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Social, environmental and economic benefits of urban trees to the society

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Abstract

In this review, we not only focus on aesthetic aspects of urban trees, but we also analysed their environmental, social and economic benefits. A literature review was undertaken for this purpose. The review is divided into three great parts. Firstly studies on the environmental benefits of urban trees are reviewed, including the biotic and abiotic factors that are closely related to the quality of life I urban areas. Secondly, the social benefits were analysed that urban trees bring to the community are investigated. Urban trees also play a pivotal role in reducing stress and in contributing to the physical and psychological well-being of citizens. Thirdly, the review shows that urban trees can have direct economic benefits, such as increased property values. The review clearly demonstrates that urban trees are not only on aesthetic contribution to urban open spaces, but they are also vital factors for the enhancement of the quality of life and sustainability of urban areas.

Key Words: Urban trees, Benefits, Silviculture, Urban Forestry.

Introduction

The city is the cultural landscape par excellence, where in the last decades great changes have taken place. While originally cities were largely integrated into their natural surroundings, which provided them with all the elementary physical, social and natural services, they have evolved into large metropolitan areas with a multitude of functions (and a huge environmental footprint) (CURIHUINCA 2001). Today we find ourselves in a situation where the world population is in constant growth and probably by the year 2050 will be around 9,300 million people, with 97 % of increase will taking place in developing countries. This demographic increase of the population has not been distributed evenly.

In 1990, the 100 biggest cities of the world housed 540 million people. Nowadays just 3 of the 10 most populated cities are in developed regions (Tokyo, New York and Los Angeles) and some of them may soon no longer be one of these. The rest belong to the Third World or developing countries.

Since their foundation, Latin American countries always had a close relationship with the environment that surrounded them. Their cities were often located in places with environmental advantages that put them in advance over other countries of the First World. However, in the last decades, the population increase and the new economic patterns have created economic and less social urban landscapes. The

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citizens are more and more disconnected from green and natural landscape elements in their residential surroundings. Urban citizens demand more often urban open spaces forces useful for the open space activities and for nature contact in their neighbourhood. There is also no doubt, that green spaces and urban trees can be an important component of the image of the city, providing ecosystem services, environmental-social and economic benefits for the society, as well as they are a important design element of the urban landscape.

Society is now becoming more concerned about the importance of environmental values, where ecological relationships considered vital, for a society that is concerned about the human well-being, the consumption and exploitation of natural resources.

This review's objective is to present a document that gathers the most important information and references on the benefits that urban trees can contribute to society, incorporating studies and bibliography from the fields of planning, architecture, climatology, botany, environmental chemistry, medicine, economy, sociology. It is hoped that an increase in of urban environmental issues will assist policymakers, green space managers, natural resource planners and residents in their formulation of and implementation of appropriate policies.

1 Environmental Benefits

1.1 The effects of urban trees on the quality of the air.

1.1.1 Reduction of the Temperature and increase of humidity

Temperature is one of the more sensitive meteorological variables for urban areas of the city, registering higher values in downtown, compared to the natural surroundings. This urban effect on the superficial thermal field in the city is called "heat island," (LÓPEZ, LÓPEZ, FERNÁNDEZ and ARROYO 1991, AKBARI, DAVIS, DORSANO, HUANG and WINNETT 1992, MORENO 1994, TSO 1996, CAMILLONI and BARROS 1997, ÁLVAREZ 1998, KLYSIK and FORTUNIAK 1999, SAARONI, BEN-DOR, BITAN and POTCHER 2000). As part of the main causal factors of this phenomenon we can mention: built-up area that store and emit heat, the layers of atmospheric contamination, the reduced evapo-transpiration in the urban centres, the small green areas and the impermeability of the grounds, the heat generation by automobiles and industrial activity (SANTIBAÑEZ and URIBE 1993).

HOWARD 1833, made the first references of this phenomenon in his study "*The Climate of London*," comparing the temperatures and the humidity of the surroundings of the City of London, as opposed to downtown and, attributed these differences to the intensive use of fuels.

Currently numerous studies exist (North America and Europe) on the moderating effect that urban trees have on temperature and humidity, and it is shown by a comparison of data obtained in streets with trees and in streets without trees (HEISLER and HERRINGTON 1976).

(OLMOS 1999, PECK and CALLAGHAN 1999) confirm that the vegetation influences the temperature of the city directly, cushioning the summer rigors and diminishing the intensity of the heat islands. Especially the tree cover provide shade and protects from the solar radiation. On the other hand, the vegetation increases the environmental humidity by its own transpiration of trees and the irrigation of grounds with vegetation, with a consequent thermal relief (BERNATZKY 1969) as a consequence.

LEONARD 1972, calculated that the transpiration of a mature tree corresponds to a fridge of more than 150,000 frigorías per day. MONTOLÍO 1988, stated and quantified, with measurements by luxometry and radiometry, the beneficiary effect of a tree lined road in the city of Valencia (Spain). A large mature tree is able to transpire 450 litres of water per day. This enables it to consume 1000 MJ of caloric energy in its transpiration process, also diminishing as a consequence the urban temperatures (HOUGH 1989).

Studies made by the Facultad de Ciencias Agropecurias de la Universidad de Entre Ríos (Argentina) and by SAITO, ISHIHARA and KATAYAMA 1991, demonstrated that significant differences exist between buildings surrounded by green zones, and those without them, amounting in some cases to temperature differences of 4°C to 11% of difference in humidity.

The importance of the vegetation depends on the nature of the urban area amounting, as well on the type of vegetation and its configuration BERNATZKY 1983, WILMERS 1991, SVENSSON and ELIASSON 1997. HONJO and TAKAKURA 1991, state that the benefits of the vegetation on the urban climate increase in zones of greater areas of vegetation cover, compared to those of smaller surface areas.

1.1.2 Diminution of atmospheric polluting agents

Trees diminish the gaseous polluting agents of the air by attracting them through the stomas of the leaves. Once within the leaves, they react with the internal structures (SMITH 1978, 1990). Vegetation plays a highly important role in the reduction of small particles that are suspended in the atmosphere. Some particles can be absorbed by the trees, (ZIEGLER 1973, ROLFE 1974, GIVONI 1991), although most of the particles that are intercepted, are retained on the surface of the plant. Those particles that adhere to the surface will return to the ecological cycle when the leaves fall or are washed off by the rain. In this way, the trees constitute an effective body of temporary retention for many atmospheric particles.

In 1994, the trees in the New York City absorbed approximately 1821 metric tonnes of atmospheric polluting agents, saving some $9.5 million. Air quality improvement in New York City due to pollution reduction by trees during daytime of the in-leaf season averaged 0.47% for particulate matter, 0.45% for ozone, 0.43% for sulphur dioxide, 0.30% for nitrogen dioxide, and 0.002 for carbon monoxide. The reduction of these polluting agents by urban trees of the New York City was greater than in Atlanta (1196 t; $6.5 mill) and in Baltimore (499 t; $2.7 mill), but the reduction of polluting agents per m^2 of covered surface was of a similar amount in all cases (New York: 13.7 $g/m^2/yr$; Baltimore: 12.2 $g/m^2/yr$; Atlanta: 10.6 $g/m^2/yr$). The reduction of the polluting agents varies according to the amount of atmospheric pollution, the duration of the leaves on the trees, precipitation, and other variables. Healthy trees, larger than 77 cm in diameter, eliminate approximately 70 times more annual atmospheric pollution (1.4 Kg/yr), than trees of a size smaller than 8 cm in diameter (0.02 Kg/yr) (NOWAK 1994a, 1994b).

1.1.3 Carbon absorption

The rapid expansion of cities, associated with greater industrialisation, has contributed to climatic change. There is no doubt that carbon dioxide is one of the gases responsible for the global warming effect and affecting atmospheric contamination. In 1990 the newer European Union, Russia and Japan contributed 50.2% of the CO_2 emissions of the planet's atmosphere

.The estimated carbon storage of urban trees in Syracuse (N.Y.) is 163,500 tons, with an annual carbon intake of 3,870 tons/yr. As carbon dioxide is an important greenhouse gas that contributes to global climate change, the estimated value of the urban forest's carbon absorption effect is $3 million for total storage and $71,500/yr for intake. (NOWAK, CRANE and STEVENS 2001)

Cities have been always great consumers of energy. The use of fossil fuels by vehicles has caused people to compromise the natural CO_2 cycle. Certainly, these problems can sensibly be mitigated by the creation of large vegetal areas in the interior of cities (DWYER, MCPHERSON, SCHOEDER and ROWNTREE 1992, MCPHERSON, NOWAK, HEISLER, GRIMMOND, Souch, Grant and ROWNTREE 1995, MACDONALD 1996). A study revealed that the urban forest of Milwaukee, Wisconsin, removes 1,521.3 tonnes of carbon per year. In Austin, Texas, the total coverage of trees of the city is around 30% and removes 5196.3 tonnes per year (MACDONALD 1996). In Chicago, the urban forests remove

annually 5.6 million tonnes of carbon, amounting to 1-2% of urban emissions (MCPHERSON, NOWAK, HEISLER, GRIMMOND, SOUCH, GRANT and ROWNTREE 1995). During the summer of 1991, the urban forests of the counties of Cook and DuPage (Region of Chicago) eliminated on average 1.2 metric tonnes per day of carbon monoxide, 3.7 t/day of sulphur dioxide, 4.2 t/d of nitrogen dioxide, 10.8 t/d of Ozone and 8.9 t/d of micro-particles suspended with a diameter less than 10µm (NOWAK 1994b).

1.1.4 Energy effects in construction

In the last years, numerous studies have demonstrated the effectiveness of urban forests for changing the temperature in the interior parts of the cities, allowing in some cases a considerable reduction in the use of energy by different refrigeration and heating systems (MCPHERSON 1991, DWYER, MCPHERSON, SCHOEDER and ROWNTREE 1992, HEISLER, GRANT, GRIMMOND and SOUCH 1995, LAVERNE and LEWIS 1995, MCPHERSON, NOWAK, HEISLER, GRIMMOND, SOUCH, GRANT and ROWNTREE 1995, GANGLOFF 1996, MACDONALD 1996, BOLUND and HUNHAMMAR 1999, PECK and CALLAGHAN 1999, SIMPSON 2002). The incorporation of trees around houses reduces the wind speed (in the winter months) and the power of solar radiation (in the summer months), leading to a reduction in costs for heating and air conditioning (LAVERNE and LEWIS 1995). A study developed in Sacramento City, analysed the energy balance of two houses over 129 days. The results obtained indicated that the two houses saved a total of 30%, with one of them saving 27% and other 42% by the shade of the trees that surrounded the houses (AKBARI, KURN, BRETZ and HANFORD 1997). In a nursery in Miami, it was demonstrated that planting shrubs and trees between 2-8 meters high around the building, resulted in a 50% saving in air conditioning costs on warm days and annually on average saving still 25%. (PARKER 1981, 1983). HEISLER 1986, calculated a reduction of between 10-15% heating costs in the winter thanks to the wind-breaking shield of trees, on the other hand, a reduction of 20 to 50% in the cost of air conditioning in the summer month. The shading effect of trees on buildings, was also analysed by KONOPACKI & AKBARI 2000, in their study of several American cities. The data were collected from different areas: stores, buildings and offices. It was demonstrated that planting an average of 4 trees for each house would bring savings of $ 6.3 million for the city of Baton Rouge, $12.8 mill. for the city of Sacramento and $1.5mill. in Salt Lake City. The surfaces of the constructions reflect solar radiation, giving it back to the atmosphere in the form of energy. The vegetation absorbs this energy and uses 80% of it for its subsistence and for biomass creation. Only 20% of the solar energy is reflected off the vegetation and given back to the atmosphere. Thus we can say, that the emitted heat from constructions, industries and vehicle emissions increase the pollution levels in the air of the city and increasing the temperatures several degrees above those in rural areas.

Nevertheless, the planting of trees in inappropriate places can increment the energy costs (DEWALLE 1978). Studies demonstrate that trees decreasing the amount of wind can affect the energy balance of structures in three ways: a) a lower wind speed around the structures, diminishes the dissipation of the heat from sun heated surfaces, b) a lower wind speed produces small drafts in the buildings, mainly in old constructions, c) a lower wind speed reduce the effectiveness of air exchange by open windows during the summer and doesn't reduce the use of air conditioners (SIMPSON 2002).

In arid zones the introduction of trees increases the cost of maintenance for the municipality. Nevertheless, in Tucson, Arizona, 16% of the annual requirements of irrigation of trees is compensated for by the savings in energy provided by the trees (DWYER, MCPHERSON, SCHOEDER and ROWNTREE 1992).

1.1.5 Trees that generate little volatile organic compounds (VOC) improve the quality of the air

The emission of Isoprene and Monoterpenes by certain arboreal species constitutes an important fraction of the emission of volatile organic vompounds to the atmosphere. Different studies have

demonstrated the importance of the arboreal VOC in the formation of photochemical oxidants like ozone (BRASSEUR & CHATFIELD 1991, FEHSENFELD, CALVERT, FALL, GOLDAN, GUENTHER, HEWITT, LAMB, LIU, TRAINER, WESTBERG and ZIMMERMAN 1992). The Mediterranean Region constitutes the main tropospheric ozone source of Europe, and this is due to the existing characteristic vegetation (SEUFERT, KOTZIAS, SPARTA and VERSINO 1995, VERSINO 1997). Studies carried out by STAUDT, BERTIN, HANSEN, SEUFERT, Ciccioli, FOSTER, FRENZEL and FUGIS 1997) demonstrated that species like *Pinus pinea* was a great source of VOCcontamination in the Mediterranean Region. The group of species that generate little VOCare *Fraximos spp*, *Ilex spp*, *Malus spp*, *Prunus spp*, *Pyrus spp*, and *Ulmus spp*. The use of these species in urban surroundings would improve the quality of the air. Contrarily, some species such as; *Eucalyptus spp*, *Quescus spp*, *Platanus spp*, *Populus spp*, *Rhamnus spp*, and *Salix spp*. generate a great amount of VOC (BENJAMIN, SUDOL, BLOCH and WINER 1996, BENJAMIN and WINER 1998).

Interactions of trees with the physical and chemical environment demonstrate that trees can cause changes in pollution removal rates and of climatic elements such as air temperatures, wind, and mixing-layer heights, which, in turn, affect ozone concentrations (NOWAK, CIVEROLO, RAO, SISTLA, LULEY and CRANE 2000).

This indicates to us that emissions of VOC from trees vary with their location, the type of species and, other environmental factors, like temperature and solar radiation (TINGEY, TURNE and WEBER 1991, GUENTHER, ZIMMERMAN and WILDERMUTH 1994). Even though the vegetation reduces temperatures, a determining factor in the VOC formation, a good vegetal cover in the cities would diminish the formation of O_3 (CARDELINO and CHAMEIDES 1990, DWYER, MCPHERSON, SCHOEDER and ROWNTREE 1992).

Isoprene and the Monoterpenes are natural chemical substances from which essential oils, resins and other plant products are obtained. These can act either as an attraction of pollinators or as a repulsion of predators (KRAMER and KOZLOWSKI 1979).

1.1.6 Trees conserve water and reduce soil erosion

Water has always been an important resource for humans, streams, rivers, lakes, providing the population with food and drinking water. With the growth of cities, the hydrographical basins have undergone great transformations; the regulation of the rivers, the drainage of humid areas and, the use of cement and asphalt in cities affect the natural hydrology of these areas (PECK and CALLAGHAN 1999).

The different land uses permit greater or smaller filtration levels of the water for the aquifers. In forest areas, the filtration reaches a value of 40-50% runoff having a value 10-20%. In urban residential areas the filtration is 35 % runoff level of 30% while the runoff reaches a level of 55% of the water flowing over paved areas, drains and channels (E.P.A. 2003). In Toronto, the principal cause of the contamination of local rivers runoff originates from the city, in the form of pesticides, fats, heavy metals and rubbish (PECK and CALLAGHAN 1999).

Urban trees in conjunction with the nature areas of the city work as absorbent water sponges, contributing to the absorption of nutrients and sometime supplying to the aquifers. These green spaces reduce runoff (SANDER 1986). In Milwaukee, where the tree cover is 16%, the trees reduce the storm water flow by 22%, saving US$15.4 mill reducing the necessity for constructing additional systems for the retention. In Austin, the tree cover is 30% of the urban area, reducing the rainwater flow by 28%, and saving US$122 mill (MACDONALD 1996).

1.1.7 Trees reduce noise pollution

Trees have for a long time been used as natural barriers to dissipate noise. AYLOR 1972, showed that vegetation reduces the sound level, while the ground absorbs them. Different studies have been carried out on this subject. While (REETHOF 1973, COOK and HAVERBEK 1971, HERRINGTON 1976, REETHOF and HEISLER 1976) were more interested in the qualitative aspects of tree vegetation like the location for planting of trees and shrubs, EMBLETON 1963, AYLOR 1972, KRAGH 1979, 1981) investigated quantitative aspects, value the type of species, the density, height, thickness of tree vegetation. Conclusions to these studies are: the density, height, length and thickness of the treed areas are the most effective factors for the reduction of the noise (COOK and HAVERBEK 1971); the size of the leaves and the characteristics of the branches have influence absorption levels (AYLOR 1972); the structure of the foliage of the vegetation can disperse the acoustic concentration at the sites near the emission source (COOK and HAVERBEK 1971); the dispersion diminishes with the distance from the source (EMBLETON 1963).

Wide and dense belts of vegetation of up to 30m are able to reduce the sounds by up to 50% (COOK 1978). For tree lines with widths of 3 meters or less, the reduction of the noise is around 3 to 5 decibels, when the vegetation is dense and supplemented by a row of shrubs (REETHOF and MCDANIEL 1978). The human perception of the sound levels is also important. Due to a blocking of the visual origin of the sound, the vegetation can reduce the perception of the amount of noise that the individuals can really hear (MILLER 1988).

1.1.8 Increase of Biodiversity

The diversity of life on Earth, from the microorganisms to the plants and animals, represents a wealth of resources whose values we are still learning to appreciate. Biodiversity contributes to societal benefits like food, medicine, materials for construction and services to the ecosystem, including the purification of water, recycling of nutrients and carbon trapping. Trees provide also food and shelter for urban wildlife. Many types of insects feed on trees, and in turn provide food for other insects and birds. Some birds and small mammals feed directly on tree pollen, flowers and fruits. Birds also use tree branches for courting and nesting

The urban agglomerations and in a special case, the cities, affect considerably the ecosystems that originally existed in the area. Loss of forests, changes in the hydrographic basins and in land use, have triggered the disappearance of natural spaces and natural resources, from which man physically and economically benefited. In numerous countries attempts are made try to revert these processes, for example by creating green space (parks, gardens, trees, etc) as places for the conservation of biodiversity and for recreation (SANTANDREU, GÒMEZ and DUBBELING 2003).

Studies have found that most of the inhabitants of the city enjoy and appreciate fauna in their daily lives (SHAW, MAGNUM and LYONS 1985), therefore it would be desirable to enrich habitats and to increase the biodiversity of urban forests (JOHNSON, BARKER and JOHNSON 1990)

This demonstrates to us that the city must be considered as a special ecosystem with a different environment, formed by species and peculiar habitats (SUKOPP and WERNER 1983, HOSTETLER and KNOWLES 2003).

An investigation, over 17 years, a family with a small garden of flowers, shrubs and trees counted 140 different species of fauna, including 64 species of birds, 5 species of small lizards, 6 species of frogs and over 70 different species of insects. This data, gave to the family of the garden a great sense of excitement in the creation of habitats for species that otherwise would not be there (GARDENING AUSTRALIA 1999).

2 Social benefits

2.1 Ecological conscience

The "re-naturing" of the city contributes an important opportunity for the population to learn about ecological aspects and their interconnections. The observation of urban nature and all its components (trees, shrubs, plants, birds, insects, etc) has always allowed us an opportunity for experimental learning. Studies by the Agency Environment Canada in 1999 stated that 43% of Canadians in 1996 were involved in outdoor activities in natural areas and, that 40% (9 mill. people) participated in nature-related activities in or near their residences. As HOUGH 1989 argued nature contact in the living surrounding is vital for the development of environmental conscience.

Recent evidences suggest the importance of the re-naturing programmes, and in this way, the separating of urban people from nature could be bridged. The urban trees form the nexus of union between the urban life and the rural one, naturalizing our cities and our lives. Those will contribute to generate an ecological conscience to the citizen. The leaves of the trees fall, change their coloration with the stations of the year, they are support a great biodiversity and cause multitude of alterations. Without trees, the streets of our cities tend to be uniform and monotonous. Community programs of tree planting can help to enlighten the lives of people in the city, especially for groups of low income (DWYER, MCPHERSON, SCHOEDER and ROWNTREE 1992).

(MILES, SULLIVAN and KUO 1998). In addition, restoration of tree vegetation offers numerous other benefits (JORDAN 1989, HARTIG, BOWLER and WOLF 1994). A study made of volunteers in Illinois who were working on restoration tasks, like gardening, planting trees, pruning, indicated that they developed a great sense of a Hatchment to nature and that they derived a great sense of satisfaction (MILES, SULLIVAN and KUO 1998).

2.2 Community Identity

Environmental planners have been interested in studying how the form of residential architecture, the dispersion of buildings, and the characteristics of public spaces could facilitate the formation of sense of community in neighbourhoods (ALTMAN 1975, BROWN and WERNER 1985). It became obvious that social ties are strongly influenced population density, lack of privacy and by noise, which may result in poor social relations in the community. (MCCARTHY and SAEGERT 1978, TOGNOLI 1987, KEANE 1991, KUO, SULLIVAN, COLEY and BRUNSON 1998a).

The presence of trees and other plants in public spaces could give a feeling of security to the people. (KUO, BACAICOA and SULLIVAN 1998b) studied individuals that experienced fear and were uncomfortable with public spaces, and found out it was because the areas were lacking in vegetation and, that people changed their minds when vegetation was introduced. This demonstrates that the vegetation strengthen the common bonds of a district. A study demonstrated that the length of time spent in a park or public space is dependant on the presence, location and number of trees (COLEY, KUO and SULLIVAN 1997, DEPOOTER 1997). Thus trees and plants play an important role in attracting people to the public spaces, embracing common interests and, creating social bonds between the residents. The opportunity for social contacts has been determined in the studies from (LEWIS 1996, BERMAN 1997). They demonstrated how neighbourhoods, where residents work together in tree rehabilitation projects, began to develop a neighbourhood identity and a sense of unity. KUO, SULLIVAN, COLEY and BRUNSON 1998a, found that in the public spaces with abundant vegetation, the social ties between the visitors were stronger in their own districtss, compared with citizens who visited green public spaces in other places. The use, enjoyment and creation of these spaces require an involved and participating community (HESTER 1984). The active participation in the programs of tree planting, involving the neighbourhood community, is a vehicle to raise or increase the social identity of the community and to generate many psychological benefits (MILES, SULLIVAN and KUO 2000),

demonstrate that people are prepared to work together, in environmental programs (DWYER 1995, KUO, SULLIVAN and COLEY 1998a).

(KWEON, SULLIVAN and WILEY 1998) found out that a great number of older people with strong social connections have a longer life expectancy, reduced rates of suicide, less fear of becoming a victim of crime and were of better physical and psychological health.

2.3 Crime and violence

Trees and shrubs in cities may be affected by acts of vandalism and spoilage; they may also give shelter for violence and crime. For that reasons many cities have continued clearing streets and parks from dense trees and shrubs stock due to the fear of criminal acts (TALBOT and KAPLAN 1984, NASAR and FISHER 1993, MICHAEL, HULL and ZAHM 1999, WEISEL, GOUVIS and HARREL 1994). On the other hand KUO and SULLIVAN 2001) suggest that trees can reduce crime by increasing the monitoring. JACOBS 1961 introduces the idea of "eyes in the street" making reference a form of public monitoring that could stop criminal acts. This idea was adopted by JEFFERY'S (JEFFERY 1971) concept of "prevention of crime through environmental design." Another concept is that of "social control of the neighbourhood" and "Territorial Functioning" making reference to the fact that criminals avoid those areas observed and controlled by neighbours (MACDONALD and GIFFORD 1989, BRUNSON, KUO and SULLIVAN 1998, NEWMAN 1972). A study using photographs of residential houses, examined the effects of architecture and the characteristics of the landscape with respect to delinquent acts. It was found that those houses with trees and shrubs seemed safer than those which did not have them (BROWER, DOCKETT and TAYLOR 1983). Another study based on a simulation of images by computer, studied the spaces in the interior of the city and, rejected the assumption that a feeling of security existed in those areas with greater density of trees (KUO, BACAICOA and SULLIVAN 1998b).

(STAMEN 1993, KUO and SULLIVAN 2001, BRUNSON, KUO and SULLIVAN 2001) found that in houses located within well-treed areas of more trees, violence was less frequent than in houses situated in areas with no or few trees. The residents of houses in nice treed areas normally are more constructive, and display less intra-family forms of violence and conflicts (SULLIVAN and KUO 1996). In addition, residents in green areas are said to be "safer" than in those zones without trees (KUO, BACAICOA and SULLIVAN 1998b).

It is interesting that during the disturbances in Los Angeles, after the verdict of Rodney King, (black citizen who was stopped and where the abuse of the police during the arrest was hard), the spaces of neighbourhoods without trees were more severely damaged, than the communities with gardens and treed spaces (BRUNSON, KUO and SULLIVAN, no published results).

2.4 Mental and physical health

The stress, the work and the speed of life has caused the urban population to become irritable, non-sociable and to lose enthusiasm and commentment for social needs (SORTE 1995). Investigations affirm that visual and physical contact with nature produces a state of mind that can cope better with stress (KAPLAN 1973, ULRICH 1976, 1984, JACKSON 2003, FRUMKIN 2001, HILL 2002). A study carried out by HONEYMAN 1992, demonstrates that young people who experienced natural landscapes diminished considerably their levels of stress. On the other hand, there was an increase in their levels of stress for those who were exposed to images of urban life. HONEYMAN concludes "that the exclusion of vegetation in the urban areas negatively affects human psychology, increasing the levels of stress" and that, the inclusion of vegetation in the city has positive impacts on residents.

Contact with nature also positively affects work satisfaction and well-being, (KAPLAN 1993), lessens mental fatigue (KAPLAN and KAPLAN 1989, SORTE 1995, ULRICH and SIMON 1986), changes negative moods and reduces pressure (HULL 1992).

Tees besides of contributing to the aesthetic quality of urban streets and communal parks (SCHROEDER 1989), generate important emotional and spiritual experiences that allows people to establish strong roots to particular places (CHENOWETH and GOSTER 1990). Trees, shrubs and flowers are of an intrinsic interest to people, allow them to rest and recreation physically and mentally (SCHROEDER and LEWIS 1991, ROHDE and KENDLE 1994)

In a hospital in Pennsylvania, patients in post-operation care were studied. Half of the patients could see through their windows great trees, the other could only see a brick wall. The results were that the patients with views to the trees recovered earlier and, obtained better medical reports than the patients with the view of the wall (ULRICH 1984).

Physical activities are always been associated with health, good fitness and as a therapy against depression. For that reason it is recommended to participate in community projects of gardening and restoration of parks. Those activities include considerable physical exercises that diminish heart diseases, in older and middle-aged people (CASPERSEN, POWELL and CHRISTENSON 1985). In addition, the shade of trees diminish the risk of problems associated with ultraviolet radiation (HEISLER and HERRINGTON 1976, HEISLER, GRANT, GRIMMOND and SOUCH 1995).

3 Economic benefits

3.1 Values of property

Urban trees contribute to the vitality and economic stability of districts, increasing the value of properties and by consequence of the neighbourhood. Most people think that the districts with trees are attractive places to live. This demand of the population in search of green spaces has increased the values of the houses as opposed to those of other places lacking vegetation (KITCHEN and HENDON 1967, CORRELL, LILLYDAHL and SINGELL 1978, MORALES 1980, MORALES, MICHA and WEBER 1983, DWELL, et al 1983, ANDERSON and CORDELL 1988, DWYER, MCPHERSON, SCHOEDER and ROWNTREE 1992). A survey on sales of single family houses in Atlanta, Georgia, indicated that the well landscaped houses with trees increased by 3.4 to 4.5% the value real estate (ANDERSON and CORDELL 1988). Another study, carried out in the city of Salo (located 110 km to the northwest of Helsinki) showed that the value of terraced house price with a view onto forest increased by 4.9% (TYRVAINEN 1999, TYRVAINEN and MIETTINEN 2000). Real estate developers consider that houses with trees are sold on average of 7% faster than those houses without trees (SEILA and ANDERSON 1982, 1984).

A survey made of 250 residents of Detroit, found out that 90% of those questioned thought that the presence of trees in their neighbourhood increased the value of their properties by 10%. In addition, they associated the presence of urban forests with neighbourhoods of high income, high property values and better educated people (GETZ, KAROW and KIELBASO 1982). These increases of the property value generated by the trees, brings directly economic gains for the community. Nevertheless, from the perspective of the owner of a house, the increases of residential taxes in treed areas is a negative consequence.

The quantification in property value by urban forestry is not always easy. In a comparison between the Hedonic approach and the Expert approach made by PRICE 2002, the author describes the importance of choosing the correct variables, the interaction among them and the difficulty of analysing several variables like “income and view quality, nice neighbourhood as an attribute and social implications of neighbourhood environmental quality interactions”. The research concludes that the context is very important in the quantification of view quality value. The factor that makes the mechanical application of standard models dangerous.

3.2 Economic benefits at the community level

Trees represent an important benefit for the society; (e.g. health, saving of energy, filtration of the water, absorbing pollutant agents and most important but hard to evaluate, comfort and well-being). Treed areas contribute to the economic vitality of a city, neighbourhood or home. MCPHERSON 1991, studied a tree plantation project of 500,000 new trees in Tucson, during 40 years, to calculate its benefits to the community. The study compared the expenses of irrigation, costs of pruning and elimination, with the ecological benefits, for example: moderation of temperature, filtration of dust and retention of run-offs. The effects of a moderation of the temperature were quantified using the (by air conditioning reduction); the other two categories were the costs of the use of alternative control mechanisms, such as paving of the streets (control of the dust) and the construction of pools for the retention of rainwater were also quantified. For the first 5 years, the costs outweighed the benefits, during the following 25 years however, the benefits exceeded the costs eventually by more than three times.

Other research, carried out in two American cities (Modesto and Santa Monica) by MCPHERSON and SIMPSON 2002, quantified the benefits and costs that urban trees contribute to these cities. The researchers calculated the economic benefits from; energy saving, atmospheric carbon dioxide reduction, air quality improvement, stormwater runoff reduction, and aesthetics. Their studies included an analysis of data on expenditures associated with urban trees, such as planting, pruning, removal, repair, leaf clean-up, administration cost and legal problems. The results of the calculations showed that trees provided net annual benefits valued at US$ 2.2 million in Modesto and US$ 805.732 in Santa Monica, which, in benefits-cost ratios correspond to 1.85:1 in Modesto and 1.52:1 in Santa Monica.

MCPHERSON and SIMPSON 2002, concluded that although these kind of studies require large amounts of data and intensive modelling and analysis, they could provide cities with information about benefits and associated expenditures of urban tree projects concrete.

4 Conclusion

Urban trees represent a nexus between artificial and natural environments. Cities require a greater degree of naturalised surroundings, work and play spaces, where the citizens experience many positive physical and psychological feelings, and where there is a need for better communication and social ties. With this review, we conclude that urban trees are not only aesthetic accessories, but become key elements in making cities more sustainable and liveable. In developing countries, new urban zones often have a lack of trees, even when they have been established in former forest zones. Urban trees, are often not enough appreciated by City councils that have other priorities, and they are unwilling to confront the expenditure today though required.

Many cities make an effort to reverse this situation. Urban green generally improves also the standard of living of people. There is a close relation between social standard and urban green of the residential area in many countries. Often the rule is: As greener the district as richer are the inhabitants. The urban green spaces still are considered to be a luxury in many countries. Urban public green is important for all social layers and all parts of the cities. It provides many benefits for a society more and more demanding nature contact as part of daily live. We believe that future investigations will focus more on a study of urban trees, since they are often only natural element that urban people have access to.

In this last decade the idea of urban sustainability gets more and more support. For urban planners data are required on the location of trees and green areas, the type and density of trees, the perspectives of the residents to urban green etc. This opens the field of extended interdisciplinary research and

application of the results in practice. With this, the urban tree would stop being a simple aesthetic component of the city and become a part of the urban ecosystem to develop its proper functioning.

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