the three existing areas of green and the enhancement of the living conditions in the city. For that reason is set up on purpose to record the characteristics of the seven streets that are crossing through the site areas, like existing vegetation, street orientation, and street width, building height, and paving materials (see foto5).



Foto4 The case study with the three areas of green



Foto5 The seven streets that are crossing through the site

The street's characteristics that have been plotting and recording according to the Ali's Toudert Fazia [25] study can be shown in to the following table1.

Strret number	Name of the street	Orientation	H/W	Materials	Percentage of existing vegetation
1	Agia Barbara	E-W	10/13=0.77	Granite asphalt	0%
2	19 th May	NE-SW	21/34=0.62	Paving slabs asphalt	1%
3	Karaiskaki	E-W	21/10=2.1	Paving slabs asphalt	0%
4	Vitsi extension Soutsou	E-W	15/12=1.25	Paving slabs asphalt	0%
5	Patriarxou Dionisiou	NW-SE	12/31=0.39	Paving slabs asphalt	2%
6	Ethnikis aminis	N-S	20/33=0.61	Paving slabs asphalt	1.6%
7	Kiprou	N-S	15/21=0.71	Paving slabs asphalt	0%

Table1. The characteristics of the seven streets that participated in the study

The orientation of the streets with numbers 1, 3, 4 which intervene between the three areas of green is E-W whereas the streets with numbers 6, 7 are N-S. The street number 2 has orientation NE-SW and the street number 5 NW-SE. The proportion of the Building height with the street width is in general low only in the streets 3 and 4 is up of the 1.25. The pave materials in all cases are asphalt whereas in the paving zone is granite with asphalt and paving slabs, so it's not allowed the ground ventilation. Vegetation has been recording only in the streets with numbers 5 and 6 but only in one side, whereas in the street number 2 have been recorded a 2m planting zone, with very bad plant's condition. To the following photos you can see the existing sections of each one road.

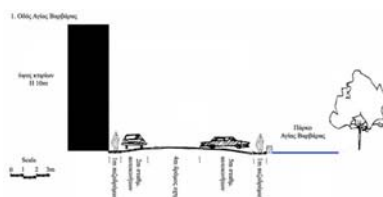


Foto6 Section Agia Barbara street

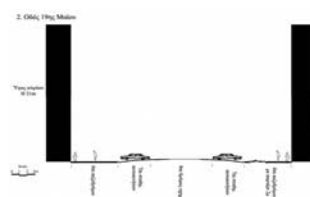


Foto7 Section 19th May

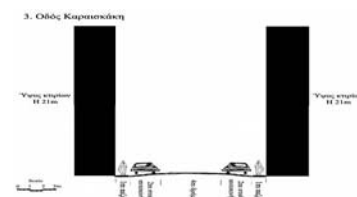


Foto8 Section Karasikaki

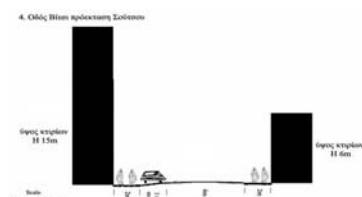


Foto9 Section Vitsi extension Soutsou

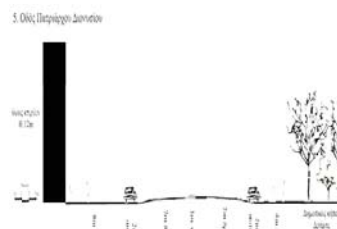


Foto10 Patriarxou Dionisiou

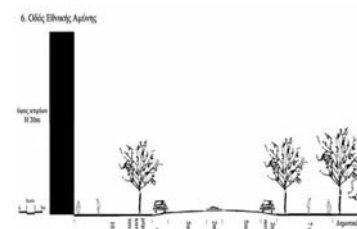


Foto11 Ethnikis Aminis

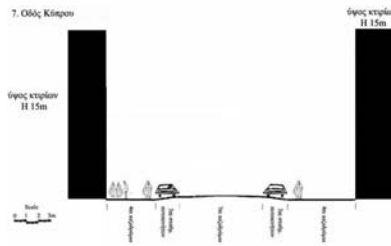


Foto12 Section Kiprou

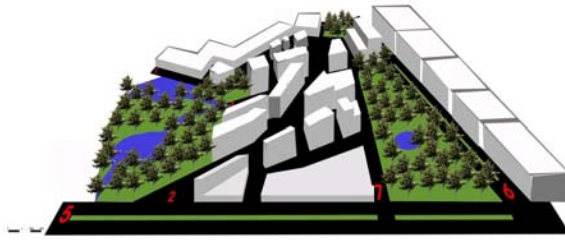


Foto13 The existing situation

4.2 Evaluation of the Results - Design Unification Proposal

Studying the results that came up from the survey, and evaluating the special characteristics of each one site, the survey concludes with a design proposal which encourages the unification of the sites, the creation of a walking network and planting techniques for enrichment of the existing vegetation. With indeed improved aesthetic and microclimatic results. The affirmation of the ideal living conditions in the city of Drama has achieved with the

- control of the shading and insolation of the open spaces and of the streets
- obstruction of the cold North winds during winter and with the possibility of natural refreshing during summer
- control of the dazzling of the solar radiation
- planting

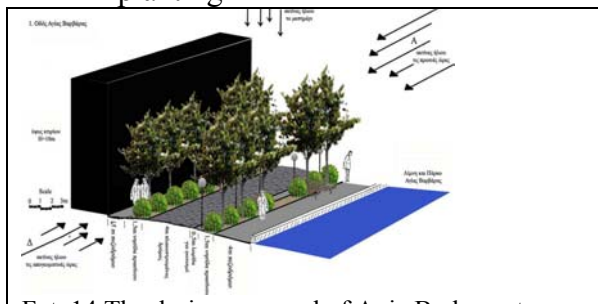


Foto14 The design proposal of Agia Barbara st.

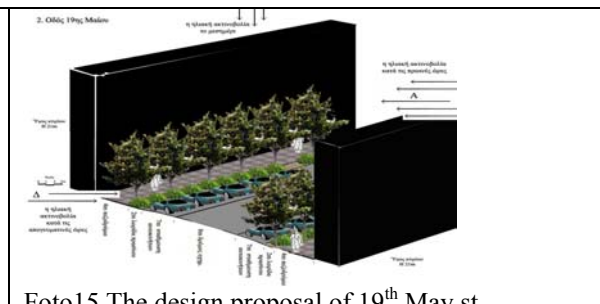


Foto15 The design proposal of 19th May st.

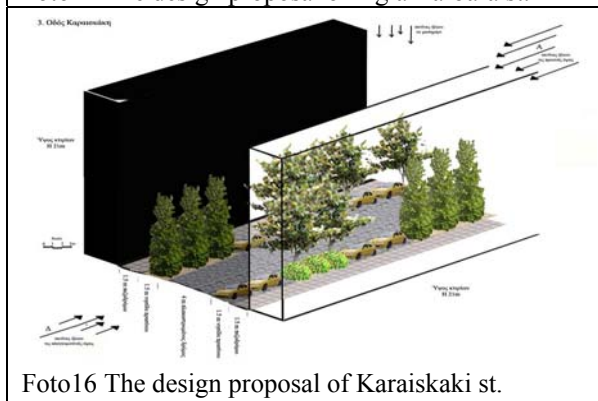


Foto16 The design proposal of Karaiskaki st.

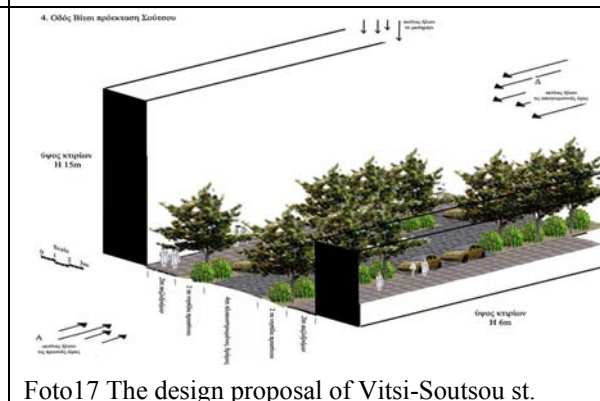


Foto17 The design proposal of Vitsi-Soutsou st.

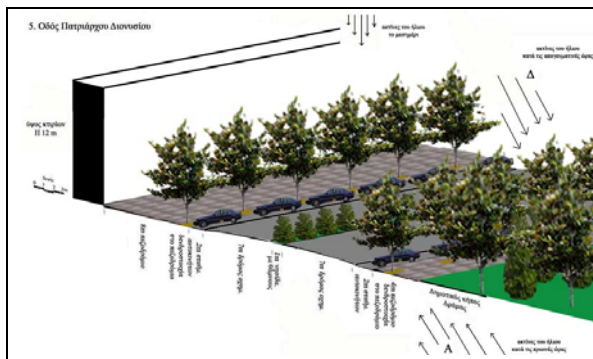


Foto18 The design proposal of Patriarxou Dionisiou st.

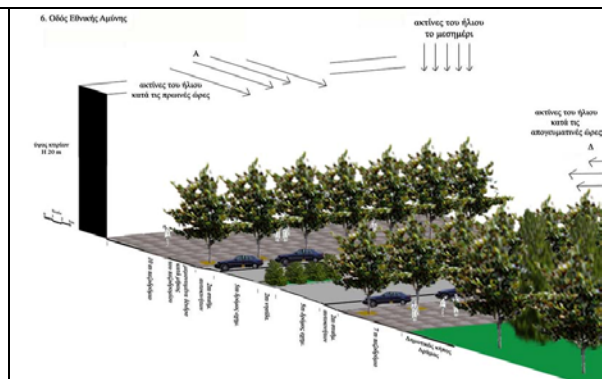


Foto19 The design proposal of Ethnikis Aminis st.

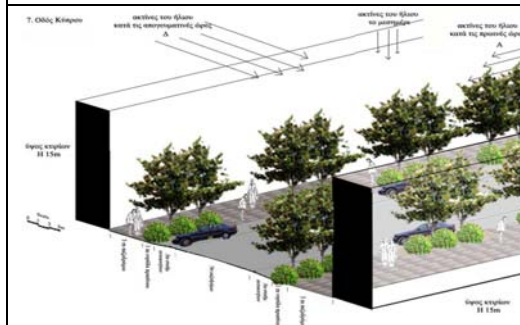


Foto20 The design proposal of Kiprou st.



Foto21 The design proposal of the unification of the three sites.

Therefore to each one site is proposed:

In the case of Agia Barbara st. the houses are to low till 10m, with $H/W= 0.77$ and protect the site only from the North side. The street is exposed to the solar radiation all day without shading. It's a necessity to plant and create high densed treerows from deciduous, wideleaved trees so as to allow the solar radiation to reach to the houses during winter. Additionally the first matinal hours and the first evening hours when the solar radiation falls parallel with the direction of the tree rows, in order to rainforce the shading is suggested to create a small fence of deciduous or evergreen shrubberies till the height of 1-1.5m, so as to allow the view to the springs of Agia Barbara. It's suggested the road to transform to a low circulation street and paved with pebbles (see foto14). The usage of nature friendly materials is allowing the water penetration in the ground, the absorption of the solar radiation and the reduction of the ground temperature, providing better living conditions [26]. For details see Table 2 number 2a.

In the case of 19th May st. even though the buildings are too high and the street is wide enough the proportion of the height with the width of the street is low ($H/W=0.62$), and the shading is inadequate. The street orientation is NE-SW; the buildings in the North side protect the street from the cold winds but leave the street exposed in the morning sunshine, whereas in the evening hours the buildings in the South side, remain exposed in the sun. Consequently, the planting of treerows is necessary, in both pedestrian zones and densed shrubberies in the **infr floor υπόροφος**. Therefore in the pedestrian zone is suggested the creation of a planting stripe, width of 2m at least, which will isolate the pedestrians, and discourage the drivers to park on the pedestrian zone (see foto15). For details see Table 2 Number 2c.

In the case of Karaiskaki st. In that case the buildings are too high and the street is too narrow so we have the biggest proportion of $H/W=2.1$, but the orientation of the street which is E-W, doesn't allow the shading. The sun lighting falls direct into the street, making the street discomfort. Additionally Karaiskaki st links the Civil Garden with the Springs of Agia Barbara, leading the visitor from one place to another, so we propose the street to transform to a low circulation street, be paved with cubes and pebbles, and reduce the parking lots alternate with the planting stripe. For details see Table2 Number 2b.

Vitsi st. extension Soutsou st. Similarly with Karaiskaki st. these two roads interpose between Civil Garden and the Springs of Agia Barbara, and have the same orientation E-W, thus during the day raises up the thermal charge. Additionally the buildings in the North side are lower so as the streets remain exposed to the cold winds during the winter.

Initially it's suggested these two roads to be paved and transformed to a low circulation street. The parking stripe should be transferred to the north side in order to be warmer and be interrupted by planting stripe. Treerows and shrubberies should be plant in turn on the left and on the right of the streets. The planting should be densed in the beginning and getting sparsely as coming closer to the Springs of Agia Barbara in order to give the impression that the site it's getting closer and closer (see foto17). For details see Table2c.

Patriarxou Dionisiou st. This particular road performs very good conditions of thermal comfort only in the evenings because its orientation is NW-SE. The first morning hours the thermal charge is too high, because of lack of planting (shading) and the small proportion $H/W=.39$. Thus a walker is suffering by the overexposure to the sunlight during summer and to the cold winds during winter.

It's suggested the creation on the paving zone, which is too wide, the creation of a planting zone with tree rows and shrubberies to the traffic island (see Foto18, Table 1). For details see Table 2 Number 2c.

Ethnikis Aminis st. This road performs the best conditions of Thermal Comfort because of its orientation N-S. Even though the proportion $H/W=0.61$ is a bit low and the existing vegetation is inadequate.

Consequently is suggested planting the gaps and enrichment of the existing vegetation of the traffic island (see foto19). For details see Table 3 Number 3a

Kiprou st. Similarly this road has the same orientation and similar proportion $H/W=0.71$, performs the best conditions of thermal comfort. Only it has been observed lack of treerows and lack of shading, so are suggested trees and shrubberies (see foto 20). For details see Table 3 Number 3a.

The whole image of the city would be upgraded if some of the suggested streets were possible to be isolated by cars and parking lots, alters its usage for pedestrians. That's something that would possible cause social reactions so instead, it's preferable to transform these roads to low circulation streets.

In the foto 21 you can see a 3D Design Proposal of the Unification of the three sites whereas in the following tables 1 and 2 you can see the suitable planting that is proposed to each one case.


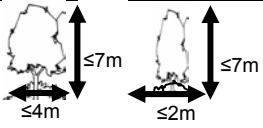

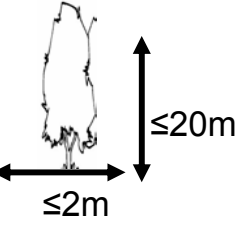
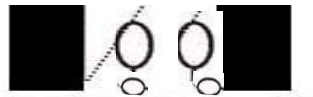

Number	Proportion H/W Orientation	The layout of Planting	Suggested setting of Planting
2a	$0 \leq H/W \leq 1$ E-W		
2b	$1 \leq H/W \leq 2.1$ E-W		
2c	$0 \leq H/W \leq 1$ NE-SW NW-SE		

Table 2 The suggested type of planting

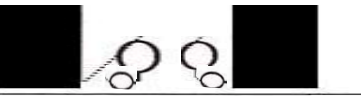
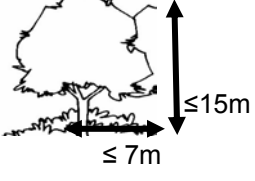
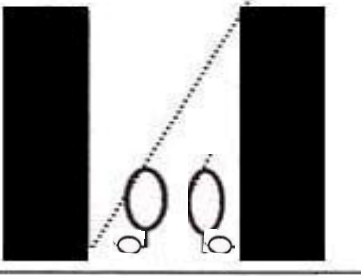
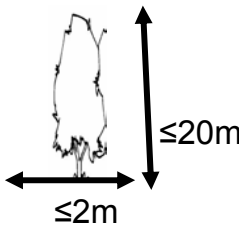
Number	Proportion H/W Orientation	The layout of Planting	Suggested setting of Planting
3a	$0 \leq H/W \leq 1$ N-S		
3b	$1 \leq H/W \leq 2$ N-S		

Table 3 The suggested type of planting

5. Conclusions

According to the proposed interferences, the enrichment of the existing vegetation and the alterations in the usage in the between streets to low circulation streets it's

succeeded the Unification of the three places of green. Planting acts as a medium of unification, as a bulkhead, separating the paving zone from the vehicles zone and as a bollard against the illegal parking. Considering that Drama is a city with plenty of water and ideal conditions for the growth of plants, the creation of green ways in between the city, can improve the microclimate especially during the summer months but also can work as a pole of attraction to visitors providing the historical sites of the city and upgrading the citizen's life with a healthy life style and with less energy consumption [8].

The unification of the green places is not an easy matter, especially when the structure of the cities doesn't allow the appropriate planning. The greening demands special design and planning.

In order to achieve the above aims in every city has to be promoted an integrated design of unification of all the natural elements so it has to be encouraged:

- The connection and the unification of all the green areas in between and with the surrounding ecosystem.
- The increasing of the percentage of the soft landscape against the hard landscape.
- The creation of a walking network with possibilities to integrated with the surrounding ecosystem.
- The adjustment, the reformation and the protection of all the wetland areas and its unification with the areas of green.

“Encouraging the biodiversity in the urban environments, via aesthetical improvements, securing the safety and the walk ability, cities can become more livable” [27].

Literature review

[1] EU 1994, European Conference of sustainable Cities & Towns, Aalborg Charter, 1994. Charter of European Cities and Towns, Towards Sustainability, Aalborg, Denmark, 29 May 1994.

[2] European Council of City Planners, The new map of Athens 1998. The theories of the European City Planners in the Town Planning, European Council of City Planners, March 1998.

[3] Papagiannis T. The sustainable management of Urban places, Design, Environmental Consequences and Method s of Evaluation. Hellenic Open University, Volume A, 1999.

[4] Kosmaki P. and Dimoudi A. Improvements of living conditions and of the quality of the environment in the urban places. Bioclimatic Design in Landscape Formation. Hellenic Open University, Volume B, 1998.

[5] Kaplan, R., Kaplan, S., Ryan, R., With people in mind: Design and management of everyday nature, Washington, Island Press, 1998.

[6] Ruff A., Tregay R., An ecological approach to Urban Landscape Design, University of Manchester: Department of Town and & Country planning, Occasional paper no 8, 1982.

- [7] Sarikou S., Encouraging Nature in Urban Public parks: An evaluation of the results of the ecological approach of 70s, in UK's Urban Nature Parks, WSEAS, IASME Transactions, Vouliagmeni, Athens, Greece, July 12-14 2005. Issue 4, Volume 2, ISSN 1790-031X, Pg. 512-518, June 2005.
- [8] Haaren C. and Reich M., The German way to greenways and habitat networks, Landscape and Urban Planning (in press), 2004.
- [9] Runge K., Die Entwicklung der Landschaftsplanung in ihrer Konstitutionsphase 1935-1973. Schriftenreihe des Fachbereichs Landschaftsentwicklung der TU Berlin: Landschaftsentwicklung und Umweltforschung 73, 1990.
- [10] Southworth M., Designing the walkable city, Journal of Urban Planning and Development, DOI: 1061/ASCE 0733-9488, p131:4(246), 2005.
- [11] EU, European Habitat Directive, Directive 92/43 EEC of the European Parliament and of the Council on the Conservation of natural habitats and of wild fauna and flora, Official journal L 206 of 22.07.1992, 92/43 EEC, 1992.
- [12] Giannas S. Bioclimatic Theories in the Town Planning. Environmental Technology. Hellenic Open University, Volume A., 2001.
- [13] Georgi, N.J., Zafeiriadis K., The impact of park trees on microclimate in urban areas, Urban Ecosystems, (in press), 2005.
- [14] Malcolm E., Promoting Nature in cities and towns: a practical guide, London: Groom Helm, 1986.
- [15] Ntafis S. Urban Forestry. Art of text. Thessalonica, 2002.
- [16] Georgi J. N., Kapnistou M., Landscaping Parking Lots IASME TRANSACTIONS Journal, ISSN 1790-031X, Issue 3, Volume 2, p.p. 405-412, July 2005.
- [17] Papparelli A., Kurbán A. & Cúnsulo M., Strategies for bioclimatic design in an urban area of an arid zone: San Juan (Argentina), Area Arquitectura Ambiental, Landscape And Urban Planning, Elsevier Science Publishers, Volume 34/Issue 1 – Págs, 19-25 Oxfords, 1996.
- [18] Nikolopoulou M., Design Planning of Urban Open Spaces with bioclimatic criteria. Centre of Recycling Sources of Energy, Key action 4 “City of tomorrow and cultural heritage” from the fifth framework programme 1998-2002, co-financed by the European Union entitled “Energy, environment and sustainable development”, 2004.
- [19] Oke, T.R., The distinction between canopy and boundary-layer urban heat islands, Atmosphere, 14: 268-277 pp, 1976.
- [20] Nunez M., Oke, T. R., The energy balance of an urban canyon, J. Appl. Meteorol. 16: 11-19, 1977.

- [21] Nakamura, Y., Oke T., Wind, temperature and stability conditions in an east-west oriented urban canyon, *Atmos. Envir.* 22: 2691-2700, 1988.
- [22] Santamouris, M., Papanikolaou N., Koronakis I., Livada I., Asimakopoulos D., Thermal and air flow characteristics in a deep pedestrian canyon under hot weather conditions, *Atmos. Envir.* 33: 4503-4521, 1999.
- [23] Georgi N.T., Aesthetical, Ecological and Functional Value of the Urban Green in the city Of Thessalonica Greece. Aristotelian University of Thessalonica, PhD Thesis, pg 1-205, 2000.
- [24] Heisler, G.M, Mean wind speed below building height in residential neighbourhoods with different tree density, *ASHRAE. Translation* 96, 1389-1396, 1990.
- [25] Fazia, Ali-Toudert, Dependence of outdoor thermal comfort on street design in hot and dry climate, Freiburg, November 2005, Dissertation *Berichte des Meteorologischen Institutes der Universität Freiburg*, Nr. 15, ISSN 1435-618X, Dissertation, angenommen von der Fakultät für Forst- und Umweltwissenschaften der Albert-Ludwigs-Universität Freiburg. 2005.
- [26] Georgi N.J., Sarikou S., The usage of Nature friendly materials in Urban Public Spaces, *WSEAS Transaction*, Venice, Italy, ISSUE 2, Volume 1, November 2005. ISSN 1790 5079, pp. 173-1862-4, 2005.
- [27] Lindsey G., Sustainability and urban greenways: Indicators in Indianapolis, *American Planning Association, Journal of the American Planning Association*, 69, 2; ProQuest Direct Complete pp. 165, Spring 2003.