METSÄNTUTKIMUSLAITOKSEN TIEDONANTOJA 739, 1999
FINNISH FOREST RESEARCH INSTITUTE, RESEARCH PAPERS 739, 1999

Monetary valuation of urban forest amenities in Finland

Liisa Tyrväinen



VANTAAN TUTKIMUSKESKUS
VANTAA RESEARCH CENTRE

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10.09.99

METSÄNTUTKIMUSLAITOKSEN TIEDONANTOJA 739, 1999
FINNISH FOREST RESEARCH INSTITUTE, RESEARCH PAPERS 739, 1999

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ACADEMIC DISSERTATION

To be presented, with the permission of the Faculty of Forestry of the University of Joensuu, for public criticism in Auditorium C2 of the University, Yliopistokatu 2, Joensuu, on August 26th, 1999, at 12 o'clock noon.

VANTAAN TUTKIMUSKESKUS
VANTAA RESEARCH CENTRE

Liisa Tyrväinen 1999. Monetary valuation of urban forest amenities in Finland. Finnish Forest Research Institute, Research papers 739, 1999. 53 + 76 p.

Distribution: The Finnish Forest Research Institute, Library. Address: P.O. Box 18, FIN-01301 Vantaa, Finland. Email: library@metla.fi

Cover photo: The townscape of Salo by Liisa Tyrväinen.

Layout: Heikki Prokkola

Author's address: The Finnish Forest Research Institute, P.O. Box 18, FIN-01301 Vantaa, Finland. Email: liisa.tyrvainen@metla.fi

ISBN 951-40-1688-2
ISSN 0358-4283

Printed in Tummavuoren Kirjapaino Oy, Vantaa 1999

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ABSTRACT

Urban development projects often decrease the amenity values of green spaces; they should, however, be taken into consideration in planning. Therefore, quantitative information on residents' valuations concerning urban forests is needed for assessing urban land-use.

The focus of the thesis was on forest and forest-like areas in the urban environment. The main objectives were to quantify the values attached to urban forests in monetary terms and analyse the possibilities of using such information in urban land use planning. Two economic valuation methods, hedonic pricing and contingent valuation, were applied in two different urban environments, Joensuu and Salo. This thesis is a summary of four empirical studies.

The hedonic pricing studies examined external benefits and costs associated with housing. The main aim of the studies was to determine whether urban forest benefits are capitalized in property prices. The data for property value studies were collected in both towns from owner-occupied terraced house apartments. Price data from real estate transactions consisted of 1020 observations in Joensuu and 662 observations in Salo. Environmental and locality data were measured with respect to each specific house.

The results show that urban forests are clearly an environmental amenity and that people pay for such benefits through apartment prices. In Joensuu, a growing amount of forested areas in the housing district as well as nearness to a watercourse and recreation area increased apartment prices. However, the effect of small forest parks was not clear. In Salo, where urban forests are more scarce, the effect on property values was clearer. Although preferences may vary between different households, on the average Salo residents were willing to pay 4,9 per cent more in order to obtain a forest view. In addition, proximity to forested parks was found to have a significant positive effect on house prices. According to the semilog model, an increase in distance of one kilometre reduced the average price of a dwelling 5,9 per cent. In the model, where distance to a park was established as dummy variables, the effect was found up to 600 metres distance from the park.

Contingent valuation questionnaires were sent to 500 randomly chosen residents between 15 and 75 years of age in Joensuu in spring 1995 and in Salo in autumn 1996. In the survey the residents were asked about their attitudes to urban forests as well as their willingness to pay for the use of wooded recreation areas and for small forested parks. The results show that urban forests were seen in both towns to produce positive rather than negative externalities. The main values in both towns were related to nature and social functions as well as mitigation of urban climate. The negative effects were related to the management of the areas rather than their existence. The use of urban forests in Joensuu was more intensive compared to Salo, due to better supply rather than cultural differences. Timber production was given distinctly low priority

in both study towns. The results stress the importance of defining urban forest policies in Finnish municipalities, where multipurpose objectives for forest management are still rare.

More than two-thirds of the respondents were willing to pay for the use of recreation areas in both towns. Moreover, good location and active management raised the average willingness to pay (WTP). Furthermore, on the average half of the people were willing to pay to prevent the conversion of forested parks to some other land use. The average WTP for preventing construction in urban forests varied in Joensuu from 126 to 206 FIM/year per household and in Salo from 74 to 169 FIM/year per household.

The main use of the methods developed here is in connection with the economic evaluation of the impact of urban land use plans as well as evaluation of the profitability of urban greening projects. The results of the study show that the monetary benefits of urban forest amenities in recreation areas are much higher than the present maintenance costs. The amenity benefits of the study areas were also demonstrated to be higher than the estimated benefits from timber production. These results indicate that on social grounds urban forests are a cost effective concept. Furthermore, the examples concerning the advantageousness of construction in green areas suggest that a certain limit could be found at which infill of housing areas is not worthwhile from the point of view of society, if the losses of green space benefits are taken into account.

Keywords: amenity benefits, CBA, contingent valuation, hedonic pricing, property values, town planning, urban forests.

TIIVISTELMÄ

Taajamametsien hoidon ja käytön ongelmat taajamissa johtuvat pitkälti tehdyistä maankäyttöratkaisuista. Suunnittelussa ja rakentamisessa alkuperäistä luonnonkasvillisuutta ei arvosteta riittävästi, ja viheralueet pirstoutuvat usein liian pieniksi kestääkseen niille kohdistuvaa käyttöpainetta. Maankäyttösuunnittelussa ratkaisut tehdään usein teknis-taloudellisin perustein. Siten metsien aineettomat hyödyt (maisema, virkistysmahdollisuudet, suojavaikutukset) ja niiden tuottamisen tavoitteet jäävät helposti syrjään. Nykyisin suunnittelusta puuttuvat keinot ympäristöhyötyjen yhteismitalliseen vertaamiseen muiden maankäyttömuotojen kanssa.

Ympäristötaloustieteissä on hinnattomien ympäristöhyötyjen arvottamista tutkittu ja menetelmiä kehitetty erityisesti Yhdysvalloissa. Tämän väitöskirjatutkimuksen tavoitteena on tutkia viheralueiden merkitystä ihmisille ja mitata taajamametsien tuottamia aineettomia hyötyjä rahamääräisesti. Työn laajempana tavoitteena on edistää viheralueiden hyötyjen huomioon ottamista maankäyttösuunnittelussa nykyistä paremmin. Työ koostuu neljästä osatutkimuksesta ja niiden yhteenvedosta.

Suomessa taajamametsien taloudellisen arvon mittaamiseen sopivimpia ovat hedonisten hintojen menetelmä ja contingent valuation -menetelmä. Empiirisen tutkimuksen kohteiksi valittiin Joensuun ja Salon kaupungit. Hedonisten hintojen menetelmää sovellettiin kummastakin kaupungista kerättyihin asuntohinta-aineistoihin. Joensuun hinta-aineisto käsitti 1020 ja Salon aineisto 662 asuntokauppahavaintoa rivitalohuoneistoista. Aineistoista estimoitiin asunnon hintaa selittäviä hintamalleja, joissa erityisesti tarkasteltiin puustoisuuden ja viheralueiden läheisyyden vaikutusta asuntohintoihin. Malleissa selittäjinä käytetyillä metsämuuttujilla pyrittiin mittaamaan asuntoalueen väljyyden, ulkoilumahdollisuuksien, metsänäkymän sekä puuston suojavaikutusten vaikutusta asunnon hintaan.

Tulosten mukaan asukkaat arvostavat vihreää ja väljää asuinympäristöä, ja ovat siitä myös konkreettisesti valmiita maksamaan asuntoa ostettaessa. Joensuussa metsäisten virkistysalueiden läheisyys nosti asunnon hintaa, mutta kuitenkin vähemmän kuin vesistön läheisyys. Salossa metsänäkymä nosti asunnon arvoa keskimäärin 4,9 prosenttia. Metsäpuistojen läheisyys nosti asunnon hintaa puolilogaritmimallissa siten, että kilometrin etäisyys metsäpuistoon alensi asunnon hintaa 5,9 prosenttia. Loglineaarisessa mallissa hintavaikutus todettiin kuitenkin epälineaariseksi siten, että hintavaikutus oli voimakkain puistometsän lähellä. Mallissa, jossa puistoetäisyys oli luokiteltu dummy-muuttujiksi, hintavaikutus oli tilastollisesti merkitsevä 600 metrin etäisyyteen asti.

Contingent valuation -tutkimuksessa tehtiin kummassakin kaupungissa 500:lle asukkaalle postikysely, jossa selvitettiin asukkaiden taajamametsiin liittyviä arvostuksia, alueiden käyttöön ja asuinympäristön metsien määrän muutoksiin liittyvää maksuhalukkuutta.

Analysoinneissa laskettiin maksuhalukkuuden (WTP) tunnuslukuja ja arvioitiin taajama-metsien virkistysarvoa suhteessa hoitokuluihin, niiden metsätalousarvoon ja arvoon rakennusmaana.

Noin kaksi kolmasosaa virkistysalueiden käyttäjistä oli valmis maksamaan käyttömaksun alueen käytöstä. Alueen edullinen sijainti ja hoitoaktiivisuus nostivat maksuhalukkuutta. Laskentaesimerkkien mukaan kummassakin kaupungissa alueiden virkistysarvo on moninkertainen verratuna nykyisiin hoitokustannuksiin tai selvästi suurempi kuin niiden arvo puuntuotannossa.

Noin puolet kotitalouksista oli valmis maksamaan rakentamisen estämiseksi viheralueille. Joensuussa kotitalouksien keskimääräinen maksuhalukkuus vaihteli 126-206 mk vuodessa ja Salossa keskimääräinen maksuhalukkuus oli 74-126 mk vuodessa. Alueen läheisyys, erityisesti sen käyttö tai näkymä alueelle nostivat maksuhalukkuutta. Tutkimuksessa esitetyt laskenta-esimerkit osoittavat, että kaupunkirakenteen tiivistäminen ei välttämättä ole paras vaihtoehto, mikäli viheralueiden menetetyt hyödyt otetaan kaavataloustarkasteluissa huomioon.

Tutkimustulokset korostavat viheraluepolitiikan sekä maisema- ja virkistysarvoja korostavan metsänhoidon tärkeyttä suomalaisissa kunnissa. Tutkimuksessa kehitetyt mallit ovat apuvälineitä maankäytön muutosten hintavaikutusten arviointiin. Lisäksi viheralueiden aineettomien hyötyjen yhteismitallistaminen ja rahamääräinen mittaaminen on apuväline maankäyttösuunnittelun YVA-menettelyyn ja sen kehittämiseen.

PREFACE

This work has been funded by the Faculty of Forestry of the University of Joensuu and the Foundation for Research of Natural Resources in Finland. I should like, in particular, to thank Professor Seppo Kellomäki at the University of Joensuu for his interest in this research topic and for arranging financial support for the research work.

The last parts of this thesis were prepared at the Vantaa Research Station of the Finnish Forest Research Institute. In particular, I wish to thank Professor Eero Paavilainen, head of Vantaa research centre, for providing the pleasant working facilities and the possibility to concretely integrate to research conducted at the Finnish Forest Research Institute.

Furthermore, Professors Timo Pukkala and Olli Saastamoinen from the University of Joensuu and Drs Heikki Pajuoja, Jyrki Kangas and Ville Ovaskainen from the Finnish Forest Research Institute as well as Drs Markku Ollikainen and Seppo Laakso from University of Helsinki have provided valuable comments during the research work. Many researchers, in particular, Drs Anni Huhtala and Matti Vainio, have given valuable assistance concerning the CV studies. Several other researchers, in particular Antti Miettinen from the Department of Economics and Prof. Juha Alho from the Department of Statistics of the University of Joensuu, have provided valuable help in econometric and statistical questions.

Research Assistants Jarkko Kähkönen, Jaakko Piirainen, Antero Remus, in Joensuu, as well as Minna Kontkanen and Harri Silvennoinen, in Salo, collected the data with care and precision. I also want to specifically thank Anne Pitkänen for collecting the data and carrying out the CV survey in Salo and Hannu Väänänen for realizing the CV study in Joensuu.

The Technical Department of City of Joensuu, in particular Chief Gardener Kai Ahmio, City Forester Matti Viirret and Planner Irene Martiskainen have been helpful in providing all the necessary information. Furthermore, I want to thank Town Gardener Matti Järvinen, Mr. Matti Rönkä from the Technical Department and Ms. Ulla Olvio from the Town Planning Department in Salo for their help.

Special thanks belong to my colleagues in urban forestry, Mr. Cecil Konijnendijk and Dr. Andreas Ottitch, who offered constructive comments to improve the articles. I want also to express my gratitude to my closest colleagues, Researchers Liisa Tahvanainen at the University of Joensuu and Irja Löfström at the Finnish Forest Research Institute, who have supported and encouraged me during the research process. Liisa Tahvanainen has shown extraordinary flexibility and patience in carrying out our numerous mutual research projects. Irja Löfström has helped through countless inspiring discussion on the research topic which have developed and improved the work.

I also wish to thank the reviewers of this thesis, prof. Colin Price from the University of Wales and Dr. Ville Ovaskainen from the Finnish Forest Research Institute, for their constructive comments that were helpful during the final revision of the manuscript. The English language of the thesis was corrected professionally by Drs Roy Goldblatt, Ashley Selby and John Stotesbury.

My family and friends have also supported me many ways. I wish to thank my husband, architect Heikki Prokkola, for his encouraging support and the practical help in preparing the illustrations as well as for the many professional discussions that have helped me to put the research results into perspective. Furthermore, I wish to thank my mother Ella for her support, my mother-in-law Ritva Prokkola, for her invaluable practical help at home during the long working days, and my father-in-law M. Sc. Esko Prokkola also for helping me out with the mathematical problems during the research process. Finally, I am grateful to my little daughter Ella Jr., who above all, has kept me in touch with the joy and other real values of life.

My warmest thanks to all who have contributed to the completion of this study.

Vantaa, 27th June 1999. Liisa Tyrväinen

LIST OF ARTICLES

This thesis includes the following articles:

I Tyrväinen, L. 1997. The amenity value of the urban forest: an application of the hedonic pricing method. Landscape and Urban Planning 37: 211–222.

II Tyrväinen, L. & Väänänen, H. 1998. The economic value of urban forest amenities: an application of the contingent valuation method. Landscape and Urban Planning 43: 105–118.

III Tyrväinen, L. & Miettinen, A. 1999. Property prices and urban forest amenities. Manuscript submitted to Journal of Environmental Economics and Management. 27 p.

IV Tyrväinen L. 1999. Urban forest benefits and economic valuation in Finland. 23 p.

1. INTRODUCTION

1.1. Urban forests in town planning

Green areas have important amenity values contributing to the quality of life. The importance of urban greens has in particular been noted in highly urbanized European countries. In Belgium, urban greening is one of the main development interests in cities (van Herzele 1998). In the Netherlands, the desire to protect and increase the amount of urban greens has led to a range of national, provincial and local policy initiatives (Konijnendijk 1998). Furthermore, in Denmark, creating new forests in and near urban areas is included as a very important goal in the national afforestation program (Jensen 1995). Although there are increasing demands for different types of green areas as a result of population growth and rising environmental awareness, at the same time there are increased pressures caused by urban development and expansion as well as cuts in the budgets for green areas to convert green areas to other use.

Planning and design of urban greens cannot be based solely on natural sciences and economics, but human values must also be involved. The resolutions of the Third Ministerial Conference in Europe call for enhancing the socio-economic aspects of forests; these also include recreational and aesthetic values (Lisboa 1998). However, there seems to be a difference between the expectations of residents and their desire to 'live close to nature' and present planning policies. In Finland, several surveys suggest that the quality of the living environment ('living close to nature') is an important criterion for choosing a permanent residence and a type of housing (e.g. Kuntien... 1987, Suomalaisten... 1991, Maarttola 1998). Although preservation of urban forests may rank high among strategic objectives in city planning, it is less successfully put into practice in land use decisions (Vuolanto & Tuhkanen 1982, Tyrväinen 1994, van Hertzele 1998).

The amount of different types of green areas in a housing district is based on planning guidelines (Asuinalueiden... 1976) stating that a certain amount of land should be set aside for open space. Although today these standards may often be met in urban planning, the suitability of the areas allocated for recreation may be low. According to Vuolanto and Tuhkanen (1982) landscape planning is seen as scattered and off the beaten path in the planning of residential areas. Building efficiencies have generally been set before inventories of nature in the planning area are made and knowledge of the carrying capacity of the potential green areas is gained. In particular, during the rapid expansion of urban areas, particularly in the 1970s, little attention was paid to environmental planning for housing areas (Mattinen 1977, Maisema... 1978, Halme & Lehtonen 1983). According to Vilkuna (1992) the main criterion for allocating land for green areas has often been their low suitability for construction. In addition, the

guidelines for protecting trees during construction (e.g. Kellomäki & Loikkanen 1982), are not systematically employed and the practice of clearing all trees on building sites is still in use.

Planning and design ideas concerning urban green areas have changed through the years. The main trends have been rather similar in the Nordic countries, especially in Sweden and Finland. In Finland, urbanization accelerated only after World War I. Until then, in the late 1800s and early 1900s, town planning was compact and based on a grid plan. In the 1910s ideas of garden cities, where residential areas were for the first time detached from the town centre, were introduced to Finland from England. Early examples of this type of planning were Kulosaari and Munkkiniemi residential areas in Helsinki (Jalkanen et al. 1997). However, in the 1920s functionalism started to gain support among town planners and during the 1930s it was the leading planning philosophy. In green space planning this trend led into the incorporation of agricultural and forest land into and between urban districts (Bucht 1997). The main difference between the garden cities and the new approach was in the design of residential quarters. In garden cities the quarters were closed whereas the new planning philosophy stressed an open quarter structure. Therefore, woodlands were secured inside and near new housing estates. The small-scale building techniques that were still being used in construction made it possible to maintain the natural forms of terrain and vegetation, including standing trees, even close to the new houses. This planning ideology continued through the 1940s and 1950s. In Finland, new housing areas in the 1950s were most often built in the forested landscape. Today, these housing districts are pleasant because of the suitable scale and careful planning of green areas (Hultin 1997).The most representative example of these 'forest towns' was Tapiola, built in Espoo in the late 1950s (Jalkanen et al. 1997).

However, during the next phase of functionalism in 1960s and 1970s, the green space benefits were mainly forgotten, as rapid construction of suburbs took place. The new construction techniques using precast elements resulted in lower environmental quality (Jalkanen et al. 1997). The technique involved huge alterations in the existing terrain, landscape structure and vegetation, and agricultural land was frequently used as construction sites. Furthermore, the grid plan was reintroduced as a planning method, and the aim was to create more urban-like environments as a response to criticism among architects against 'forest towns' (Jalkanen et al. 1997). According to several surveys the quality of housing areas built during those decades was often low. Removal of old trees and forest vegetation and lack of new plantations in new housing areas was common. The difference between the environmental quality of areas built in the 1940–1950s and 1960–1970s is distinct (e.g. Mattinen 1977, Helin et al. 1982, Halme & Lehtonen 1983). The new vegetation was artificial and out of balance with

man-made lawns and new tree plantations replaced original vegetation. The planning was best in terms of environmental quality in one-family residential areas (Mattinen 1977, Halme & Lehtonen 1983).

At the end of the 1970s and the beginning of the 1980s ideas from central Europe (England and the Netherlands) concerning ecological parks and nature-like plantations were also introduced to Finland (e.g. Kivi & Simons 1988, Tyrväinen 1998). Since then efforts have been made to conserve trees and natural ground vegetation in the construction of new residential areas (Flårgård & Schibbye 1984). However, condensing the existing town structure became the prevailing ideology in town planning as a reaction to suburbs (Jalkanen et al. 1997).

In the 1990s the main theme in city planning has been ecological construction. In principle, it means the use of recyclable building materials and energy-saving solutions as well as nature-saving construction, where landscape planning is important (Jalkanen et al. 1997). Infill of existing housing areas has been seen as a general solution for attaining the goals of sustainable development in the urban environment in order to achieve the main targets: savings in transportation costs and in the use of natural resources and energy (e.g. Lahti & Rauhala 1994). This has resulted in an increasing demand for land within city limits and demands to build on land allocated to green spaces (e.g. Grahn 1991). This usually means decreasing the amount of green spaces within housing areas as well as increased use pressures on the remaining green areas, which often leads to overuse and the impoverishment of nature. In extreme cases it leads to building up parks instead of using natural vegetation, which considerably increases their establishment and maintenance costs.

Today, in Finland, the problems related to compact city policies are current because of continuing migration from the countryside and smaller towns to development centres. This exerts increased pressure on land use in urban population centres – in particular in the Helsinki metropolitan area, which is expected to receive 180 000 new inhabitants by the year 2020 (Väestö... 1999). Thus far, the economic aspects – as narrowly defined – have dominated the discussion of urban development, but the criteria for environmental quality have been discussed much less. Rather little consideration has been given to determining the impacts of infill on green areas and how the successfully condensed town structure and sustainable use of green areas can be combined (e.g. Vilkuna 1992).

1.2. Definition of urban forest

The concept of 'urban forestry' originates from 1965 and was used in a Master's thesis at the University of Toronto (Jorgensen 1986). Although the concept was introduced in Canada, it took firmer root in the United States: during the past thirty years urban forestry grew from an academic concept into its present form (Johnston 1996). According to Miller (1997) the major driving force behind

the issue for foresters was that political power had shifted to the cities and that foresters had to deal increasingly with the demands of urban residents. This situation is similar to that of Finland today.

In North America 'urban forests' are defined to embrace all urban green spaces including woody vegetation (Grey and Deneke 1978, Johnston 1996, Miller 1997). The closest corresponding Finnish word is *viheralue* (green area) and encompasses all types of urban greens in the built environment (Tyrväinen 1995). In Europe, in contrast, no definitive meaning for urban forestry has yet been found (Cost... 1997). The concepts vary between countries due to different national circumstances. In some parts of Europe the majority are man-made green spaces while in some parts, particular in the north, most green areas are formed from preserved forest vegetation.

Today, however, a common European definition is being sought because of multidisciplinary research interests (Cost... 1997). According to Nilsson & Randrup (1996) most people consider urban forests to consist primarily of two types of plantings: urban forests and single urban trees. Urban forests can be defined by their location, placed in or near urban areas, and by their multi-functional aspects, such as amenity values, mitigation of urban noise and pollution control. Based on these arguments, a broad definition of urban forestry has been suggested for European conditions: 'the establishment, management, planning and design of trees and forest stands with amenity values, situated in or near urban areas' (Nilsson & Randrup 1996).

In Finland, the urban forest (*taajamametsä*) was first defined by Löfström (1987) as a forest located in or near an urban area, in which the main function is recreation. The areas consist mainly of natural forest vegetation and therefore the definition excluded, for example, man-made parks with lawns. The size of urban forests may vary from less than half a hectare to tens or sometimes even hundreds of hectares. Usually the areas are fairly small but may often be numerous in a housing area. Large forests preserved for recreation are usually found on the urban fringe (Tyrväinen 1994). The most typical definition of urban forestry in Europe is rather similar to the Finnish definition: 'planning and managing forest and forest-like vegetation in and near human settlement' (Konijnendijk 1997).

In Finland, the municipalities own about 430 000 hectares of forest (Löfström 1999). They also own the large majority of urban forests and are responsible for providing the green space services. Although the amount of urban forests may be rather small compared to production forests, they are located near people, where a major part of environmental "consumption" takes place (Tyrväinen 1994). On the one hand, some areas may have already a rather long history, such as the Helsinki Central Park, but many of the present urban forests in Finland originate from previous timber production forests. These areas are characterized by silvicultural practices used in production forests because

often no preparatory management methods have been introduced prior to construction.

Still today, urban forest policies, i.e. specified objectives for forests, are rare in Finnish cities and towns. According to Löfström (1990) two-thirds of municipal forests are commercial forest, i.e. dedicated to timber production. The share of recreational forests is about 16 percent. More than half of the recreational forest in municipal ownership is located outside urban areas. Although most municipalities have a forest plan, multipurpose objectives are commonly lacking in urban forest management. The distinct features include a lack of management and a lack of outdoor recreational facilities. Furthermore, the recent economic depression has been reflected in cuts in the maintenance budgets in many towns. A similar trend is also found across Europe (e.g. Lidestav 1994, Konijnendijk 1999). These facts imply that the amenity values of urban forests have not been adequately recognized by decision-makers in municipalities and in general.

1.3. Cost-benefit analysis of urban forests

The advantageousness of an urban development project can be calculated as the difference between the benefits and drawbacks of the project. In town planning benefits and drawbacks can seldom be measured by one and the same quantitative unit. There are impacts which cannot be measured precisely, but this should not mean that these things do not have to be taken into account in the decision-making. However, the final objective is a situation where as much of the decision as possible is based on scientific measurements, information and comparisons, although perfection is unattainable (Lahti 1975).

In the planning of residential areas cost analysis and control should be an integral part of all planning and decision-making as a result of savings in building costs (Fig 1.) (e.g. Kivistö & Lahti 1974, Kivistö 1987, Asuntoalueiden... 1990). However, today comprehensive economic assessments of town plans are rare. One reason is that basic information for the comprehensive economic evaluation of alternative plans is inadequate. Furthermore, the environmental impact assessment (EIA) required in city planning is qualitative and does not include monetary valuation (Ympäristövaikutusten... 1998). Therefore, the environmental impact assessment of town plans leaves space for subjective valuation.

The land use planning phase, which includes questions of how many and what kind of areas are to be allocated as green spaces, is crucial for urban forest management. It determines the long-term possibilities for sustainable management of green areas. Many of the present management problems are caused by assigning inadequate areas for open spaces or areas with low trampling tolerance (Vilkuna 1992, Löfström 1996).

Moreover, the continuous fragmentation of forests leads to serious management problems. It is also worth noting that the cost of establishment of new woody vegetation is more than ten times higher than pre-

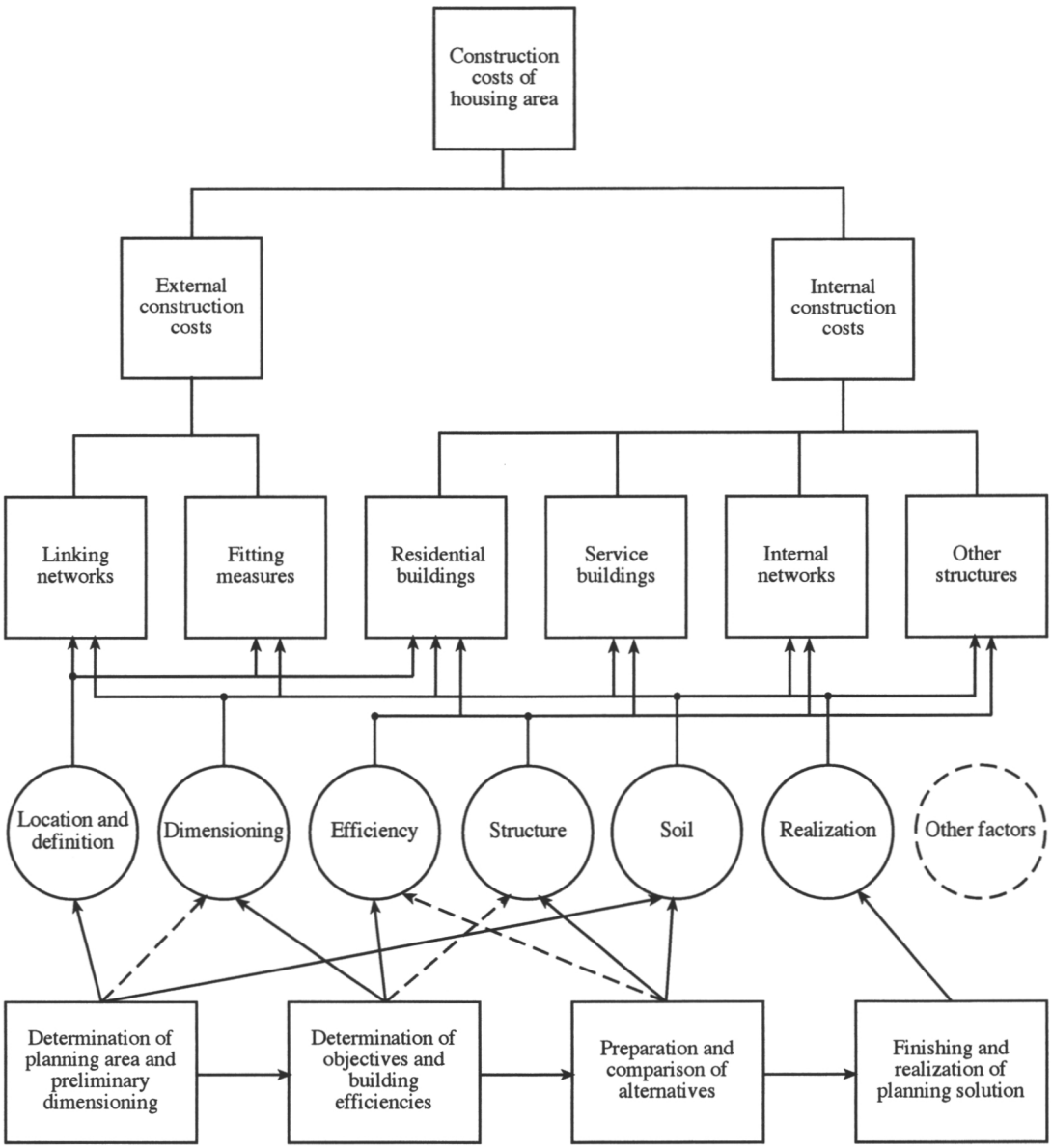

Figure 1. Planning process of residential areas and construction costs (Kivistö 1987).

serving existing forest vegetation (e.g. Vuolanto & Tuhkanen 1982).

In addition, the amenity benefits of green areas are many and local residents often oppose development plans such as infill of residential areas. Therefore, the losses and gains of different development alternatives should be assessed comprehensively from the point of view of society.

Land use planning is to a great extent a question of priorities between competing interests. According to Andersson (1992) environmental interests have low priority compared to technical and economic ones. This is due to several factors, such as lack of political will, sectorization, lack of knowledge and attitudes. Poor planning results may be based on poor knowledge of green space benefits, but low appreciation by planners of wooded green spaces is often based on narrowly-defined economic reasons. According to (Grahn 1991) condensing the structure of many Swedish cities is justified by means of economic arguments.

In principle, the amenity value of an urban forest is assessed for the first time by a municipality when unimproved land is purchased. According to Hiltunen (1997) the most important factors affecting the price of unimproved land were purchaser, time of purchase, area size, and distance from the town centre and the main road. However, the advantageousness of constructing on unimproved land at the urban fringe rather than infill of existing housing areas depends to a large extent on costs other than the price of land. In fact, the cost of unimproved land is only 1 percent of the municipal costs in residential areas; approximately 90 percent is a result of public services such as schools and health care (Tamminen et al. 1997). The expense of building the general infrastructure of the new area is crucial; it varies between towns and depends of the situation in each municipality. It has also been found that most condensed areas are not the best in economic terms. The net income of municipalities is highest in rather condensed one-family residential areas (Tamminen et al. 1997). Nevertheless, the low price of unimproved land compared to other municipal costs may be the reason why little attention is paid to the preparatory work of forested areas before construction or to the low interest in preserving the woody vegetation during construction.

There are several methods that could be used to provide information of residents valuations for urban land-use desicion-making. These methods include participatory planning, desicion analysis methods such as the Analytic Hierarchy Process (AHP) and monetary valuation of urban forest amenities. Participatory planning, or communication and co-operation between different interest groups, is a rather recent tool for urban forest planning (Lewis 1991, Tikkanen 1996). However, according to the new land-use and construction law conditions for citizen participation must be fulfilled at all stages of city planning (Maankäyttö... 1999). Another significant change to previous law dating back to 1958 is that desicion power will be delegated more to the municipalities than before.

Although participatory planning is a promising approach, there are certain problems such as the planning may attract certain types of people who may dominate the planning situation (Tyrväinen & Löfström 1998). One consequence of the phenomenon may be that although the dissatisfaction of the more well-formulated interest groups is

minimised, the plan does not necessarily lead to optimization of the total satisfaction of needs, but rather to the formulation of a mediocre compromise. Furthermore, the number of participants is limited and the compilation of plans is largely dependent on the opinions and expertise of planners. Therefore, more general picture of expectations and preferences of residents is also needed to define the goals and satisfy the needs of the citizens.

Moreover, the AHP can be used as an approach to produce information for desicion-making. By using the AHP, a ratio scale can be constructed on the basis of pairwise comparisons for describing the importance of objectives and the priorities of desicion alternatives (e.g. Kangas & Kristiansen 1995). The method can be used for example to determine household's utility function i.e. to assess the relative importance of different environmental quality indicators for individuals, such as accessibility of green areas, in home acquisition. The main advantage of the approach is the ability to deal with both quantitative and qualitative objectives without converting them to absolute measures such as monetary units. The drawback of the method is that it is difficult to make overall conclusions concerning the importance of values, because the valuations are expressed in relative units, i.e. in relation to individuals utility.

Monetary valuation aims in measuring the benefits and costs of environmental goods in the same quantitative unit than the market-priced goods. Today, land use planning procedures do not include any systematic assessment of urban forest benefits. Qualitative valuations of green spaces are difficult to integrate into the assessment procedure and, in practice, it is difficult to speak in favour of green areas in the face of strong economic interests. Nonetheless, if the benefits of urban forests are not valued explicitly, they will still be valued implicitly through policy decisions. Therefore, quantitative information is needed as a component of land use planning. Economic estimates of amenity values are more concrete in decision-making than the results of qualitative studies.

Though the costs of supplying urban forests can be determined in a relatively straightforward way, the benefits are more difficult to estimate. The economic value of forests is typically measured in terms of forest products such as timber, and associated products such as game, berries and mushrooms, and the values can be expressed at least partially in monetary terms. However, the value of urban forests mainly consists of non-priced benefits, such as a pleasant landscape, clean air and tranquillity. Collectively these values can be termed as "amenity values". An important step in sustaining this conventionally non-valuated resources is, therefore, to define them as goods and services which can be quantified in economic terms.

1.4. Monetary valuation of urban forests and trees

1.4.1. Benefits and functions of urban forests

Although there is no precise information about the role of green spaces in the quality of urban life, the benefits of urban forests are seen as being manifold. The multiple environmental and social benefits are well documented in the literature (Robinette 1972, Grey & Deneke 1978, Miller 1997). Many of the benefits are produced simultaneously in the same area, because the provision of one benefit usually produces other types of benefits as well. For example, a wooded recreation area provides recreation possibilities, and also abates wind and traffic noise while improving the landscape in a nearby residential area. The grouping of benefits and functions of urban forests varies, but the value categories most often mentioned in the literature are architectural, aesthetic, climatological and engineering, and social and economic benefits (e.g. Robinette 1972, Miller 1997) To a certain extent the division, for example, between architectural and aesthetic uses is artificial, but they also have their own distinctive features and can, therefore, be presented separately (Table 1).

Architectural benefits deal with the use of vegetation in urban planning and development. The main purpose of trees and forests is to improve and restore constructed townscapes. Vegetation is used in defining open space and integrating the buildings into the surrounding environment. Moreover, aesthetic benefits deal with people experiencing different colours, structures, forms and densities of woody vegetation. Much of the aesthetic experience is subjective in nature and has impacts on a person's mental and emotional state (e.g. Kaplan & Kaplan 1989, Korpela 1995). A great deal of the consumption of amenities occurs indoors through a window or from a car or bicycle (Ulrich 1984, Schroeder & Cannon 1987, Bucht et al. 1996).

Visual variation is often stressed as being a key factor in aesthetic experiences (Kellomäki 1975, Hultman 1983, Axelsson Lindgren 1995). In particular, forest edges, which are plentiful in the urban setting, are essential to human aesthetic experience and visual perception and therefore the structure and design of a forest edge is important (Lucas 1991, Gustavsson & Fransson 1991). A well-designed edge consists of a mixture of bush and tree species, which have great ecological and aesthetic importance (Gustavsson & Ingelög 1994).

Technical uses of urban forests include the improvement of urban environmental conditions, for instance, through purifying air (Warren 1973, Metsä... 1987), abating noise (Kellomäki et al. 1976) and wind. Important environmental benefits include cooling and impacts on air humidity (Huang et al. 1992, Nowak & McPherson 1993). There are also many engineering benefits – glare and reflection reduction as well as water and wind erosion control.

Table 1. Benefits and functions of urban forests (adapted from Robinette 1972, Kellomäki & Loikkanen 1982, Miller 1997)

Architectural benefits	Defining open space, framing and screening views, landscaping buildings.
Aesthetic benefits	Landscape variation through different colours, textures, forms and densities of plants. Growth of trees, seasonal dynamics and experiencing nature.
Climatological and engineering benefits	Cooling, wind control, rainwater retention, impacts on urban climate through temperature and humidity control. Air pollution reduction, sound control, glare and reflection reduction and erosion control.
Social benefits	Recreation opportunities, improvement of home and work environments, impacts on physical and mental health. Cultural and historical values of green areas.
Ecological benefits	Value of urban biotopes for flora and fauna, conservation of biodiversity, nutrient cycles etc.
Economic values	Value of market-priced benefits (timber, berries, mushrooms, etc.), raised property values.

One of the main functions of urban forests is the provision of recreational opportunities (Sievänen 1993, Jensen 1995). It is estimated that Swedes visit a forest for recreational purposes twice per month and 55 percent of all visits take place in the home environment (Kardell 1985, Lindhagen 1996). In Finland outdoor recreation is also very active and 60 percent of all visits are estimated to occur in urban forests (Sievänen 1993). The distance to the forest is an essential factor in choosing among different forests for recreation purposes (Kardell 1982, Katila 1987, Lindhagen 1996). Furthermore, nearby urban forests are in particular important for elderly and young people who are restricted in their capacity to move (Nordström & Gora 1995, Jensen 1995). The most active users of neighbourhood forests are probably children.

A pleasant living environment and recreation opportunities improve people's mental and physical health and mean savings for the society in health care. Many studies show that green spaces have an important psychological effect in reducing human stress levels (Kaplan & Kaplan 1989, Ulrich et al. 1991, Korpela & Hartig 1996). Several studies have shown that exposure to setting with vegetation can produce siginificant recovery from stress, as indicated by physiological changes such as reduced blood pressure and muscle tension. Research is also beginning to document the benefits of urban greenery in ways that can be reconciled with legal and medical interpretations of public health, and in certain situations can be linked to economic benefits (Ulrich 1999).

There is also a great educational value in urban forests. Urban residents even in Fin-

land are becoming more and more unfamiliar with nature as 80 percent of the people now live in urban settings. Urban forests act as examples of forests and their management to the public. This may also have a strong influence on the general attitudes towards forestry. Furthermore, daily contact with nature may give an insight into the interdependence of all things in nature. More recently, the ecological importance has been also stressed because urban biotopes have their own special ecological features. Although comprehensive research in Finland is only beginning, urban biotopes have been found to be surprisingly rich in fauna and flora (Niemelä 1999).

Traditional economic values, timber, mushrooms and berries, remain rather small due to pollution, fragmentation of forests and changes in the structure of vegetation caused by trampling. Furthermore, although mushrooms and berries have a market price, it only partially reflects their value because the recreational value of their picking is excluded. The value of game is also unimportant as hunting is not allowed in urban areas. Furthermore, the revenues from timber, if any, are usually fairly small. Management of urban forests is more expensive than normal forest management because of small-scale management practices. However, in most cities and towns in Finland the management costs have to be paid for by income from timber sales. Moreover, management of man-made green areas with single trees is more expensive than those of forested areas because of more intensive management methods, including the use of considerably older planting material, pruning and tree surgery.

Urban forests also generate external costs, for instance, shading of gardens and damage to property or sewage systems, which may be caused by an extensive root system. Falling branches or windfall may also cause injuries to people or vehicles. Furthermore, some areas attract anti-social elements, cause security problems and reduce the normal recreational use of the areas.

The majority of research conducted in the Nordic countries has been qualitative. One of the main research themes in Finland has dealt with recreational use of urban forests, in particular in the 1970s and 1980s (Jaatinen 1974, Heikinheimo et al. 1977, Saastamoinen & Sievänen 1981, Sievänen 1984, 1993). The results of forest landscape preference research show that factors affecting aesthetic valuations include species, age structure and management intensity (e.g. Haakenstadt 1972, Kellomäki 1975, Savolainen & Kellomäki 1981). More recently the focus has been on ecological values of green areas (Tyrväinen & Löfström 1998, Niemelä 1999). Until now the research has been quite fragmented, but the current trend is to establish networks of researchers and multidisciplinary projects.

1.4.2. Economic value concepts

Urban forests in Finland can be viewed as a public good, but not a pure one. Usually municipalities are responsible for providing

the services of urban forests, even if their maintenance is contracted out. In principle, everyone has the possibility of consuming a pleasant wooded landscape. However, people can also contribute to their living environment by planting trees and other plants on their own property. Households also have the option of paying for the environment as a joint product with a job or a house, for example, by choosing a house close to a public park. Accordingly, these households consume more of the 'public good' than others but are also paying for it (at least partially) in elevated house prices. However, the nature of the urban forest as a public good depends of the property rights and ownership of urban forests in each country (Tyrväinen 1994).

In environmental economics a specific taxonomy of values related to environmental goods has been developed, although no set terminology of values yet exists. The values attached to public environmental goods are usually classified as use values and non-use values. Use values are divided into direct, indirect and option use values. Direct use values are further divided into consumptive and non-consumptive use values. Moreover, non-use values are often divided into quasi-option, bequest and existence values, although definitions of these values seem to be somewhat unclear or overlapping (Randall & Stoll 1983, Randall 1987, Randall 1991, Young 1992, Turner et al. 1994) (Fig. 2).

Use values derive from the actual use of the environment (Turner et al. 1994). The consumptive use values of urban forests include values of market-priced products such

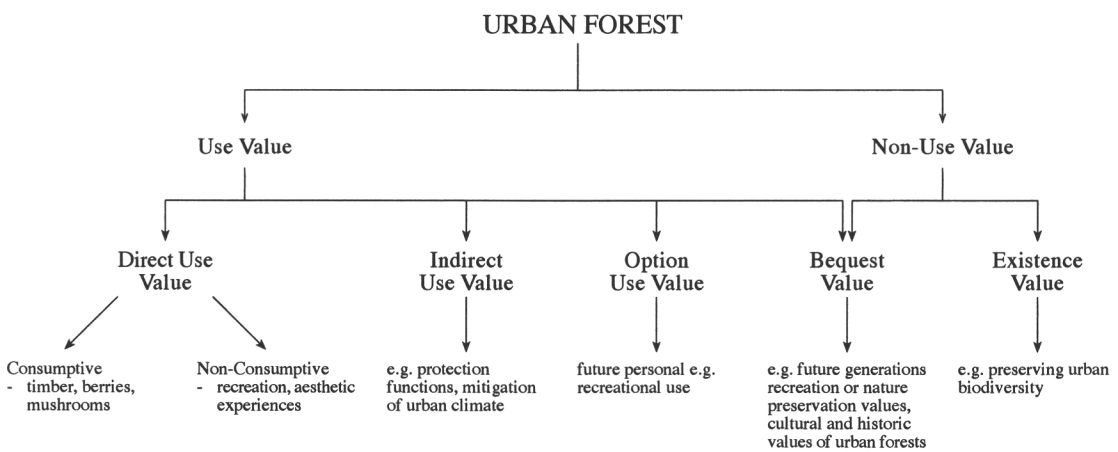

Figure 2. The total economic value of urban forest (adapted from Turner et al. 1994).

as timber, game, berries and mushrooms. These values have less importance in urban areas than in production forests outside city limits. Most of the values attached to urban forests are non-consumptive use values (Fig. 2). These values include benefits derived from a pleasant landscape, clean air, peace and quiet and screening, as well as observation of wildlife and other recreational activities taking place in the natural environment.

The indirect use values include benefits such as reduced wind velocity, balanced microclimate, shading, and erosion control; their economic value may be determined, for example, through reduced costs of heating or cooling or alternative costs of environmental control. More recently this type of ecosystem services is presented in the literature as a separate value category named as 'ecological function value' (Barbier 1991, Young 1992, Edwards & Abivardi 1998). These services include urban forest functions such as soil protection and supply of clean water, which are becoming increasingly important in highly urbanized areas.

There are also optional uses which concern the possible use of the resource in the future. Option value is defined as individual willingness to pay (WTP) for ensuring the future availability of a particular amenity. These values include both consumptive or non-consumptive use in the future. Option values can be attached for example to preservation and future use of well-known public parks such as Central Park in New York, Bois de Boulogne in Paris or Kaivopuisto in Helsinki, which can be expected to have importance for people other than residents of the city.

The non-use values (bequest, existence) may be less important in urban than in natural forests but still worth taking into consideration. The values are derived from other than use motives. The possible motives for these values are altruism, heritage or existence, but theoretically the different value categories have not been consistently defined (Naskali 1993). A related form of value to option value is bequest value, a willingness to pay to preserve the environment for the benefit of one's descendants. It is not a use value for the current individual valuer, but a potential future use value or non-use for their descendants (Turner et al. 1994). Many parks have, among other values, cultural and historical importance. Public parks often have important local and regional values even if national or global values are not at stake.

The existence value is derived from the knowledge that the resource continues to exist and it is often connected to extinction of species. In spite of the fact that biodiversity in urban forests is lower than in natural forests, there might be species which survive only in an urban environment. This is a case for example in Finland where several endangered shelf fungi live only on old park trees in Helsinki as these tree species have become rare in nature due to agriculture and forest management practises (Niemelä & Erkkilä 1987). However, it can be concluded that non-consumptive use value categories

Table 2. Methods of estimating the amenity value of urban forests in monetary terms.

Method	Types of values	Suitability	Constraints
Hedonic pricing	Use values (option value)	All green spaces	Data restrictions, difficulty in defining environmental quality variables
Contingent valuation	Use and non-use values	All green spaces	Hypothetical, assumptions on people's behaviour
Travel cost	Use values on-site	Parks or recreation areas	No or small travel costs to neighbourhood parks, time excluded
Tree pricing	Use values	Individual and groups of trees	Not suitable for forested areas, mitigation effects of climate excluded.
External benefit valuation	Part of non-consumptive use values	All green spaces	Aesthetic values excluded, data restrictions

are the most significant nonmarket benefits of urban forests.

1.4.3. Economic valuation techniques

The economic value of urban forest can be estimated different ways. Traditional methods include opportunity costs, estimation of maintenance costs, and production value of forest (Kula 1992, Miller 1997). The methods are based on estimating the market-priced benefits of forests. As the main benefit category of urban forests is non-consumptive use values which have no market prices, the use of the traditional valuation methods is limited.

The methods widely used in estimating non-priced benefits of forests include contingent valuation (CVM), travel cost (TCM) and hedonic pricing (HPM). In environmental economics the methods are divided into direct or *stated preference* methods (CVM), where hypothetical markets for the environmental goods are created, and indirect or *revealed preference* methods, where people's willingness to pay (WTP) for the good is observed through related market transactions (TCM and HPM). Furthermore, other approaches such as tree pricing and external benefit valuation have been developed for assessing urban forest amenities (Table 2).

Hedonic pricing

One of the best approaches for valuing urban forests is to study how much people pay for amenity benefits in housing. The hedonic pricing method (HPM) estimates the value of environmental benefits from the costs and prices of related market transactions. The most common application of the HPM is in the property market. The approach assumes that differences in property prices are due to different housing characteristics (cf. Palmquist 1991). Firstly, the price reflects char-

acteristics of a dwelling such as the number of rooms, size, age, size of garden, etc. Secondly, the price reflects locational and environmental features such as the view onto or access to a wooded park or watercourse, proximity to shops, schools, etc. (cf. Palmquist 1991, Turner et al. 1994). Theoretically, if a household wishes to enjoy a view onto a forest or a park or to have easy access to wooded recreation areas, it will buy this type of house and pay a premium for it.

A hedonic price model can be computed from data concerning the prices and features of properties. There are, however, several limitations and problems involved in conducting a comprehensive HPM study, and they have led to an abundant literature on the subject (e.g. Palmquist 1984, Cassel & Mendelsohn 1985, Freeman 1985, Cropper et al. 1988, Palmquist 1991). The method requires large data sets collected during restricted time periods, which are difficult to collect. The main limitation is that property markets have to be relative stable to combine the price data from different years. In addition, empirical applications of the data should address some of the major problems, such as collinearity, the choice of the functional form of the equations, and the separability of variables.

The property value technique consists, theoretically speaking, of two steps (Rosen, 1974, Freeman 1985, Palmquist 1991). Firstly, implicit prices for different housing characteristics are estimated by means of multiple regression or some other relevant estimation procedure. Here, variation in prices can be explained in relation to the characteristics of the property. Theoretically, these implicit prices can be used directly to evaluate the benefits or losses arising from marginal changes in the supply of environmental goods. This will apply when the environmental change affects only a small number of people: the prices of the houses affected will adjust to the level of properties with similar characteristics, but the hedonic equation will remain unchanged. If the houses are owner-occupied, the environmental improvement (degradation) will provide a capital gain (loss) for those living in the area (Palmquist 1991).

The assumption of marginal changes is suggested to be relevant in the majority of cases involving urban forests: where green spaces are converted to another use or new areas are established, the spatial impact on property prices in the housing area will be limited. The main losses or received benefits will be experienced by nearby inhabitants, while the impact diminishes the further away the residents are located. In consequence, the direct use of implicit prices received from first-stage hedonic functions in the valuation of urban forest benefits (or costs) is justified.

In contrast, the use of price estimates is more problematic if the change in question covers the whole urban area or a large part of it. This is the case, for example, in air quality projects where restrictions on pollution affect large areas and large proportions of the population (e.g. Goodman 1989, Vainio 1995). Accordingly, further restrict-

ing assumptions, such as the constant marginal benefits of the households, have to be made or, if the required assumptions do not apply, a second stage of analysis is required (e.g. Hufschmidt et al. 1983, Palmquist 1991). In this second stage, information about implicit prices and data pertaining to environmental quality are combined to identify an inverse demand function.

Owing to the strict requirements of the data and the econometric problems connected with the second stage, most empirical valuation studies have used only the first-step hedonic regression model although non-marginal changes have been involved (e.g. McMillan et al. 1980, Widgren 1986, Michaels & Smith 1990). In this case the use of implicit prices often results in less accurate estimates of the value of the environmental characteristics.

Contingent valuation

Another promising approach is contingent valuation (CVM), which is presently the most frequently applied method in the valuation of environmental assets. CVM belongs to the class of preference elicitation methods called 'stated preference' (SP). Other types of SP approaches such as choice experiment capable of eliciting environmental preferences have not been yet widely used in environmental valuation (e.g. Boxall et al. 1996). In a CV survey the respondents are asked what they are willing to pay (WTP) towards the preservation or improvement of an environmental asset. The researcher can then estimate the monetary value of the asset by calculating the average WTP of respondents and multiplying this by the total number of consumers. Mail surveys or interviews (in person or by telephone) are normally used in data collection.

As the CV questionnaire is the principal tool for using the method, formulating a good questionnaire is crucial. The problems of survey design have been widely discussed in the literature (e.g. Cummings et al. 1986, Carson 1991, Mitchell and Carson 1993, Arrow et al. 1993, Freeman 1993). Care must be taken in the design to minimize the risk of bias, which may include the free rider problem, part-whole bias (embedding problem), information, vehicle (payment format) and starting point bias, as well as self-selection bias.

Typically, CVM surveys have different types of components: a description of the good being valued and the situation in which the respondent has to imagine him/herself; willingness to pay questions for the environmental good; and questions concerning general attitudes towards the good in question and the socioeconomic characteristics of the respondent.

The first component creates the hypothetical markets for the good. In the survey, the non-priced asset in question has to be defined explicitly. It is assumed that the asset can be described in such a manner that it corresponds to the way people perceive the asset or its change in reality (Freeman 1993). The situation can be illustrated using maps, photographs or even videos (e.g. Brookshire et al. 1982, Johnson et al. 1994).

Furthermore, the method is flexible, for example, it permits the level of precision and amount of information given about the good to be changed. The main aim is to seek a balance between the respondents' need for information and their capacity to process it (Cummings et al. 1986). Arrow et al. (1993) suggest assessing the degree of understanding and acceptance of information with follow-up questions in the survey itself.

In the second phase the WTP elicitation format has to be chosen. Two of the most common techniques are open-ended (OE) or discrete-choice (DC) questions. Other common formats include the payment card and the bidding game (e.g. Carson 1991, Mitchell & Carson 1993).

The OE format means that people are directly asked to state their WTP (or maximum WTP) for the issue at hand. The advantage of the method is that the calculation of the WTP estimates is rather simple. The weakness of the method is that it may be difficult for the respondent and may result in many refusals and protest answers (Kriström 1993).

The payment card is a variant of the open-ended question, and presents an array of potential WTP amounts to the respondent, who is asked to identify his/her maximum WTP for the good. The method is thought to be less burdensome for the respondent, because the card provides visual assistance. The weakness of the method is that answers may be influenced by the range presented (Boyle & Bishop 1988, Mitchell & Carson 1993). The payment card is vulnerable to a strategic response, since the respondents can state a very large or a very small sum (Johansson et al. 1995).

The idea behind the DC format is to mimic an everyday purchase situation by presenting a bid to the respondent, which he/she has to accept or reject. The format is thought to be more realistic to the respondents than open-ended questions. The weakness of the method is that parameter estimation is rather complicated and dependent on a distribution assumption.

Theoretically, the question of maximum WTP provides a more accurate estimate compared to the discrete-choice question. Furthermore, the open-ended format has proven to be a conservative choice and does not generate overbidding (Kriström 1993, Kealy & Turner 1993, Johansson et al. 1995). Boyle et al. (1996) compared open-ended and dichotomous-choice formats with three different data sets and found differences. Since it is difficult to know what the 'true' values were, the conclusion was that either open-ended underestimated values or dichotomous-choice bid structures may lead to systematic overestimates. Furthermore, according to Ready et al. (1996) the observed behaviour may be attributable in part to yea-saying by DC respondents. On the other hand, the opposite results has been achieved, for example Arrow et al. (1993) preferred the DC techniques, because the WTP estimates given by the OE format were larger than those given by the conservative DC format. So far, none of the techniques has proven superior to another. A suitable

question format also depends on the asset in question and the general arrangements of the survey (e.g. Johansson et al. 1995, Mäntymaa 1997).

The last component, attitude questions, often constitutes the main body of the survey. They are of value to both the respondent and the researcher. The questions introduce the respondents to the issues in question and give information to the researcher on factors that may influence the respondents' WTP for the good. Because the valuations are expressed in hypothetical markets, it is necessary to carefully explain the institutional context of and sources of funding for the asset (Boyle & Bishop 1988).

CVM provides a way of assessing a larger number of amenities than indirect methods such as TCM and HPM (Mendelsohn and Markstrom 1988, Carson 1991). For instance, CVM enables the estimation of the willingness to pay for wooded green spaces or facilities for urban recreation areas which are contemplated but not yet provided. Furthermore, it is the only method that produces direct estimates of amenity values for benefit-cost analysis. Carson (1991) suggests the use of conservative estimates in the final calculations or presentation of a range of values. According to Freeman (1993) the motivations under any non-use value need not be defined when total value is estimated.

The main weakness of the method is that responses are based on hypothetical and not actual behavior. Indeed, the degree to which CV estimates are accurate representations of the respondents' true willingness to pay is often questioned (Mitchell & Carson 1993). Criterion validity tests of CVM compare the hypothetical WTP to actual cash payments. Field and laboratory experiments show a difference between payments (e.g. Neill et al. 1994, Cummings et al. 1995). A recent study by Loomis et al. (1996), however, indicates that although the payments are not equal, the differences are smaller than in other experiments, where the hypothetical WTP may have been two times larger than the actual. This is suggested to be caused by the problems in the survey design. To obtain valid answers, the respondents must understand and accept the hypothetical market situation introduced by the CVM, where payments are to be made for services which were previously free.

In general, it seems that there is considerable validity in the estimated use values. In contrast, concerns regarding the validity of the estimates of non-use values remain (Bishop & Heberlein 1990, Arrow 1993, Portney 1994). Most values attached to urban green spaces are, however, direct or indirect use-values. Therefore, in a well-designed CV questionnaire and an adequate definition of the commodity, i.e. urban forests, the estimates received from empirical applications can be considered to be serviceable.

Travel cost method

The basic idea of the travel cost method is to estimate the demand for recreational benefits

using the costs of travel, which are used as a proxy for price (Clawson & Knetch 1966, Sinden & Worrel 1979). The method is problematic in urban settings because there are usually no or only small costs involved in travelling to the site. Furthermore, the recreation experience does not occur only on-site but getting to the site is also part of the trip. In addition, one important use of urban forests is through-passage, for example, cycling or walking to work through forests (Tyrväinen & Väänänen 1998).

To apply the TC method in an urban setting the value of time spent on each visit should be estimated. However, there is no generally accepted criterion such as how to value time in monetary terms (e.g. Mendelsohn and Markstrom 1988). Although the use of the method in an urban area remains limited, it is worth noting that many people live far from their work place or public services and pay indirectly for living 'close to nature' in the form of higher transportation costs (Tyrväinen 1994). Dwyer et al. (1983) suggest using the method in larger cities where recreational areas are few and distances are long.

Tree pricing

Practical needs have led to the use of rule of thumb techniques in valuing urban trees. The most widely used method, tree pricing, has been developed for valuing individual trees as well as tree lines in towns and cities. Tree pricing simply assumes that the value of urban forests is the sum of the prices of individual trees. The method itself was presented for the first time in 1951 in the United States, although there have been modifications of the system over the years (Helliwell 1967, Chadwick 1980). In the UK the tree value is based on several factors such as size, expected age, aesthetic value, location, form and other special features (Arboricultural... 1990). In the US the tree price is determined on the basis of diameter, species, location and estimated health. The value of a single tree may rise to several thousand dollars (Council... 1983). Martin et al. (1989) applied the method to value the effect of individual trees on property prices, which was estimated to average 13 percent of the property values.

The method is widely used in many large European cities due to its practicality. In Helsinki the price of a tree is determined according to tree species, size, location, health, rarity and planting costs (Helsingin... 1987). Determining prices for single trees has been necessary for estimating the compensation of injuries to the landowner – often the community – caused, for example, by vehicles or construction. This means that urban trees are treated as any public property, for instance, buildings.

The method is, however, based to some extent on subjective judgement and the arithmetic determination of the tree price has no solid theoretical basis. Moreover, the criteria for valuing trees differ because some factors, for example, rarity of species and planting costs, vary between towns. Furthermore, a disadvantage of the method is that data collection may be time-consuming.

The estimation of tree characteristics is conducted by tree maintenance specialists. Detailed information is often lacking and tree inventories need to be conducted in the field: in bigger towns, however, full street- and park-tree inventories have recently been carried out.

Tree pricing has typically been used for single or groups of trees, but it is not suitable for forest areas. Moreover, tree pricing does not take into account the possible environmental services, such as shading and adsorption of pollutants, the trees provide (McPherson 1992).

External benefit valuation

A more recent approach is valuing the external benefits of trees by quantifying the impact of trees on urban climate (shading, evapotranspiration and air flow modification). These benefits can be valued through the alternative costs of environmental control, such as people's WTP for air pollution control and noise abatement, or directly through, for example, energy savings in heating or cooling (Heisler 1986, McPherson 1992).

This approach is suitable for valuing individual trees as well as forested areas. However, in many countries there is not enough quantitative information on the impacts of trees on urban climate (McPherson 1992, Nowak & McPherson 1993). Thus far, most of the research has been conducted on the energy-saving impacts of trees. Measured and simulated results show that the use of plants contributes to a 5 to 15 percent savings in energy consumption, but larger values have also been presented (Heisler 1986, Nowak & McPherson 1993). This approach has awakened major research interest in the US in the past and in this decade in states where shading and cooling high urban temperatures is a relevant research subject. However, the approach excludes one important aspect from the analyses, the aesthetic values of trees. In spite of certain shortcomings, the technique will have application possibilities in the future, when the impact of trees on the urban climate is studied further.

1.4.4. Review of previous research

Although the list of benefits obtained from urban forests is long, the resources spent on urban forestry research in Europe are relatively scant (Cost... 1997). In particular, there has been little research seeking to determine the amenity values in monetary terms. Until recently most research has been conducted in the United States. However, the history and shape of cities and the pattern of urban forests are different in Finland. Therefore, there is a need to develop methods and national empirical research in the field.

In Europe more than 200 economic valuation studies using contingent valuation, travel cost and hedonic pricing methods have now been carried out (Navrud & Pruckner 1997). Most of them have been undertaken in Northern Europe, in the UK, Norway and Sweden. The main focus has been on the non-use values of environmental

goods, and there are very few examples of the pricing of urban forest amenities. Most of the European studies have used CV and TC methods. Most of the HP studies were carried out in the 1970s and 1980s, both in the US and Europe, but there are very few examples of recent applications of HPM (Navrud & Pruckner 1997). Furthermore, Carson et al. (1995) list about 2000 references covering a great number of subjects including applications dealing with water and air quality, health risks and wildlife, but few on urban forests.

Moreover, there is no Nordic experience in valuing urban forests. Johansson et al. (1995) reviewed 18 Nordic economic valuation studies, five of which focused on forest recreation, and all were outside urban areas. The majority of the reported studies applied the CV method, and there were no examples of HPM studies.

HPM studies

The fact that urban forest amenities are difficult to define and measure has also been reflected in property value studies: in most studies the variables are missing or only very approximate. One problem in including accurate variables describing green space benefits in models is that no compiled statistics or other usable data is available.

In the United States HPM has been used for estimating the contribution of urban parks, green belts or individual trees to property values. One of the first applications was conducted by Darling (1973), who used the method to assess the value of amenities at urban water parks. The sample size was small, but a positive effect on property prices was demonstrated. Weicher & Zerbst (1973) studied externalities of neighbourhood parks in Columbus, Ohio, and reported that the parks raised property values but the price effects were dependent on park attributes. Positive externalities were generated only in those properties which face open space; externalities were non-existent or negative in other cases. They concluded that heavily used public parks may cause negative externalities to adjacent houses and may even decrease their prices. Furthermore, Correll et al. (1978) showed with a small data set (85 observations) that proximity to a greenbelt increased residential property values. In this study it was assumed that neighbourhood effects end at a distance of approximately 1 kilometre (3200 feet), because linear functional form was used.

Payne (1978) reported that trees contribute substantially to the value of residential property. Houses on well-treed lots may sell at 6–12 percent more than identical houses on lots without trees. The estimates were received from realtors and home owners who compared photographs of similar houses on lots with a differing number of trees. Furthermore, Morales (1980) looked at 14 variables influencing the price of suburban homes in Manchester, Connecticut, including the presence or absence of tree cover. The presence of mature tree cover contributed an average 6 percent to the selling price of the homes. In another study, Morales et al. (1983) applied multiple regression to

predict the selling prices of property in Greece, New York. In this study, houses on lots with tree cover sold at an average of 15 percent more than those on untreed lots. More et al. (1988) estimated urban parks to influence property prices up to 600 metres (2000 feet) from houses. Anderson and Cordell (1985) applied the method to a larger data set compared to previous studies, more than 800 house sales, in Athens, Georgia. They found that tree cover increased property values by 3–5 percent. The explanatory variable used was number of trees in the front yard. These studies do not, however, fully address the econometric problems of models such as collinearity and separability of variables.

In Europe, in the UK, Willis and Garrod (1993) studied the effect of countryside characteristics on property prices. They found a significant positive relationship between broad-leaved woodlands and house price, and a significant negative relationship between mature coniferous forests and house price. Their conclusion was, however, that the explanatory variables for forest benefits were inadequate. There was no precise information on how the houses were actually located with respect to the forest areas, because measurements of the amount of woodlands and proportion of tree species were made using 1 km^2 units, due to data acquisition problems.

In Germany Bergen and Pfister (1995) applied the method in a small case study to value neighbourhood externalities related to an afforestation project in the Göttingen region. One of the factors included in the property value model was landscape value. Afforestation was found to improve landscape amenity value in the area and capitalize in properties. Furthermore, in a recent HPM study conducted in the Netherlands Luttik (1998) found that a pleasant view alone would lead to a considerable increase in house price, particularly if the house overlooks water or open space. However, the results regarding trees were less clear. In some cases a value-increasing effect was found but in most cases the hypothesis that a view adds to the property value had to be rejected. Proximity of public parks also yielded ambiguous results; only when water was a distinctive feature in the park could a premium on the house be demonstrated. It was found that the added value of being situated in a town surrounded by a pleasant landscape – with woods, lakes or a diversity of landscape types – could be 5 to 12 percent.

Although the research described shows that there is some experience in the research area, the results are not transferable to Finnish conditions. Much of the research has used small data sets and focused on the impact of single trees on prices. Today, there is not enough basic information, for example, on the suitable variables for describing green space benefits in HPM studies.

CVM studies

In the US, Dwyer et al. (1989) measured urban dwellers' WTP for trees in recreation areas. Furthermore, Johnson et al. (1994)

applied the method in measuring residents' WTP for scenic easements in forest management in an urban/forest interface. Image-capture technology was used to illustrate different management options. One part of the study asked residents (41 adults) their willingness to pay in employing some practice other than clear cutting within a 200-foot buffer along their property line. Two-thirds of the respondents were willing to pay enough money to protect the scenic quality; they were prepared to compensate timber owners for the full loss of income associated with a less-intrusive harvest practice.

In the UK, Bishop (1992) studied the recreational value of two urban fringe forests. The study is one of the few in which different land use values are compared to gain an insight into the relative importance/value of woodland environments. A sample of 100 respondents was taken at each site and different WTP question modes were used in the study. Respondents were found to be more willing to pay an entrance fee than other types of payment. Furthermore, the existing user benefits, in terms of recreation value, were found to exceed the associated management costs by a factor of three.

Lockwood and Tracy (1995) measured the monetary value of an urban park in Sydney, Australia. The valuation of a visit to the park was made in a mail survey using an open-ended question format (105 respondents). They concluded that the public investment required in the management and maintenance of the park is clearly justified. They also suggested that the benefit estimate was probably an underestimate of value of the park due to the unsuccessful hypothetical scenario presented to the respondents in the survey.

One of the most comprehensive studies related to the issue has been conducted in Germany by Elsasser (1996), who applied the method for valuing the recreational use of two urban fringe forests in the Hamburg region. The data used was exceptionally large (approximately 3500 respondents) and the travel cost method was used to verify the results. The mean WTP/year for the use of the forest was 114 DM in Hamburg, which was higher than that of the more remote Pfälzerwald (WTP 101 DM/year), since using remote areas means higher travel costs.

In Finland, the CV method has been previously used for estimating the benefits of regional recreation areas on the outskirts of Helsinki (Sievänen et al. 1991). Visitors to the Luukkaa area (north of Helsinki) were asked to pay a hypothetical entrance fee. Three different kinds of WTP questions were posed: a conventional question on WTP an entrance fee, WTP for travelling to the site and an attitude question in which the visit was to be compared to other leisure activities familiar to the respondent. The idea of the last question mode was to make the question less hypothetical and capture the psychological value of the visit rather than elicit the monetary value of the forest experience. The data was collected by in-person interviews (406 visitors). Here, the average WTP for a visit was about 12 FIM. The estimated benefits in the attitude question dif-

fered dramatically from the others, producing values 6–9 times higher for a visit than the two other question modes.

1.5. Objectives of the study

The main focus of this study is on forest and forest-like areas in an urban environment. In Finland, one of the distinctive characteristics of the green areas is their 'natural state': most green spaces are formed from preserved natural landscape, often in the form of forest vegetation. The scope of the research is also different from previous forest recreation studies in Finland, because it includes wooded recreation areas as well as small forest patches inside city limits.

The main objective of this thesis is to quantify the values attached to urban forests in monetary terms and analyse the possibilities of using such information in urban land use planning. Two economic valuation methods were applied in two different urban environments, Joensuu and Salo. The thesis is a summary of four empirical studies, and the specified objectives of the four are as follows:

I) The aim of Study I was to apply the hedonic pricing method to determine whether the benefits of urban forest are capitalized in property prices and to find suitable variables for describing the green space benefits in HPM studies. The study was conducted in Joensuu, Finland.

II) The objective of Study II was to enlarge the methodology in economic valuation by applying contingent valuation in the same study town, Joensuu. The purpose was to measure the use-values of wooded recreation areas and the residents' willingness to pay for small forested parks in the housing environment.

III) Study III further examined the importance of the near-home environment and the effect of green spaces on property prices in urban conditions different from the first study. The study sought to define further variables suitable for describing 'near-home' forest benefits in HPM studies. The study was conducted in Salo, located in south-western Finland.

IV) The objective of Study IV was to compare the attitudes towards and the benefits experienced in relation to the use and existence of urban forests in two different urban environments. In particular, the purpose was to measure and compare the valuations in monetary terms, i.e. residents' willingness to pay for wooded recreation areas and small forested parks contributing to the quality of the home environment.

2. MATERIAL AND METHODS

2.1. Study towns

The studies were conducted in two towns, Joensuu and Salo, in Finland. The limitation placed on the selection of the towns was that in conducting the property price studies the towns needed to fulfil special criteria. Firstly, suitable towns were sought amongst single-centred and medium-sized towns to avoid the complexity of constructing price models in large and multi-centred towns.

Secondly, the town to be selected was expected to have a lot of terraced houses and a sufficient quantity of housing market transactions occurring during the study period. Terraced house apartment sales were chosen because the characteristics of apartments vary less than those in blocks of flats or one-family houses. The third requirement was that aerial photographs of the town should be available for describing the housing environment at the time of home purchase. Moreover, towns with distinctively different supplies of urban forests were sought in order to obtain sufficient variation within the environmental quality variables.

Joensuu is a town of 48 000 inhabitants, the capital of North Karelia, located in eastern Finland. In general, the landscape in Joensuu is rather flat. Typical landscape features in the town are water and abundant urban forests. Joensuu is bounded on the south and southwest by Lake Pyhäselkä, and the River Pielisjoki runs through the town centre. Green spaces represent 34 percent of the town area, the majority of which are forested parks preserved from natural forest vegetation. The town owns 1050 ha of forest within the administrative area of town that are classified into park, recreation and protection forests (Joensuun... 1998). The total amount of recreation forests is 902 ha, which are mainly located outside town limits. The dominant tree species in 69 percent of the forest areas is Scots pine and birch species dominate another 17 percent. Most of the areas are middle-aged (60–70 years old) forest stands. The average volume of timber is 142 m^3/ ha. The town has two main wooded recreation areas within town limits. In addition, most of the housing districts have some sort of wooded recreation area with facilities such as skiing and jogging trails. Moreover, there are 175 ha of constructed green areas.

Salo is a town of 23 000 inhabitants in southwestern Finland, 110 kilometres northwest of Helsinki. The town is an old commercial centre in a large river valley. In contrast to the Joensuu region, the main features in the landscape are agricultural fields and forested eskers between the fields. The River Salo runs through the town centre and both housing and industry are concentrated along the river. The biggest employer in the region is the Nokia Mobile Phones company, which has a production plant in Salo.

The town of Salo has considerably less urban forests than Joensuu: a large part of the housing is located on former agricultural land. There are few green areas near the town centre and they are found along the river. Although the town of Salo owns approximately 1 100 hectares of forest, the majority of these areas (74%) are found outside the area included in the town plan. Most of the forested areas are found at the urban fringe, located on hills starting abruptly from the valley. Housing has only expanded in these hills in recent decades (Salon... 1996).

In 1996 the green spaces covered 17.3 percent (356 hectares) of the planned town area. 81 percent of the green areas were forested and 19 percent, 67 hectares, were con-

structed parks or shelter belts (Salon... 1996). During the last decade greening projects have substantially increased the amount of green areas; in 1986 they amounted to only 10 percent of the planned town area. Recreation possibilities on municipal land within town limits are few. Therefore a part of the trails for skiing and jogging have been established in private forests and are maintained by the town's park office.

2.2 Property valuation with hedonic prices

The price data for the property value studies (I and III) were collected in both study towns from owner-occupied terraced house apartment sales. In both study areas the data were collected from apartments which had a maximum of five rooms. Price data from real estate transactions in Joensuu consisted of 1020 observations from 14 different housing areas. The number of observations in the final data set was 1006, as seven entries were rejected due to distinctively low sales prices, and another seven because the apartments could not be determined precisely in the field. In the Salo region the data consisted of 662 observations from 19 housing areas. The number of housing unit transactions in the final sample is 590, since 55 observations had to be ignored. This was because information concerning the view from the windows of the dwellings concerned could not be determined precisely in the field. Furthermore, another 17 entries were rejected as the sales price was distinctively lower than the general price level in the housing market. Unencumbered sales prices and basic structural data concerning the characteristics of the dwellings were collected manually at the local Inland Revenue Office from the records of the stamp duty charged on housing share transactions.

In the property value studies (I and III) both study towns were treated as a single housing market area. Hedonic theory suggests that large cross-sectional data sets should be used. Observations may be collected from several years, but aggregation over time is justified if the housing markets have been relatively stable (Palmquist 1991). Therefore, data were collected from a reasonably stable period, 1984–1986; price fluctuations have been strong in the Finnish housing market since 1987 as a result of the liberalisation of the financial markets and an increase in interest rates. Thus, in both study areas the data consists of all apartment sales in terraced housing over three years in the mid-1980s. The data from different years (1984–1986) were combined by converting all prices to the 1983 price level using local (if available) or regional price indexes for row houses calculated quarterly by the Statistics Finland.

The observations, the location of shops, schools and other public services during the time of purchase (1985) as well as the size and the location of the urban forests, were marked on a town plan of 1 : 10 000 scale. Information about public and private services for 1985–86 was obtained from the Departments of City Planning. The urban forests were inventoried in Joensuu from forest

management plans and from aerial photographs of 1 : 10 000 scale (1987). Since no urban forest management plan was available in Salo, only aerial photographs of 1 : 5000 scale were used. The minimum size necessary for an area to be classified as a wooded green space was 0.3 hectares. Environmental attributes, for example, distance to watercourses and recreation areas as well as locality data, i.e. distance to town centre, shops or schools, etc., were measured with respect to the specific row house. All measurements were made from maps of 1:10 000 scale with a mapmeter in units of 0,1 kilometres.

Similarly, variables describing the urban forest benefits were measured in respect to each apartment. In Salo, the only exception was in the case of distances to the nearest forested park: it was measured in the field to the closest 10 metres, if there was a view onto a forest from the dwelling concerned. The distances to urban forests were measured to the edge of each area. In addition information about roof-types and facade materials was collected in the field in both towns. Possible alterations to the roof structure, from flat to pitched roof, after the date of purchase were checked with the local building inspector in the town's Technical Department.

Four different variables describing urban forest amenities were measured with respect to each dwelling. These environmental variables were chosen according to the theory of urban forest benefits (Miller 1997, Tyrväinen 1997).

(i) *Distance to the nearest wooded recreational area* mainly measures the recreational opportunities in the housing area, although these large forests also have protective and aesthetic functions. In the mid-1980s only two housing areas in Salo had a wooded recreational area with facilities such as skiing and jogging trails. In Joensuu all the housing areas in the study had a forested recreation area which was used for jogging, skiing and walking. The distance to the areas was measured along the streets, pavements or paths.

(ii) *Direct distance to the nearest forested area* (i.e., forest park) was measured from each terraced house to the edge of the forested area. These forested areas were small, ranging from 0.3 hectares to several hectares, or narrow strips of forest land within the housing district. They are important for screening and pollution control, and have psychological effects with regard to noise abatement and improvement of the urban landscape.

(iii) *Relative amount of forested areas in the housing district* mainly describes the amount of space (construction density) in the housing area and to a certain extent the general visual landscape in the area. In addition, this variable is thought partly to encapsulate the technical benefits that urban forests provide (i.e., noise and pollution control). The amount of forested areas was measured on a map of the town by means of a planimeter.

(iv) *View from the dwelling window* was measured in Salo and was classified into five

categories: (1) view to a building or to a constructed area, (2) forest view, (3) view onto a constructed park, (4) distant views (e.g. a view overlooking a field), and (5) other (i.e. a view consisting of various features from the previous classes). The view was included in the class if more than 50 percent of the direct view from the window belonged to the specific class.

In Joensuu, distance to watercourses was included in the measurements. In Salo, however, no separate variables describing such benefits were included in the model. This was because there are no lakes in the Salo region and the main recreational harbour on the River Salo is located by the market square, where the distance to the town centre had already been measured. In consequence, the distance to the town centre can also be considered to serve as a proxy for recreational benefits received from the river. In addition, river views were rare from the terraced house apartments because the river is rather narrow and the landscape is flat.

Information on the status of housing areas was obtained by telephone inquiries from local real estate agents and discussions with town planners. Moreover, data on renovations of dwellings was not available and the age of a building serves as a proxy for the condition of the apartment in question. The age variable was calculated in the following way: age of building = transaction year – construction year of building.

In Joensuu, hedonic price functions were calculated with multiple regression analysis using SPSS software. Halvorsen and Pollakowski (1981) have suggested that the property value data should be allowed to determine the appropriate functional form, using the general quadratic Box-Cox functional form. In Salo, the Box-Cox transformation was fitted to the data using Shazam software.

2.3. Contingent valuation

The CVM questionnaire was sent in Joensuu in spring 1995 (Study II) and in Salo in autumn 1996 (Study IV) to 500 randomly chosen residents 15–75 years of age. The samples were drawn from the database of the Finnish Official Register of Persons and Addresses. In both towns two follow-up letters were sent to increase the number of responses. The questionnaires were pre-tested before the main surveys; in Joensuu some 80 respondents in two housing districts were involved in the test and 40 respondents in Salo. The smaller amount of people in Salo was thought to be adequate because the survey had already been tested in Joensuu. The purpose of the tests was to see whether the questionnaire was logical and, in particular, if the WTP questions were understood correctly. When designing the survey care had been taken to make it interesting for the non-users of urban forests as well. Arrow et al. (1993) suggest assessing the degree of understanding and acceptance of the information with follow-up questions in the survey itself. Here, the comprehension of the definition of urban forest was pre-tested in Joensuu using different questions.

The final questionnaires consisted of four different parts. First, respondents were told to consider the benefits of urban forests and their use. Subsequently, people were asked to express their valuations in monetary terms. The first part of survey consisted of instructions for answering, the definition of urban forests with examples, and the explanation of the attached three maps illustrating urban forests. The first map presented the size and locations of all urban forests (minimum size 0.5 hectares) in the town. The second showed the three main recreation areas for which people were asked to state their WTP. The third map presented potential construction areas, i.e. particular green spaces in the housing district. The second part of the survey consisted of general questions concerning attitudes towards urban forests and the use. The first two questions dealt with the benefits and negative effects of urban forests. The next seven questions dealt with the use of different areas and the type of recreation, In the first two parts of the survey were similar in both study towns.

The third part included willingness to pay questions, which were designed to fit the different conditions in the study towns. First, the actual users were asked to state their WTP for the use of the three main wooded recreation areas in each town. The areas differed with respect to size and location. In Joensuu two of the areas were located inside town limits and the third was 10 km away from the town. In Salo all the areas were found at the urban fringe outside the administrative area of the town. Two of the areas were privately owned. In both towns the respondents were asked to imagine a situation where free access to and use of the areas was denied. It was explained that the maintenance costs of the areas were to be collected from the users and not covered by taxes because of the recent budget cuts by the town council.

The payment card technique was used because no clear evidence had been found in empirical studies on whether an open-ended or close-ended question format would be superior. The payment card presents an array of potential WTP amounts to the respondent, who is asked to identify his/her maximum WTP for the good. The method was also chosen because the card provides visual assistance compared to the open-ended questions. Furthermore, the design of a bid-vector for discrete choice questions would have needed a considerably larger sample size, which was limited by the research budget.

The sample in Joensuu was split into two subsamples. Half of the visitors were asked to pay an entrance fee per month and half a seasonal fee for the use of the recreation areas. People were asked to state their willingness to pay separately for summer and winter seasons. The summer season was defined as five months (May – September) and the winter season as seven months (October – April). The question read: "What would you be willing to pay per month (or season) to use this recreation area?" A payment card with a scale from 0 to 300 FIM/month (0 to

1100 FIM/season, 0–187 EUR, FIM = 0.17 EUR) was used. The values on the card were presented with a line segment divided into 10 FIM (25 FIM) intervals. The question mode also allowed the respondents to specify a larger amount if they so wished.

The question in Salo read: "What would you be willing to pay for a two-hour visit to this area?" A payment card with a scale from 0 to 150 FIM was used. As in the Joensuu study, the question mode also allowed the respondents to specify a larger amount if they desired. People were asked to state their willingness to pay separately for summer (7 months) and winter seasons (5 moths). The reason for the different question mode in Salo was that the people were expected to use the areas less intensively than the residents of Joensuu and therefore a payment per visit was thought to be more acceptable to respondents.

The second WTP questions were connected to ongoing town planning projects, where new housing areas were planned for forested areas. All respondents were asked to state their WTP to prevent the development of forested parks in the town for housing purposes. The potential areas in both towns were chosen after discussions with planners in the town planning office in order to present a relevant situation for the residents. In this question the town was divided into three regions. Each household was asked to state their WTP for one of the potential construction areas presented in the attached map. In Joensuu it was explained that the areas were owned by a private developer and the land would be bought by the town. In Salo it was explained that the town needed additional money to buy an alternative land area for housing purposes if this area was not used. The funds were to be collected through taxes. The question read: 'How much additional tax would your household be willing to pay annually during the next three years in order to help the town buy the land (or preserve the land) and maintain it as a green space?" A payment card with a scale from 0 FIM to 1500 FIM was used.

In Joensuu, there were two potential construction areas chosen in the town. Residents in the northern and western regions were asked to pay for preserving a green area in their own (or nearby) housing districts, Noljakka and Rantakylä, and those in the southern region were asked to pay for a change in another area, i.e. Noljakka, in the western region. The construction area (size 50 ha) in the western part, Noljakka, was located in the middle of the housing area. The second area was larger (102 ha), located in Rantakylä at the urban fringe, on the northern town border, and expanded the present housing area. This area was one of the suggested development areas in the current general town plan proposal.

In Salo, the three potential housing development areas were located at the urban fringe, because of the location of forest areas. The largest potential construction area, Anjala, was located in the eastern part of town, five kilometres from the centre. The second area, Isohärjänmäki, 59 ha, located in

the northeast, was the only larger undeveloped forest area left in northern part of town. It was a suggested housing development area which had raised intense public discussion in the town in 1996. This discussion resulted in an alteration of the original town plan by increasing the amount of green spaces to be left in the area. It was expected that this area would receive the highest in willingess to pay. The third and smallest construction area, Utiskamäki, was located in the south. The households were divided into three regions and asked to pay for one of the areas closest to them. It should be noted that in each area small forested green spaces were planned to remain and, therefore, the situation was to a certain extent different from Joensuu.

The fourth part of the questionnaire dealt with socio-economic variables describing the respondent.

The zero responses were classified into two categories: true zero bids and protest bids, depending on people's motives. Protest zero occurs when the respondent resists a feature in the scenario. For instance, the respondent objects to paying in a certain way or refuses to place monetary values on non-marketed goods (Freeman 1993).

Response rate and statistical analysis

The response rate of the survey in Joensuu was high, 68.0 percent. However, some of the questionnaires were not complete and, therefore, the amount of accepted questionnaires was 64.8 percent. The representativeness of the data was tested and found to be statistically representative of the whole population, i.e. the residents of Joensuu, according to sex and age distribution, education, housing type and place of residence.

The response rate of the survey in Salo was moderate, 47.0 percent and the final amount of accepted questionnaires was 44.8 percent. The data was found to be statistically representative of the whole population, i.e. the residents of Salo, according to sex and age distribution and education. The people living in blocks of flats were not representative and the amount of people living in terraced houses exceeded their share of the whole population. Moreover, families with children were more interested in the survey than families without children, who were underrepresented in the data. More than 40 percent of the respondents stated to live in a 100 metre radius of a forest area, which suggests that people living close to forests may have been more active in answering the survey. In Salo, the inquiry was repeated in June 1996 in respect to the second WTP question after a mistake was found in the range of values in the payment card. The second round resulted in an 80 percent response rate compared to the first round.

The statistical analyses were made using SPSS and LIMDEP-software. The validity of WTP answers were assessed using two techniques: first, regression analysis was used to explain WTP. The observations that exceeded the standardized residual value 3.0 were discarded as outliers. Second, the questionnaires were checked to see whether the stated WTP was too high with respect to

the stated income. The respondents whose WTP answers were more than 5 percent of their income were discarded as outliers. The effect of socio-economic variables on WTP was analysed by linear regression and tobit models in the Joensuu data. Theoretically, the tobit model (censored regression model) is better suited for analysing the data, because the estimates received by OLS techniques may be biased in the case of the dependent variable being limited in its range (WTP is 0 or positive). The estimation of the tobit model is usually undertaken by maximum likelihood techniques (e.g. Maddala 1983).

3. RESULTS AND DISCUSSION

3.1. Amenity values reflected in property prices (Studies I and III)

The results of the first property value study (I) conducted in Joensuu show that most environmental variables had a significant positive influence on apartment price. On the average, an increasing amount of forested areas in the housing district as well as nearness to a watercourse and recreation area increased apartment prices. In contrast, forest parks had a negative effect on prices, which was not expected. One problem in the data was that most of the apartments (78%) were at a distance of 100 metres or less from a forested area. Therefore, the range of variation in variable values remained small. It was concluded that one of the main conditions for capitalization was not fulfilled, namely enough variation in the distance to a forested park.

The negative impact of the nearby forests, however, can also be understood by the notion that dense, mature coniferous forests, which dominate the town's landscape, may not be appreciated close to a house in these latitudes. In Joensuu, the length of the day is only six hours during winter and the amount of light is an important apartment feature. This conclusion was confirmed by in discussions with the staff responsible of Joensuu urban forests and by opinions presented in information meetings organized for residents concerning urban forest planning. Residents have often wishes to increase the amount of light in the garden or in the apartment by management of the adjacent forest.

There are few possibilities to compare the results to earlier studies. Willis and Garrod (1993) found a significant positive relationship between broad-leaved woodlands and house price, and a significant negative relationship between mature coniferous forests and house price. However, it is unclear whether this was due to differences in aesthetic valuation or other factors such as shading effect, since they did not know how the houses were actually located with respect to the forest areas. Furthermore, forest preference studies in Finland also show that deciduous or mixed stands have been preferred to pure pine or spruce stands (e.g. Savolainen & Kellomäki 1981, Pukkala et al. 1988).

A further conclusion was that direct distance to the nearest forested park was a rather rough variable which did not capture forest benefits well enough in near-home environment. There was no information, for example, on whether there was actually a view to a forest. Therefore further research concerning the effect of small forest parks on property prices was needed.

The second property value study, conducted in Salo, included an additional variable, the quality of the view from apartments, in the price models. The results of the investigation confirm that urban forests are clearly an environmental amenity and that people pay for such benefits through property prices. Although preferences may vary between different households, on average Salo residents are willing to pay 4.9 percent more in order to obtain a forest view. In addition, proximity to forested parks was found to have a significant positive effect on house prices. According to the semilog model, an increase of one kilometre in the distance to the nearest forested area leads to an average decrease of 5.9 per cent in the market price of the dwelling. However, according to the price model, where the distance to a forested park was logarithmic the effect was strong up to a distance of 300 metres, after which price changes were increasingly smaller. Furthermore, in the model, where the distance to park was established as a dummy variable a positive relationship between dwelling price and the distance could be demonstrated only up to 600 metres.

The results suggest that distance to forested parks has a price effect as long as the areas are within walking distance (600 m) from home. Previously, also More et al. (1988) have estimated urban parks to influence property prices up to 600 metres (2000 feet) from houses. This is also in line with many recreation studies which report that the most intensive use of the areas occurs near the home environment (Gåsdal 1993, Sievänen 1993, Jensen 1998). The distance must not exceed a walking distance from home, if the forest is to be used frequently (Kardell 1985, Bussey 1996). This is true in particular concerning small parks, but larger areas may be attractive even at longer distances. Theoretically, the size of the area, facilities, landscape features, accessibility and available substitute areas have an impact on the attractiveness of each recreation area.

In contrast to the findings of a previous study conducted in Joensuu, larger recreational areas did not have a significant impact in Salo. The result is thought to be due to the differences in the supply of recreational areas in the towns. Proximity to a recreational area is not suggested to be a relevant variable in Salo since by the mid-1980s the recreational opportunities were too scarce to be captured in the models: there were only two rather small recreational areas in the town. In Joensuu, in contrast, there were several larger wooded recreational areas with facilities within the town limits.

Furthermore, woody plants grow slowly in northern Europe and improvements in the environment take time. Hence, capitalization

of green space benefits as an investment in property value is gradual and theoretically reaches its highest level only when the trees themselves are fully grown and healthy. This fact may have affected the value of a forest view in Salo, where many areas were established on former agricultural land in the 1980s and the forests have not yet reached their mature visual appearance. This suggests that the value of a view may be even higher in the future.

To some extent the significant variables (other than environmental ones) in the Salo model differed from those used in the Joensuu study. This is thought to be partly due to the features of the local housing markets and partly to differences in the geographical location of the study towns. For example, in contrast to the findings of the Joensuu study, roof-type did not seem to have an effect on property prices in the Salo district. One reason is that the winter season in Salo is shorter and the typical problems of flat roofs caused by excessive snow are much smaller in southern Finland. Nevertheless, cultural differences and architectural valuation attached to housing may also differ between regions. Furthermore, explanatory variables also reflect features of housing that are different from what they explicitly purport to measure, for instance, the distance to the town centre in the case of Salo also encompasses benefits accruing from the proximity of a watercourse, the age of buildings functioning as a proxy for the historical or architectural value and the condition of dwellings, and so on.

The results achieved stress the importance of the quality of the near-home environment and in the study in Salo the aesthetic value of urban forests in particular. A large part of the consumption of amenities is passive: it occurs indoors through an apartment or office window (e.g. Schroeder 1990, Bucht et al. 1996). This fact encourages the maintenance and establishment of new green areas nearby homes.

The results also bring out the importance of well-managed larger urban wooded recreation areas. According to Lindhagen (1996) their importance in Sweden has rather increased than decreased: the inhabitants in Växjo tended to visit recreational forests closer to their home in 1991 than they did in 1975. He concluded that a person with roots in the surrounding countryside is willing to travel 'home' for recreation close to his or her roots, while the following generation, who have no links to the countryside, choose instead to visit the closest forest.

The basic feature of the hedonic models is that they are local, i.e. based on local housing markets, town structure and environment. However, the results of this study provide a good gauge of valuations of urban forests in Finland. Here, as in the other Nordic countries, a wooded environment is generally appreciated, a fact which is evidenced by the large number of holiday homes as well as by the present trend to live in scattered settlements even within the Helsinki metropolitan area.

In central Europe, however, landscape preferences and demands for quality in urban greens differ as a result of cultural differences and the history of land use. In the Netherlands Luttik (1998) found that a pleasant view alone would lead to a considerable increase in house price, in particular when the house overlooks open space or water, but results regarding trees were less clear. The different results imply that there are differences in the specific characteristics of open space that make a housing environment attractive in each country. Furthermore, the recreational use of forests also differs between European countries; for example, in Italy the average number of visits, less than 10 times per year, is considerably lower than in Finland (Scrinzi et al. 1998).

One essential question is if the results of HPM studies, where data from the mid-1980s was used, can be transferred to the present. Recent Nordic research shows that the importance of forest recreation has remained stable or increased. According to Jensen (1998) the use of forests as well as behaviour and preferences in connection with forest recreation has remained relatively stable in Denmark – at least over the past few decades. Furthermore, forest recreational visits have increased in Sweden between 1977 and 1997, especially among older people and during the winter (Lindhagen & Hörnsten 1998). Although no equivalent comparative studies have been conducted in Finland, the similar trend is thought to exist. Furthermore, according to Konijnendijk (1999) in the 1990s, social conflicts have become more frequent and intensive as the demands for urban forests have become more diverse. These facts suggest that the relative importance of the quality of the home environment and its effect on property prices has remained important and the results are transferable through time.

Another question is how the preferences of inhabitants in terraced houses can be generalized to other residents living in different housing modes. In a large survey in the early 1990s, the majority of Finns (86%) preferred living in small houses: 73 percent preferred one family houses and 13 percent terraced houses. Only one tenth preferred block of flats, but in reality almost one-third of the respondents were actually living there (Suomalaisten... 1992). It must be noted that housing type does not only reflect the preferences of a household, but also their ability to pay for housing quality. Furthermore, only approximately 13 percent preferred the city or town centre as a dwell ing place. A large proportion (27%) preferred suburbs or scattered settlements (13%) near towns. The rest of the respondents preferred living in scattered settlements or in population centres in the countryside. The importance of nature in the home environment and preferences for small houses have also recently been confirmed by Maarttola (1998), who studied people's wishes related to home acquisition. These results show that the desire to live close to nature is rather general in Finland and not related to only one housing type.

3.2. Use and valuation of urban forests (Studies II and IV)

The results of the CV surveys show that in general, the respondents had a positive attitude towards urban forests in both study towns. The three most valued categories of urban forest functions were the same. The benefits related to nature were valued most; over 40 percent of respondents viewed it as the most important function in both towns. Moreover, social values, i.e. outdoor activities and exercise, were considered to be important. In Joensuu 36 percent and in Salo 32 percent of the respondents saw these values to be the most important. Furthermore, the urban forest benefits attached to climate, such as wind protection and pollution mitigation and noise abatement, were appreciated. Larger differences between the towns were found in architectural values, i.e. in screening, raising property values, etc. In Salo, these values were more important (9%) than in Joensuu (1%), because many housing areas are constructed on former agricultural land, where vegetation provides the needed greening for the built landscape. Furthermore, the timber production function of forests was clearly the least valued function of the forests in both study towns.

A large part of the respondents in Joensuu (66%) and in Salo (46%) could not state any negative effect of urban forests. The negative effects mentioned were related more to the management of the areas than to their existence. These facts confirm the validity of willingness to pay questions in the urban setting; urban forests are seen more as producing multiple benefits rather than causing negative externalities.

The main negative features reflected the quality and location of the forests in the town. In Joensuu shading, danger from falling branches and litter were mentioned most often. The stated problems support again the findings of the property value study in Joensuu, where forests located too close to a house were suspected of even decreasing its value. The shading effect of trees can be mitigated by proper forest management, for example, by frequent thinnings or by planting or favouring deciduous and low-growing trees near houses, especially in areas located on the south side of houses. Furthermore, tall trees could even be dangerous in stormy weather. Falck (1994) therefore suggests creating step-shaped forest edges close to gardens. This means about a 30-metre-long edge having low trees and bushes close to the gardens or house and successively higher trees towards the rising high forest. However, the step-shaped management of a forest edge is possible only in larger forest areas adjacent to housing; the urban forests, however, are often rather narrow belts that have housing or other constructions on both sides. Therefore, the choice of species is crucial and in many cases the change to low-growing deciduous species would be effective in changing the microclimate and in particular, increasing light in gardens. In management of areas nearby homes a balance between different goals, including screening, pollution control and aesthetics, has to be found.

Indeed, the acceptable or desirable forest management seems to depend on the type of use (e.g. Rydberg 1998). In a study by Tyrväinen and Ihalainen (1999) Joensuu residents living next to a large recreation forest and recreationists visiting the area accepted alternative forest management practices presented differently in photographs. It was concluded that zoning should be used in managing larger urban forest areas; forests close to homes could be managed to meet the wishes of residents and the rest of the area to meet the wishes of recreationists.

In Salo, the main negative features were that forest areas attract anti-social people and may cause other security problems. Again, negative externalities are thought to occur due to lack of management. The key factor for security is visibility in the area. Through active maintenance the area seems to be supervised. Security issues are typical, for example, in the UK, where towns have rather few urban forests. Although people enjoy woodlands, the enjoyment is tempered by fear and gives rise to an ambiguity regarding their use. In a study conducted by Burgess (1995) dealing with the public's perception of safety in urban fringe woodlands, management and design were also suggested to improve the perceived safety.

The high appreciation of the amenity benefits and the low priority of timber values stress the importance and need for multi-objective urban forest policies and management plans in Finnish municipalities. According to Löfström (1999), most municipalities have a forest plan, but in general multiple objectives are lacking in their management. Today, some largest cities apply participatory planning of urban forests, but only Helsinki has adopted specified policy for all green areas (Helsingin... 1999). However, in Joensuu a new forest plan was recently adopted in which forests are classified according to the main use types i.e. park forests, protection forests and timber production areas outside the administrative area of the town. For the first time, through public hearings, public discussion has also been part of the planning process. In contrast, there is no management plan for urban forests in Salo.

The rate of using urban forests was high in both study towns; most of the respondents, in Joensuu approximately 96 percent and in Salo 84 percent, reported having used urban forests during the past year. However, the difference in the recreation possibilities between the towns was reflected in the use intensities: measured by the frequency of visits and time spent in the areas, the residents were more active in Joensuu than in Salo. In Joensuu the majority of the respondents, 73 percent, stated visiting an urban forest at least once a week while in Salo only half the respondents used the areas weekly. One-third of the respondents used the areas 2–3 times per week in Joensuu and one-fifth in Salo. Moreover, about 40 percent of Salo residents and only one-fourth of Joensuu residents were rare users, i.e. visited the areas only 1–3 times or less per month. In Joensuu, where there are many cycling and walking routes through forest areas, the

respondents were also asked to estimate how often they use urban forests for through-passage. Almost 60 percent stated using the areas for this purpose. Furthermore, short visits to urban forests were typical in both towns: the duration of a visit was usually from 1/2 to 1 hour. However, the visits in Joensuu were on the average longer: more than one-third of the respondents spent more than one hour on a visit while in Salo the proportion of longer visits was only 21 percent.

Willingness to pay for urban forests

The appreciation of outdoor recreation possibilities was also seen in the fact that the majority of the visitors in both towns were willing to pay for the use of wooded recreation areas. In Joensuu, the proportion of visitors willing to pay varied from 64 to 83 percent depending on the area. Half of the visitors were asked to pay an entrance fee per month and half a seasonal fee for the use of the recreation areas. The mean WTP ranged from 42–53 FIM/month (108–141 FIM/season) depending on area and season. The lowest willingness to pay was at the Lykynlampi area in winter. The area is located outside of town, 10 km from the centre, and is actively used for skiing; it is, however, rather easy to find other areas for skiing in the Joensuu region.

In Salo, the amount of people willing to pay for recreation was in the same range as in Joensuu, between 63–80 percent. The actual users were asked their WTP for a two-hour visit to the area. The visitors' mean WTP ranged from 9 to 17 FIM for a visit. The smallest willingness to pay was at the Kankare recreation area, which was the smallest and had the poorest trail system. Non-users in Salo were asked to state a reason for not using these recreation areas. Half of the respondents noted long distance as the main reason and more than one-third preferred other areas.

In Joensuu the aggregate recreational value was calculated by multiplying the average WTP in the area by the proportion of users among residents. The effect of the two different payment formats, monthly and seasonal fees, on the WTP were different. People were willing to pay smaller amounts of money more often than bigger sums less often. This resulted higher annual monetary values using WTP/month for the recreation areas than when using seasonal payments. The similar result was also found by Elsasser (1994) in a study dealing with the recreational use of forests in Germany.

We are here dealing with an embedding problem, which is also called part-whole bias. (e.g. Hanemann 1994). This means that for example, respondent may not consider the time horizon of the payment or they may not distinguish between personal/household payments. However, the result that the aggregated seasonal fee is lower than the monthly fee is understood to derive from the uncertainty of the future use of the good. People who buy a season ticket run the risk of not using the area every month and therefore, a lower WTP per season is logical.

In Joensuu the recreational value for the whole year was 1.79 mil. FIM in Repokallio area, in most intensively used recreation area Linnunlahti 4.04 mil. FIM and in Lykynlampi area 1.94 mil. FIM. Using monthly payments results in distinctly higher aggregate benefit estimates for the different areas (4.35–8.58 milj. FIM/year) assuming that the people would use the areas every month. A conservative choice would be to use these lower WTP estimates in cost benefit analysis.

The monthly fees in Joensuu can be compared with the Salo figures by calculating the recreation value per visitor/month; the average WTP is multiplied by the average number of visits/month/person in each area. In Salo, the use value per visitor in different areas ranged from 31 to 76 FIM/month. The WTP in Joensuu for the monthly fee (42–53 FIM/month) falls within this range. In Salo the differences in aggregate values are larger but also the quality and size of the areas varied more than in Joensuu. The use value per visitor in the most intensively used and best managed area, Tupuri, was twice as high as in the other areas, 76 FIM/person/month. The annual recreation value of the Tupuri area is estimated to be 6.14 mil. FIM/year. The lowest seasonal value was at Kankare located in privated forests, which was the smallest and poorly maintained, only 0.58 mil. FIM/year.

It can be concluded that good location and active management raised the average WTP. In can also be concluded that in Salo with adequate provision and proper management of the areas more people would use them. Moreover, it is suggested that the use is higher in Joensuu mainly because of better supply and not to due to cultural differences. Several studies show that increasing distance to recreation areas decreases their use (e.g. Sievänen 1984, Grahn 1991, Jensen 1998). According to Grahn (1991) when distance to park exceeds 300 m, 25 percent of people postpone a daily visit. In this study, too, long distance and a fear of assault are the most prevalent reasons for people not visiting forest areas.

The zero responses were classified into two categories: true zero and protest bids, depending on peoples' motives. In Salo, the main motives for true zero WTP were either the possibility of using substitute areas or no interest in using the area during a particular season. In Joensuu, the main reason for true zero WTP was either the possibility of using substitute areas or economic reasons. The main reasons for protest bids in both towns were either that the question was not meaningful or that the respondents felt that it was difficult to express their valuations in monetary terms.

In assessing the validity of the results the accuracy of the use-intensities play an essential role; they are one of the key components when aggregate benefits are calculated. The average amount of visits in Salo was 85/year/resident: it was higher in Joensuu, 110 visits/year/resident. The results are in line with previous studies in Finland. Sievänen (1993) estimated the average

amount of urban outdoor recreation to be 72 visits/year, which was estimated from the stated participation in outdoor activities, and also included outdoor recreation elsewhere than in urban forests. Compared to this the use activity is higher in both study towns, but the scope of the research is also different. Here, the use of small forest patches inside city limits was also included.

The second WTP question concerning forested parks was ascertained from all the respondents. The scenario presented in the questionnaire can be considered to be realistic, because the suggested change in the amount of green space was connected to ongoing town planning projects. In Joensuu approximately half of the respondents were willing to pay to prevent the decrease of urban forests in the housing area. The amount of respondents willing to pay varied from 45 to 55 percent and the average WTP from 126 to 206 FIM depending on the area. The lowest WP was found among households living in the southern part of the town, which was least affected by the proposed construction. The highest aggregate WP was in western part of the town in Noljakka 1.79 mil. FIM/year, where the development scenario meant condensing the housing area.

In Joensuu according to the tobit model a higher amount of positive bids occurred when the potential construction area was located near the living place. In addition, the results suggest that a view to the forest had even a larger positive influence to people's willingness to pay than the use of the area. This refers to the importance of the urban forests in the home environment where substitute areas are difficult to find. However, the level of income did not seem to have influenced people's willingness to pay. This implies that green spaces are not a superior good, but rather an essential part of the everyday life in the study town. This can also be concluded from the high use of and positive attitudes towards urban forests. The same income effect has been found in several valuation studies dealing with nature conservation, which have shown that the protection of biodiversity is not a luxury good (Pope & Jones 1990, Veisten et al. 1993).

In Salo from 48 to 66 percent of respondents were willing to pay to prevent the construction depending on the area. The average WTP varied from 74 to 169 FIM / year / household. The highest WTP was found as expected in the case of Isohärjänmäki, which was the largest remaining forest area, located in the northern part of the town. The household's aggregate annual WTP for this area was 0.65 mil. FIM.

The zero bids were classified into the same two categories as in the previous question. In Joensuu the main reasons for true zero WTP were either that respondents were not affected by the suggested land use change, had the possibility of using substitute areas or poor economic situation. In Salo the main reasons for being unwilling to pay were enough green spaces after construction, no use of the area and economic reasons. Furthermore, the main motives for protest answers in both towns were that people refused to pay more taxes and the re-

spondents found it difficult to express their valuations in monetary terms.

It is worth discussing how these results apply to other countries. Urban forests have their special features in Finland – they are in a relatively natural state. The fact that the valuations were similar in both towns in spite of different cultural and landscape conditions suggests that values attached to urban forests are also very similar in other towns in Finland. Furthermore, differences in Finland appear to be small compared to the rest of Europe, where clear cultural differences are found to exist (e.g Konijnendijk 1999). Several studies, however, show that people's need for recreation appears when the possibility exists (e.g. Grahn 1991). In other words, existing green spaces inspire residents to different activities, which are beneficial both physically and psychologically. Furthermore, forests may have benefits that other types of green spaces lack. The park qualities clearly have impacts on the activities chosen to be carried out in the park and that natural environments are suitable for many different types of activities (Grahn 1991, Grahn & Mårtensson 1999).

The general acceptability of the CV method in Europe is not clear, and it has not yet achieved the stage of routine application (e.g. Navrud 1992). However, according to Carson and Flores (1998), the recent criticism of CV has produced very few theoretical and methodological insights. Many arguments pertain to the applied welfare economics in general rather than specifically to CV. The future development of the method will show if it is accepted as a tool in decision-making in Europe as well.

In considering the design of urban forest valuation studies in the future it must be noticed that during the past few years other types of stated preference approaches such as choice experiment have been developed and tested. The choice experiment method has its origin in conjoint analysis, which is a method used to represent individual judgements of multiple-attribute stimuli. The approach seems to have some advantages over traditional CVM methods, because it relies on the representations of a choice situation rather than the specific change in the good or service using an array of attributes (e.g. Boxall et al. 1996). Using attributes and levels of specific choice situations, experimental design procedures are used to make packages of attributes that reflect different states of the environment. This approach would also be worth exploring in the valuation of urban forest amenities in the future.

It is difficult to draw final conclusions which of the two methods, contingent valuation or hedonic pricing, in general produces more accurate estimates or if there is any systematic bias such as one produces higher/lower estimates. In practise, there are different possibilities to implement both of the methods. In contingent valuation for example different payment formats and estimation techniques may produce different value estimates. Furthermore, hedonic pricing is rather sensitive to particular functional form and attributes used, and a range of value estimates may be generated from the

same data set. Carson et al. (1996) compared 83 studies where 616 comparisons of contingent valuation and different revealed preference (RP) techniques were made. They found that CV estimates are smaller, but not grossly smaller, than their RP counterparts. They also found that some CV estimates exceeded their revealed preference counterparts, and therefore one should not conclude that CV estimates are always smaller than revealed preference estimates. However, no investigations dealing with urban forests were included.

Carson et al. (1996) also concluded that there were differences also in how closely the goods in CV and RP comparisons matched up. This problem is relevant also in this investigation, because the commodities (urban forest areas) valued could not be designed to be precisely the same in different studies. The results of this research, however, show that value estimates of urban forests are of the same magnitude and the differences can be logically explained.

4. CONCLUSIONS

Land use planning is to a great extent a question of priorities between competitive interests. Urban development projects may cause negative externalities, loss of amenity values of green spaces, which should be taken into consideration in planning. One of the key questions is whether the provision of green areas is in balance with the residents' expectations and willingness to pay for the areas. This information is essential in designing green space policy at the city as well as the local level.

The main objective of this thesis was to quantify values attached to urban forests in monetary terms. The results received with both methods, hedonic pricing and contingent valuation, show that the urban forest is an important quality factor in the built environment and people receive considerable benefits from the areas measured in monetary terms. Economic estimates of benefits are useful in decisions regarding town planning, urban forest policy and budget allocation. Although economic valuation is hardly the solution to all problems, but it helps in connecting urban forests and trees to an integrated weighing of interests in spatial planning.

The resultant use of such economic estimates of the benefits in decision-making would impact at several different levels. At a minimum level they might stimulate public awareness of potential values lost in the construction of green spaces and in the distribution of the various types of impact. At a more advanced level, the value lies in their ability to influence or identify decisions through cost-benefit analysis at project level. This level seems to be the most appropriate in the case of urban forests, since local circumstances vary between cities and towns.

The effect of an attractive environment on house prices may be intuitively evident, but it is unclear which environmental factors make a location pleasant to live in and of high quality, and how much people are willing to pay for providing these amenities.

The construction of a price model that follows the hedonic theory is also demanding. The main problems are those of gathering the data and the multicollinearity of variables. The benefits are difficult to classify and measure quantitatively, and today information on the values that residents attach to forests remains still insufficient. As the environmental variables are themselves correlated, the researcher has to choose those variables that are thought to represent the different benefits. This is difficult, since many forested areas produce multiple benefits such as pollution control, screening and aesthetic attractions. In this research, view and distances to green areas are suggested as descriptions of different benefits received from urban forests, although it is difficult to avoid overlapping completely.

The main advantage of HPM is that it relies on actual market data instead of hypothetical valuations. One limitation of HPM, however, is its ex post rather than ex ante focus and its restriction to a narrower range of urban forest benefits than CVM. Furthermore, HPM expresses only the benefits associated with housing and does not cover the whole range of the multiple benefits ensuing from urban forests. It represents some of the external benefits that occur off-site, such as reductions in air pollution, temperature, noise, and greater diversity of wildlife. Excluded are, for example, non-use values such as the value of urban biodiversity, benefits from timber production as well as the recreational benefits experienced by tourists or other visitors not living in the area. In consequence, the capitalization of amenity benefits is only partial, which has to be kept in mind when using the monetary estimates. Although they are beyond the criticism of overvaluation, the underestimation of their value does not, however, lead to optimal allocation of land either.

Collecting data for property value studies was time-consuming, but in the future data on house prices will be more readily available from price registers. Moreover, recent innovations in GIS and, for example, numerical town maps facilitate the automation of measurements for this kind of study. It will considerably decrease the costs of conducting a similar study. In addition, many communities in Finland are also making inventories of green space structures in a digital format, which greatly eases the collation of precise information on urban greens with respect to housing.

In addition, attempts were made to estimate whether forest management might have an impact on valuation. In Salo forest views were first listed under four age categories: young seedling stands, young forests, middle-aged forests, and mature stands. Differences were subsequently found only between views onto young seedlings and mature forests, which implies that management does have an impact on property value. However, there was not enough variability between the age classes for further research. Urban forests are often rather old or may be even-aged, and insufficient variation is found in the quality of the forest view (age and species distribution). Therefore, HPM

may not be a suitable tool for detecting this kind of more detailed effect caused by management, suggesting that other research methods will also have to be used.

CVM's main advantage is its flexibility and ability to estimate total value including passive use values. In urban settings the great advantage is that the method can be used parallel to HPM. In spite of the apparent easiness of applying the method, care must be taken to conduct comprehensive and well-designed studies to maintain the credibility of the method. Each particular study needs to be scrutinized carefully and to be adapted to the circumstances of each study town or area.

Furthermore, even CVM does not fully capture multiple range of urban forest benefits, but only those benefits that people experience. The residents are most likely not to be aware of all the multiple benefits urban forests provide, for example engineering benefits of green areas such as rainwater retention and erosion control, which are becoming increasingly important in central Europe. Assigning the economic values to amenity benefits has also the drawback that market prices reflect only the prices that the consumers are willing and also able to pay. Therefore, the valuation techniques tend to ignore important equity and moral considerations such as economic values are limited and conditioned by the distribution of wealth. Therefore, it can be concluded that the CV estimates will probably understate the true value of urban forests.

One of the problems in applying the CVM is that knowledge of use intensities in urban forests is still rather limited. However, the ongoing 'National Outdoor Recreation Demand and Supply Assessment' study in Finland will collect statistics and create databases on a continuous basis, which will facilitate the use of CVM in the future. The aim of the project is to monitor changes of participation in outdoor activities, behaviour patterns, and the changes in the supply of recreation opportunities and the quality of services. The study also includes recreational use of urban forests. Furthermore, the project will produce information concerning recreation areas, trails and other recreation services from over 400 communities, which will be registered in a GIS-database.

Typically, in Finland, it is rather difficult to formulate willingness-to-pay questions concerning forest use due to right of public access. Nevertheless, in this study the scenario presented was generally accepted rather well. Most visitors were willing to pay for the use of the forested recreation areas and the number of protest bids was rather low. Thus it is concluded that in an urban setting, people are more accustomed to pay for their leisure time and therefore payments for outdoor recreation are probably more acceptable than in other forest areas.

The application possibilities of the methods include an assessment of lost benefits in condensing the existing town structure as well as the economic impacts of establishing new green spaces. Understanding that the

investments in new green areas will be capitalized in the property prices helps in justifying greening projects. It is also possible to estimate the value loss to nearby properties due to construction of a green area or compare the benefits of green areas to their maintenance costs. In addition, property value models may serve as a tool for pricing apartments or for pricing the building sites, where environmental variables could be included. Furthermore, the models may be used in arguing in court whenever monetary compensation is demanded, for instance, for the loss of a forest view as a result of construction, in cases where a house buyer bought a view onto forest which was later converted to some other use.

The results of this study show that the monetary benefits of urban forest are much higher than the present maintenance costs. Furthermore, the management decisions often concern trade-offs between timber production and recreational benefits – in particular at the urban fringe. The amenity benefits of the study areas were also demonstrated to be higher than the estimated benefits from timber production. These results indicate that on social grounds urban forests are a cost effective concept.

The main use of the methods applied is in analysing environmental impacts of land use alternatives in town planning. The key question in the urban setting is more often where to build than whether to build at all. The loss of amenity values should be included in the analysis when choosing the best land-use alternative from the point of view of society. The estimated non-priced benefits should be compared to the increase in costs when providing building sites elsewhere. The calculation examples from the study areas suggest that a certain limit could be found where condensing, i.e. construction in green areas, is worthless from the point of view of so ciety, if the losses of green space benefits are taken into account.

The total value of a certain area depends on its location, size, quality, use intensity and the amount of substitute areas. In general, the scarcer the resource becomes, the higher the value is per hectare. However, here it should be stressed that social and ecological carrying capacity of the urban forest area is limited. The relatively low value of green spaces in this study was thought to be due to the abundance of green areas in the town, and also because the suggested forested areas for construction were rather large.

Although in this study the valuation methods were applied to forested areas, the methods are suitable in valuing all types of green spaces. In fact, forests should not be seen as competing with other types of green spaces, but rather as a typical example of the values in Finnish conditions. This research project is just one step and the future research should involve:

1. People's valuation and willingness to pay for different types of green spaces (HPM and CVM studies). This information is important in defining green space policy

and allocating scarce resources in different types of green areas.

2. Integration of residents' valuations into ecological values in the management of urban forests.

3. Comprehensive case studies on the CBA of urban forests in different land use options.

4. Urban forest preferences and WTP for maintenance of green areas using visualization of management alternatives.

5. Comparison of attitudes towards and valuation of urban forests in Europe.

Specific urban green space policies and management methods are needed in towns and cities to maintain and increase the amenity values of the areas. Given the residents' high appreciation of urban forest benefits, it seems worth reintroducing a nature-saving construction culture and defining quality criteria for housing environments that are currently inadequate. Finnish townscapes have a special image that is worth preserving and enhancing – an image where urban forests are an essential feature.

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ELSEVIER

Landscape and Urban Planning 37 (1997) 211–222

LANDSCAPE AND URBAN PLANNING

The amenity value of the urban forest: an application of the hedonic pricing method

Liisa Tyrväinen

University of Joensuu, Faculty of Forestry, PO Box 111, 80101 Joensuu, Finland

Received 29 May 1996; accepted 11 October 1996

Abstract

The majority of urban forest benefits represent non-consumptive use values, which include benefits derived from pleasant landscape, clean air, peace and quiet and screening, as well as recreational activities. The hedonic pricing method examines external benefits and costs of urban forests associated with housing. This investigation studied whether and how urban forest benefits are capitalized in property prices. It also searches for suitable variables for describing the green space benefits in hedonic pricing studies.

Apartment sales data (1006 apartments) were collected in Joensuu, a town of 48 000 inhabitants in North Carelia, Finland. Hedonic models were designed to explain purchase prices. Apartment characteristics, location, and environmental quality variables were used as explanatory variables in the models. Environmental and locality data were measured with respect to each specific house.

Results indicate that urban forests are an appreciated environmental characteristic and that their benefits are reflected in the property prices. Proximity of watercourses and wooded recreation areas as well as increasing proportion of total forested area in the housing district had a positive influence on apartment price. However, the effect of small forest parks was not clear. The range of the variable values was small, because there were many small wooded green spaces in the study locale. In addition, data concerning the views from the apartment or the composition of the forests was not available. © Elsevier Science B.V.

Keywords: Hedonic pricing method; Urban forests; Property values; Non-wood benefits

1. Introduction

Urbanization and increased leisure time have highlighted the importance of urban forests. However, the quality of the living environment needs to be improved in many cities. Even in countries such as Finland with abundant forest resources, the preservation of forests or trees has often been neglected in construction. During the rapid expansion of urban areas, particularly in the 1970s, little attention was paid to environmental planning for housing areas (Mattinen, 1977; Halme and Lehtonen, 1983). In developing countries urbanization has caused dramatic results by creating environments lacking amenities (Kuchelmeister and Braatz, 1993).

The concept of urban forests in central Europe differs from that in Scandinavia. In central Europe the concept refers to individual trees, tree lines and man-made parks. In Scandinavia the towns are surrounded by forests and new construction often oc-

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PII S0169-2046(96)00354-4

curs in forested areas and, therefore most green spaces are formed from preserved forest vegetation. The size of urban forests may vary from less than half a hectare to tens or sometimes even hundreds of hectares. Usually the areas are fairly small, but may often be numerous in a housing area. Large forests preserved for recreation are usually found on the urban fringe.

Urban forests provide many environmental and social benefits, which are well documented in the literature (Robinette, 1972, Grey and Deneke, 1978; Laurie, 1979; Miller, 1988). Most of the values attached to urban forests are non-priced environmental benefits. These values include those derived from pleasant landscape, clean air, peace and quiet and screening as well as potential recreational activities in wooded green spaces. Other benefits include reduced wind velocity, balanced microclimate, shading, and erosion control.

The low appreciation by planners of wooded green spaces in urban areas is often based on narrowly-defined economic reasons. One basic problem is that land-use planning procedures do not include systematic assessment of urban forest benefits. The costs of supplying urban forests can be determined in a relatively straightforward way, but the benefits are more difficult to estimate. In spite of the existing need, there has been little research seeking to determine the amenity values in monetary terms. In the urban setting the suitable methods are contingent valuation (CVM) and hedonic pricing methods (HPM). The travel cost method (TCM) has limited applicability in the urban setting because there are often no travel or other expenses involved in accessing the areas (Tyrväinen, 1994).

The contingent valuation method is the most frequently applied method in valuation of environmental assets. The method bypasses the need to refer to market prices by asking the individuals explicitly to place monetary values upon environmental goods (Turner et al., 1994). Mail surveys or interviews are normally used in data collection. The CVM provides a broader way of assesing larger numer of amenities than other methods do, e.g. estimating the willingness to pay for wooded green spaces or facilities for urban recreation areas which are contemplated but not yet provided.

The hedonic pricing method estimates the value of environmental benefits from costs and prices of related market transactions. Unlike CVM, this method has the advantage of being based on actual transaction data, choice and purchase price. The most common application of the method is property market. The HPM is based on the idea that properties are not homogenous and can differ in respect to a variety of characteristics. The method relies on the fact that house prices are affected by many factors: number of rooms, access to workplace, size of of garden, etc. One important factor is local environmental quality, for example, view or access to a wooded park or watercourse (e.g. Palmquist, 1991; Turner et al., 1994). Theoretically HPM can be used in calculating external benefits and costs of urban forests associated with housing. The price of an apartment or a house reflects the residents' willingness to pay in order to gain easy access to urban forests and to 'consume' their amenity values. The method, however, excludes, for example, the benefits to recreationists from other housing areas using the urban forests (Tyrväinen, 1995).

There are several restrictions and problems in conducting a comprehensive HPM study. The method needs large datasets from restricted time periods, these are difficult to collect. In addition, the empirical applications should address some of the major problems such as collinearity, choice of the functional form of the equations and separability (e.g. Freeman, 1985; Palmquist, 1991).

It is necessary to choose environmental variables in the hedonic model so that they correspond to the ways people perceive the environment. A remarkable amount of research has dealt with estimating the value of clean air and quietness (Nelson, 1978, McMillan et al., 1980; Brookshire et al., 1981; Brookshire et al., 1982; Graves et al., 1988). The variables describing, for example, air quality used in several hedonic price studies are probably difficult for people to perceive and therefore, it is questionable that they actually have affected decision-making.

In most of the HPM studies conducted in urban economics, the variables describing the urban forest benefits have either been missing or rather crude, such as the total amount of green space in a housing area (e.g. Widgren, 1986; Laakso, 1992). The urban forests, however, are definitely a visible element of

the urban landscape: their existence, or lack, is evident. In Finland, at least in flat parts of the country, forests are the dominate element and lasting component of urban vegetation.

In the United States HPM has been used for estimating the contribution of individual trees to property values (Darling, 1973, Morales, 1980; Morales et al., 1983; More et al., 1988). Anderson and Cordell (1985) found that tree cover increased property values by 3–5% in Athens, Georgia. Most of these studies have not, however, fully addressed the above-mentioned econometric problems.

This paper describes a hedonic pricing study conducted in Joensuu, Finland. The purpose of the investigation was: (1) to determine whether the urban forest benefits are capitalized in property prices; and (2) to find suitable variables for describing green space benefits in HPM studies.

2. Material and methods

The hedonic theory was first introduced by Rosen (1974), later summarized by Freeman (1979); Freeman (1985) and recently by Palmquist (1991). The approach assumes that differences in property prices are due to different housing characteristics. Accordingly, property prices should reflect the extra money that people are willing to pay for better environmental quality, e.g. for wooded property or a house near a public park.

A hedonic price model can be computed from data about prices and property features. Theoretically the property value technique consists of two steps (Rosen, 1974; Palmquist, 1991). First, implicit prices for different housing characteristics are estimated by multiple regression analysis. The implicit prices can be used to evaluate the monetary value of marginal changes in the environmental asset. If the hedonic price function is linear in the characteristic, then the implicit price for any characteristic is constant for unit changes in the supply of the environmental asset, such as amount of green spaces.

Theoretically, the hedonic model can be used in evaluation of benefits or losses of marginal changes in the supply of environmental good. In case on nonmarginal changes, further restricting assumptions, e.g. constant marginal benefits of the households, have to be made (e.g. Hufschmidt et al., 1983; Palmquist, 1991). If none of the assumptions apply, which in practise may be the case, then a second stage of the analysis is required. Here, the information about implicit prices and the data pertaining to environmental quality are combined to identify an inverse demand function (Hufschmidt et al., 1983; Palmquist, 1991). If the first-stage hedonic price function is linear in the characteristic estimation of the inverse demand curve is not possible.

Because of the strict requirements of the data and the econometric problems connected to the second step, most of the empirical studies have used only the first-step hedonic regression model in assessing the economic value of non-priced environmental benefits (McMillan et al., 1980; Michaels and Smith, 1990; Willis and Garrod, 1993). Restriction of analysis only in the use of the implicit prices often means less accurate estimates for value of the environmental characteristics. In spite of this, these estimates are in most cases suggested to be adequate and provide useful information of people's willingness to pay for environmental assets.

This study was conducted in Joensuu, a town of 48 000 inhabitants in North Carelia, in eastern Finland. In most of the housing areas one-family houses or row houses predominate. The terrain of the town is rather flat and a typical feature in the landscape is water: Joensuu is bounded on the south and southwest by Lake Pyhäselkä, and the river Pielisjoki runs through the town centre (see Fig. 1). Abundant forest areas is another typical feature in the landscape. Green spaces represent 34% of the town area, and the town owns 860 ha of forested areas and 175 ha of man-made parks or other green spaces within the town limits. The dominant tree species in 69% of the forest areas is Scots pine and birch in 17%. Most of the forest areas are middle-aged, 50–60 years old, forest stands (see Fig. 2).

Data were collected from row house apartments because the characteristics of apartments in row houses vary less than those in blocks of flats or one-family houses. Price data from real estate deals consisted of 1006 observations from 14 different housing areas. The data were collected from apartments which had a maximum of five rooms. Information on purchase price and apartment characteristics were collected manually from documents received from local tax authorities.

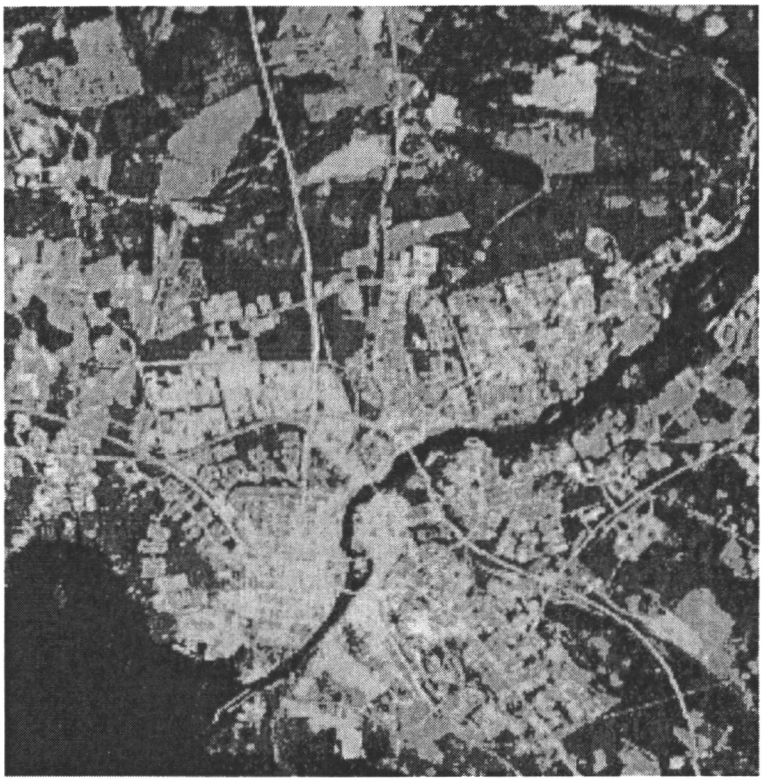

Fig. 1. Satellite view of Joensuu housing areas which were studied (*). * ESA, 1988, EURIMAGE, National Landsurvey of Finland/Satellite Image Centre.

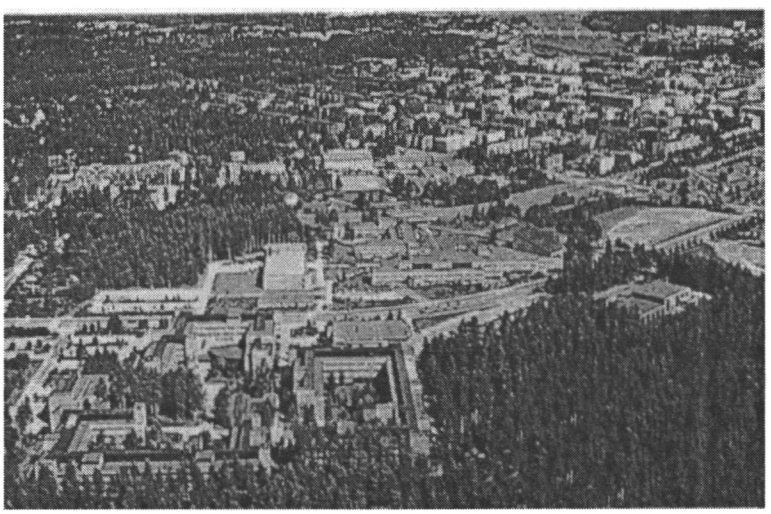

Fig. 2. The abundant forests areas dominated by Scots pine are a typical feature in the urban landscape of Joensuu. View to the north from the University area.

To apply the property value approach, two assumptions have to be made: (1) that the entire urban area can be treated as a single market; and (2) that the housing market is in or near equilibrium (Freeman, 1985, Palmquist, 1991). In addition, hedonic theory suggests that large cross-sectional datasets should be used. If necessary, aggregation over time is justified if the housing markets have been relatively stable (Palmquist, 1991). In this study the above mentioned assumptions are relevant: (1) because of the small size ot the housing markets in the study town; and (2) because of the strong fluctuations in the housing market in Finland since 1987 data were collected from a reasonably stable period, 1984–1986. The data from different years (1984–1986) were combined by converting all prices to the 1983 price level using price indexes for row houses calculated quarterly by the Bureau of Statistics.

The observations, the location of shops, schools and other public services during the time of purchase (1985) as well as the size and the location of the urban forests were marked on a town plan of 1:10 000 scale. The urban forests were inventoried from forest management plans and from aerial photographs of 1:5000 scale (1987) (see Fig. 3.). The minimum size necessary for an area to be classified as a wooded green space was 0.3 ha. Environmental attributes, e.g. distance to watercourses and recreation areas as well as locality data, i.e. distance to town centre, shops or schools, etc., were measured with respect to the specific row house. All measurements were made from maps of 1:10 000 scale with a mapmeter in units of 100 m (see Fig. 4).

Similarly, three different variables describing the urban forest benefits were measured in respect to each apartment. The distances to urban forests were



Fig. 3. The size and the location of the urban forests were inventored from aerial photographs. Example of one of the study locales, Niinivaara housing district (*). * FM-kartta Oy, 1995.

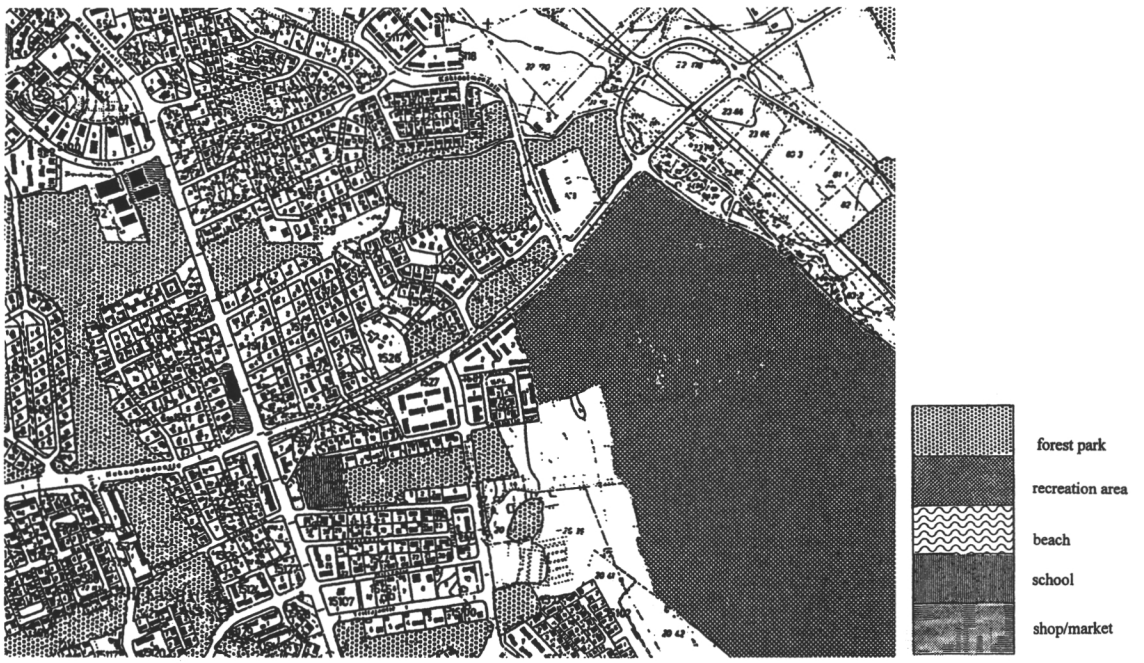

Fig. 4. A part of a Joensuu town plan used for measuring distances to social and environmental services. Example from Niinivaara housing district (scale 1:10 000).

measured to the edge of each area. The variables below were chosen according to their functions and types of benefits they provide:

(i) Distance to the nearest wooded recreation area was mainly meant to describe recreation opportunities in the area, although these forests have also protective and aesthetic functions. All the housing areas in the study had a forested recreation area, which was used for jogging, skiing and walking. The areas were usually fairly large areas, i.e. tens of hectares, and had recreation facilities such as trails, lights and benches. The distance to the area was measured along the streets or cycle paths or pavements.

(ii) Direct distance to the nearest forested area ('forest park') was measured from each rowhouse. These areas were small, from 0.3 ha to few hectares, or were narrow strips of forest within the housing district. They are important in screening and pollution control, and have psychological effects in regard to noise abatement and appearance of the urban landscape (Kellomäki, 1979; Löfström, 1987, Miller, 1988).

(iii) The relative amount of forested areas in the housing district was thought to describe the amount of space (construction density) and to a certain extent the general visual landscape in the area. The amount of forested area was measured with a planimeter.

The first-stage hedonic price functions were calculated in order to explain the apartment prices (P) using the general formula

$$P = f(A_i, L_i, E_i) \quad (1)$$

where A_i is a vector of the apartment characteristics such as size, age and type of construction. L_i is a vector of the locality attributes such as accessibility to town center, schools and shops.

E_i is a vector of the characteristics describing the environmental quality in the housing district including variables such as accessibilty to watercourse, recreation areas and relative amount of green spaces. The main row-house characteristics expected to affect on property prices are presented in Table 1.

A linear hedonic function was calculated to first explain the total purchase price, a model which

Table 1
The main row house apartment characteristics and their expected effect on property prices

Housing attribute	Expected sign [a]	Housing attribute	Expected sign [a]
Apart. characteristics (A):		*Environment (E):*	
Apartment size	+	Watercourse	+
Number of rooms	+	Wooded recreation area	+
Age	−	Wooded park	+
Flat roof	−	Low housing density	+
Renovations [b]	+	Own garden	+
Facade material brick	+	Traffic noise [b]	−
		Pollution [b]	−
Location (L):		Low 'status' of the housing area	−
Town centre	+		
School	+		
Shops	+		
Other public services	+		

[a] +increasing/− decreasing effect on the purchase price.[b] Data not available in the study town.

explained 85.5% of the price variation. The residuals of the model, however, were heteroscedastic; the variance of residuals increased with apartment size. Therefore, price per square metre was chosen to be the dependent variable in the final models (Table 2). Linear and log-linear hedonic price functions were calculated with multiple regression analysis using SPSS software. Due to the data restrictions the variables describing traffic noise or pollution and renovations were not included in the analysis.

The standard apartment type used in the models was a studio with a bathroom located in a row house with a pitched roof. The effect of additional rooms, sauna and flat roof on property prices were analysed using dummy variables. In addition, the Rantakylä housing district was distinguished from others as a

Table 2
Hedonic price model: implicit price estimates (dependent variable price m^{-2})

Independent variable	Coefficient/implicit price	*t*-ratio	Coefficient/implicit price	*t*-ratio
Low 'status' housing area, Rantakylä (D [a])	−378.23	−7.47	−0.137	−7.547
2 rooms (D [a])	−332.58	−9.56	−0.118	−9.473
3 rooms (D [a])	−513.86	−13.56	−0.182	−13.372
4 rooms(D [a])	−565.7	−11.27	−0.199	−11.027
5 rooms (D [a])	−620.41	−8.18	−0.229	−8.386
Age (year)	−43.28	−15.73	−0.016	−15.721
Sauna (D [a])	119.95	3.51	0.039	3.163
Flat roof (D [a])	−116.92	−4.80	−0.042	−4.797
Dist. to town centre (100 m) [b]	−158.42	−7.32	−0.053	−6.793
Dist. to school (100 m) [b]	42.97	2.01	0.012	1.615
Dist. to shop (100 m) [b]	72.17	2.45	0.023	2.118
Dist. to recreation area (100 m) [b]	−41.78	−1.76	−0.016	−1.896
Dist. to 'forest park' (100 m) [b]	471.46	3.94	0.146	3.39
Green space (%)	7.36	3.37	0.003	3.291
Direct dist. to watercourse (100 m) [b]	−153.97	−4.03	−0.60	−4.391
Dist. to nearest beach (100 m) [b]	40.38	2.03	0.016	2.165
Size of lot (m^2)	0.23	2.04	1.148×10^{-4}	2.818
Constant	3991.68		8.332	
	Linear model $R^2 = 0.664$		Semilog model $R^2 = 0.651$	

[a] (D = 0 − 1 variable, $n = 1006$).[b] Distances to social and environmental services were measured in units of 100 m.

low 'status' area, because the average price of the each type of apartment was clearly lower than elsewhere. Most of Rantakylä was built in the 1970s, and the proportion of blocks of flats is larger than in the other housing districts. In addition, the employment rate is the highest and the income level the second lowest compared to other housing districts in Joensuu.

3. Results

The linear model, calculated to explain the variation of price per square metre (FIM m^{-2}), explained 66.4% of the apartment price variation. The dummy variables describing different facade material (brick/wood/other) and whether the apartment has a kitchen or kitchenette did not enter the model with significant coefficients and were excluded from the final model. The apartment characteristics, e.g. age, number of rooms, sauna and roof type entered the model with significant coefficients with a priori expected signs. Additional rooms decreased the apartment price per square metre as expected and a sauna increased the apartment price by 120 FIM m^{-2}. The location variables entered the model with significant coefficients. Age and distance to town centre seemed to be the strongest explanatory variables for the apartment price.

The environmental variables were all significant at the 5% level, except distance to wooded recreation areas, which was significant at the 10% level. The variables describing urban forest benefits had an a priori expected sign and had a positive influence on the apartment price, except direct distance to nearest forested park. On average increased size of the lot and amount of forested areas in the housing area as well as nearness to watercourse and recreation area increased apartment prices (Table 2).

The semilog model explained 65.9% of the apartment price variation. The variables entering the model and their signs were the same as in the linear model. In the semilog the *t*-ratios were only slightly improved for distance to watercourses, wooded recreation areas and beach (Table 2).

The investigations showed that the residuals of the models were homoscedastic. The investigation of correlation coefficients revealed no significant degree of intercorrelation between independent variables. The highest correlations were found between the coefficients for distance to town centre and the relative amount of green spaces (Pearson correlation coefficient = 0.5707) and between distance to watercourses and wooded recreation areas (−0.5577).

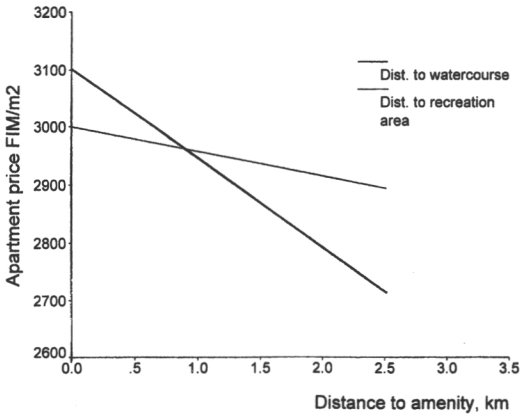

Fig. 5. An application of the estimated implicit prices in evaluation of changes in the environmental quality. The effect of changes in distance to recreation area and watercourse on apartment price per square metre.

Because in this study the estimated hedonic model is linear in different characteristics, the estimation of the inverse demand function was not done. Therefore, the implicit prices are used directly in evaluation of changes in the environmental assets. By using the estimated implicit prices and holding all other variables at their sample mean level, the effect of any explanatory variable on apartment price can be calculated. For example, a 100 m increase in distance to watercourse decreases the apartment price per square metre by 154 FIM. In the similar way, a 100 m increase in distance to wooded recreation areas decreases the apartment price by 42 FIM m^{-2} (see Fig. 5).

In principle, the developed model can be used in estimating the economic effects of land use changes in the Joensuu town area. This can be illustrated, e.g. by analyzing the economic consequences of land use changes in the Kanervala housing district. The total number of apartments in Kanervala is 566 (51 150 m^2). Converting the Kanervala recreation area into a housing district would increase the average distance from apartments to a substitute recreation area by

500 m. This would mean that the average price of an apartment in the area would decrease 211 FIM m^{-2}. The economic effect of the proposed land use change can be calculated by comparing the total property values before and after the change. In this particular case a change to building the recreation area would decrease the total value of apartment prices in the district by approximately 7%.

4. Discussion

Urban forests provide many positive external effects and their importance is emphasized by the fact that environmental 'consumption' is concentrated in the home environment. A pleasant living environment and recreation opportunities improve people's mental and physical health and mean, for example, savings in health care for the society. External costs consist of damage to property caused, for example, by an extensive root system or injuries to people caused by falling branches or windfall.

In Finland, several surveys suggest that the quality of the living environment ('living close to nature') is an important criterion for choosing a permanent residence and a type of housing (e.g. Kuntien... 1987; Suomalaisten... 1992). However, economic estimates of urban forest benefits present people's valuations in a more concrete way than qualitative studies. This study also indicates that urban forests are an appreciated environmental characteristic and their benefits are reflected in the property prices. Although the preferences vary between different households, on average Joensuu residents seem to appreciate green housing districts and accessibility to forested recreation areas.

Usually municipalities are responsible for providing the services of urban forests, even if their maintenance is contracted out. This suggests the urban forest should be considered as a public asset; in principle everyone has a possibility of consuming, for example, the pleasant wooded landscape. At present, methods are needed to assess the impacts of land-use changes more comprehensively. There is a need to further develop land-use planning and urban forest management strategies to respond to increased demand for environmental quality. Furthermore, allocating resources for establishing and managing different types of wooded green spaces should be reconsidered. At the moment most of the costs for towns are allocated to maintenance and establishment of man-made, traditional green spaces such as parks, such costs are many times higher than the maintenance of forested areas.

Determining the monetary value of urban forest benefits is important in finding a balance between different land-uses in the built environment as well as providing justification for urban forest management. In the urban setting, hedonic pricing is one the most promising methods, as it measures the amenity values of urban forests associated with housing. Although HPM is theoretically promising in measuring non-priced goods, there are several strict requirements for conducting comprehensive empirical studies. In many countries data on property prices is often difficult to get and, in this study it, also had to be collected manually. The econometric problems of the method include separability and omission of variables and choosing the proper functional form of the models (e.g. Freeman, 1985; Palmquist, 1991). There are no strict rules for determining the hedonic equations and, therefore, most models must be defined empirically. To interpret the results Ohsfeldt (1988) suggests restriction to a rather small number of variables. In general, a flexible functional form is suggested, but it may reduce the ability to obtain significant results (e.g. Palmquist, 1991).

This study was simplified by the fact that standard apartment types were used and the study locale had only one main centre and no serious traffic noise or pollution problems. The data included the majority of the relevant variables influencing the row house apartment prices in the town, but the choice of the functional form was pragmatic. The omission of variables describing traffic noise and pollution is suggested as not being important in this small town study. However, the data on apartment renovations, for example, were not available, which may have affected the coefficiency estimates.

In property value studies the variables describing urban green space benefits have usually been missing or have been rather rough, such as the total amount of green space in a housing district. The main improvement over previous studies was that the housing environment was described more accurately: the locality and environmental data were measured

in respect to the specific house. Measurement of the characteristics of the housing environment, is however, labour intensive. In the future geographical information systems and numerical maps will simplify data collection. Furthermore, in the future, town and general planning will be done numerically using GIS and therefore, the hedonic price models will become more usable for assessing the economic consequences of land-use changes in EIA.

The results show that the environmental variables, with the exception of direct distance to nearest forested park, had a significant positive influence on apartment price. On the average, increasing amount of forested areas in the housing district as well as nearness to watercourse and recreation area increased apartment prices. In contrast, forest parks had a negative effect on prices, this was not expected. Aparently this occurred because the range of variable values remained small since most of the apartments (78%) were at a distance of 100 m or closer from a forested area. According to Starret (1981) the conditions for capitalization are fulfilled if: (1) there is enough variation within the variable, e.g. distance to forested park, to insure that there are also people living at such a distance to prevent an effect on house prices; and (2) that the residents' preferences are homogeneous. If the preferences are heterogeneous, capitalization is only partial. In this particular case the criteria for capitalization were not fulfilled.

The negative impact of the nearby forests, however, can also be understood by the notion that dense, mature coniferous forests may not be appreciated close to a house in these latitudes. In Joensuu the length of the day is only 6 h during winter and the amount of light is an important apartment feature. In the town, Scots pine is the dominant tree species in 69% of the urban forest areas and most of the forest areas are middle-aged (50–60 years old) forest stands often located close to rowhouses.

The shading effect of trees, however, can be mitigated by proper forest management, for example by planting deciduous and low trees near houses. In addition, in preference studies conducted in Finland, deciduous or mixed stands were preferred to pure pine or spruce stands (e.g. Savolainen and Kellomäki, 1981; Pukkala et al., 1988). In the United Kingdom Willis and Garrod (1993) have studied the effect of countryside characteristics on property prices. They found a significant positive relationship between broad-leaved woodlands and house price, and a significant negative relationship between mature coniferous forests and house price. However, their measurements of the amount of woodlands and proportion of tree species were made using 1 km square units and there was no precise information on how the houses were actually located with respect to the forest areas. Other previous studies of the economic value of urban forests have focused on individual trees and although the results are similar to this study, comparisons are difficult to make.

According to the results of this study distance to wooded recreation area and total amount of forested area in the housing district are good variables for describing urban forest benefits. In contrast, direct distance to the nearest forested park was rather rough, because the variable did not indicate, e.g. whether there was actually a view to a forest. To further study the reflection of small forest areas on property prices additional data is needed. Such data should include information on the composition of the forest (age class and species) as well as more detailed information concerning the possible view and the direction of the forest as seen from the window.

Study of the amenity value of urban forests requires a deeper understanding of how people perceive their living environment and the values they attach to urban forests. This is also essential in identifying and improving the variables in hedonic price functions. This study suggests that the effect of urban forest on property prices is nonlinear rather than linear. The nearby forests may decrease the house prices when located too close and the increasing effect on price depends on their distance, size and quality. Therefore, the maintenance of the urban forests is suggested to be capitalized in property prices. Small forest parks can be assumed to have impact on short distances (200 m) after which no impact is expected, and large recreation areas will have a positive impact on house price even at longer distances.

Furthermore, attitudes towards urban forests depend on the supply of urban forests as well as people's cultural background. Therefore, the valuations are expected to differ in different parts of the country, for example, between towns in eastern and

western Finland, and also be substantially different from people's attitudes in central Europe. It is also expected that people's willingness to pay for the environment depends on their ability to pay. This will be further analyzed by conducting contingent valuation studies in urban settings.

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ELSEVIER

Landscape and Urban Planning 43 (1998) 105–118

LANDSCAPE AND URBAN PLANNING

The economic value of urban forest amenities: an application of the contingent valuation method

Liisa Tyrväinen*, Hannu Väänänen

University of Joensuu, Faculty of Forestry, P.O. Box 111, SF-80101, Joensuu, Finland

Received 3 October 1997; received in revised form 6 March 1998; accepted 30 April 1998

Abstract

Green spaces have important amenity values contributing to the quality of urban life. The deconstruction of green spaces cause negative externalities e.g. the loss of non-priced benefits. In land-use planning, therefore, amenity values should be systematically assessed and measured commensurately, i.e. in monetary terms with material values. This paper discusses the suitability of the contingent valuation method in assessing urban forest benefits, and presents the main results of an empirical study conducted in Joensuu, the capital of North Carelia, Finland. The study was designed to measure the use-values of urban wooded recreation areas, and the residents' willingness to pay for small forest parks contributing to the quality of the housing environment. The results suggest that most visitors were willing to pay for the use of wooded recreation areas. Furthermore, approximately half of the respondents were willing to pay to prevent the conversion of forested parks to another land-use. The results can be used to assess the profitability of the management of urban forests. In addition, the results are useful in assessing the value of green space benefits in different land use options. © 1998 Elsevier Science B.V. All rights reserved.

Keywords: Contingent valuation; Urban forests; Amenity values; Environmental impact assessment; Urban planning

1. Introduction

Many qualitative surveys show that urban forests are an appreciated characteristic in the home environment (Suomalaisten elinympäristö: toiveet ja todellisuus, 1992; Kuntien maapolitiikka ja sen vaikutukset asukkaiden ja yritysten sijoittumiseen eräissä Etelä-Karjalan kunnissa, 1987). Most of the values attached to urban forests are non-priced environmental benefits that include e.g. pleasant landscape, peace and quiet and potential recreation opportunities (Robinette, 1972; Grey and Deneke, 1978; Miller, 1997).

Benefits and costs of land-use change and management of urban forests are often assessed in monetary terms. Qualitative valuations of green spaces are difficult to integrate into the assessment procedure. Nonetheless, if the benefits are not valued explicitly, they will still be valued implicitly through policy decisions. At present, many municipalities have not specified their urban forest policies and many forested areas are considered as left over areas waiting for more intensive use (Löfström, 1990, 1998). Low appreciation of green spaces is also reflected in the recent cuts in the maintenance budgets of many towns.

Quantitative information concerning urban forest benefits is needed as a component for urban land use planning. Urban development projects have negative

*Corresponding author. Fax: +358-73-151-4444; e-mail: liisa.tyrvainen@forest.joensuu.fi

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PII S0169-2046(98)00103-0

externalities, loss of the amenity values of green spaces, which should be taken into consideration in planning. Suitable methods for the monetary valuation of the benefits are contingent valuation (CVM) and hedonic pricing methods (HPM). The travel cost method (TCM), which is widely used in estimation of recreational benefits, has limited applicability in urban settings because there is often no travel or similar expense involved in accessing the areas (Tyrväinen, 1994).

The CVM is at present the most frequently applied method in the valuation of environmental assets. Mail surveys or interviews (in person or by telephone) are normally used in data collection. In a CV survey the respondents are asked what they are willing to pay (WTP) towards the preservation or an improvement of an environmental asset. The researcher can then estimate the monetary value of the asset by calculating the average WTP of respondents and multiplying this by the total number of consumers. As the CV questionnaire is the principal tool for using the method, formulating a good questionnaire is crucial.

Typically, CVM surveys have three types of components: a description of the good being valued and the situation in which the respondent has to imagine him/herself; willingness to pay questions for the environmental good; and questions concerning general attitudes towards the good in question and the socio-economic characteristics of the respondent. The problems of survey design have been widely discussed and carefully documented in the literature (e.g. Cummings et al., 1986; Carson, 1991; Arrow et al., 1993; Freeman III, 1993; Mitchell and Carson, 1993; Turner et al., 1994).

CVM provides a way of assessing a larger number of amenities than do indirect methods such as TCM and HPM (Mendelsohn and Markstrom, 1988; Carson, 1991). For instance, CVM enables the estimation of the willingness to pay for wooded green spaces or facilities for urban recreation areas which are contemplated but not yet provided. Furthermore, it is the only method that produces direct estimates of amenity values for benefit-cost analysis. Carson (1991) suggests the use of conservative estimates such as 5% trimmed mean WTP in the final calculations or presentation of a range of values.

This method has been widely applied in the USA. Carson et al. (1995) list about 2000 references on a great number of subjects including applications dealing with water and air quality, health risks and wildlife. CVM has also been accepted as a method for natural resource damage assessment (Arrow et al., 1993). In Europe, the method has not yet found routine application (Navrud, 1992). The primary reason seems to be the absence of a legal obligation to require a monetary evaluation of environmental policies, and also scepticism about the method by policy-makers (Hoevenagel et al., 1992).

Empirical applications seeking to determine the amenity values of urban forest in monetary terms have been few. In the US Darling (1973) has used CVM to study the value of amenities at urban parks and Dwyer et al. (1989) for measuring the urban dwellers' WTP for trees in recreation areas. In Germany, Elsasser (1994) has applied the method in a study dealing with the recreational use of forests. In Finland, the CV method has been used for estimation of benefits of regional recreation areas on the outskirts of Helsinki (Mäntymaa et al., 1992).

One of the special characteristics of green areas in Finland is their 'natural state'. In Central Europe the majority of areas are man-made parks while in Finland most green spaces are formed from preserved forest vegetation (Tyrväinen, 1997). The public sector is responsible for the supply of green spaces. This usually means that people have already paid for their provision through taxes. Furthermore, in Nordic countries forest recreation is traditionally based on the right of public access to all natural, undeveloped areas ('everyman's right'). These facts may cause negative attitudes towards WTP questions concerning urban forest use (e.g. Bostedt, 1995a; Mäntymaa, 1997).

The aim of this study was to apply CVM for the valuation of urban forest benefits in Nordic conditions, where most green spaces are formed from preserved forest vegetation and the use of forests is based on free access to all forest areas. The purpose of the investigation was to measure the use-values of wooded recreation areas and the residents' willingness to pay for forested parks.

2. The study area and the survey

The study was conducted in Joensuu, a town of 48 000 inhabitants in North Carelia, in eastern Fin-

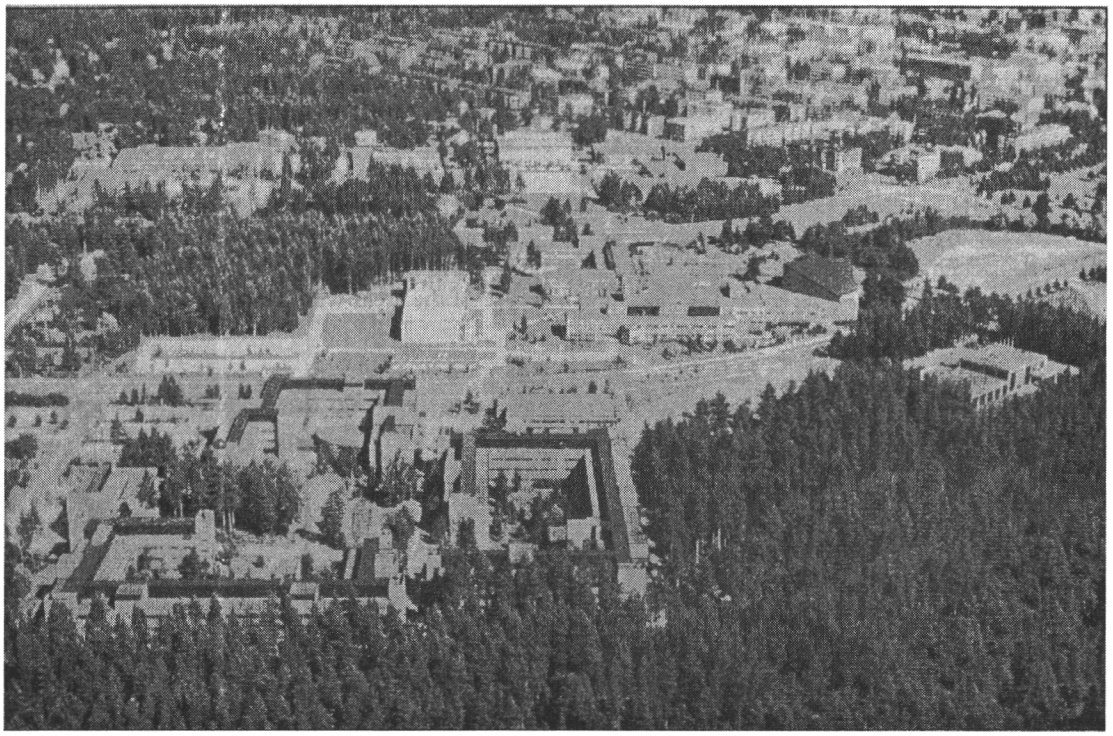

Fig. 1. The majority of green spaces in Joensuu are forested parks, dominated by Scots pine, preserved from natural forest vegetation. View to the north from the University area.

land. The terrain of the town is rather flat and typical features in the landscape are water and abundant urban forests. Joensuu is bounded on the south and southwest by Lake Pyhäselkä, and the River Pielisjoki runs through the town centre. Green spaces represent 34% of the town area, the majority of which is forested parks preserved from natural forest vegetation (Fig. 1). The dominant tree species in 69% of the forest areas is Scots pine and most of the areas are middle-aged (50–60 years old) forest stands. The town has two main wooded recreation areas within town limits. In addition, most of the housing areas have some sort of wooded recreation area with facilities such as skiing and jogging trails.

The CVM questionnaire was sent in spring 1995 to 500 randomly chosen Joensuu residents between 15 and 75 years of age. The sample was drawn from the database of the Finnish Official Register of Persons and Addresses. Two follow-up letters were sent to increase the responses. The questionnaire was pretested twice before the main survey; some 80 respondents in two housing districts were involved in the test. The purpose of the test was to see whether the questionnaire was logical and in particular, if the WTP questions were understood correctly. Arrow et al. (1993) suggest assessing the of degree of understanding and acceptance of information with follow-up questions in the survey itself. In this study the comprehension of definition of urban forest was pre-tested using different questions.

The final questionnaire consisted of four different parts. When designing the survey, care was taken to make it interesting also for the non-users of urban forests. First, respondents were made to consider the benefits of urban forests and their use. Subsequently, people were asked to express their valuations in monetary terms.

The first part of survey consisted of instructions for answering, the definition of urban forests with examples (Appendix A) and the attached three maps were explained. The first map presented the size and locations of all urban forests (minimum size 0.5 ha) in the

town. The second one showed the three main recreation areas of which people were asked to state their WTP. The third map presented a potential construction area i.e. a particular green space in the housing district.

The second part of the survey consisted of general questions concerning attitudes towards the use of urban forests. The first two questions dealt with the benefits and negative effects of urban forests. The next seven question dealt with the use of different areas and the type of recreation.

The third part included (willingness to pay) questions. First, the users were asked to state their WTP for the use of the three main wooded recreation areas in the town. The areas differed with respect to the size and location; the largest area, Lykynlampi, was located outside town limits and the smallest, but most frequently used, Linnunlahti area was located in the town center (Fig. 2, Table 1). The respondents were asked to imagine a situation where free access to and use of the areas was denied. It was explained that the

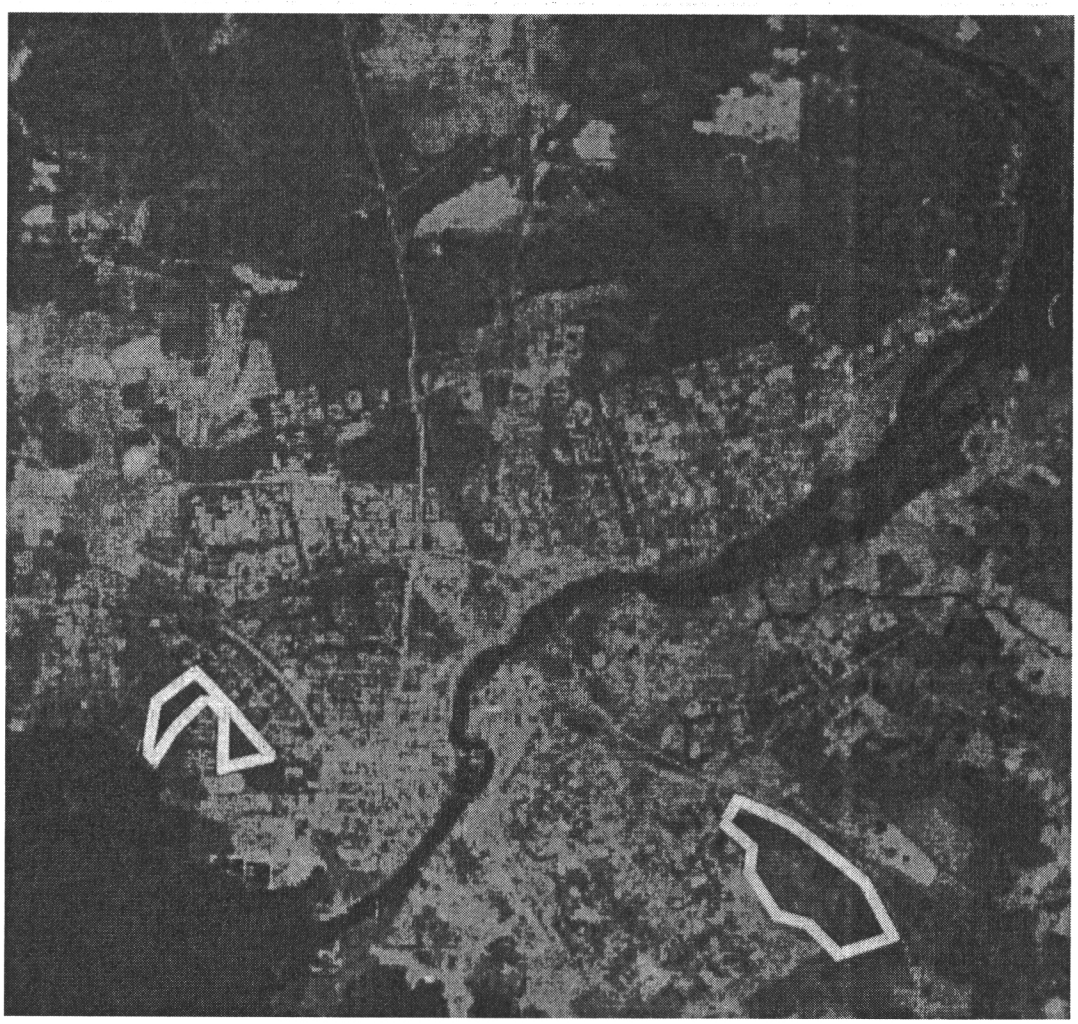

Fig. 2. Satellite view of the study town. The recreation areas used in the survey are located in the south-eastern (Repokallio) and in the western part of the town (Linnunlahti). Lykynlampi is located in the west outside town limits. *ESA, 1988 EURIMAGE, National Landsurvey of Finland/Satellite Image Centre.

Table 1
Description of recreation areas

Recreation area	Size (ha)	Location, average distance (km)[a]	Forests/landscape	Facilities
Repokallio	86 ha	Eastern part of the town, 4.8 km	Mixed forest, varying topography	Nature trail, skiing/jogging trail (1.3 and 3.9 km), lights
Linnunlahti	45 ha	Town centre 3.5 km	Pine forest, flat terrain	Nature trail skiing/jogging trail (1.7 and 3.7 km), lights
Lykynlampi	200 ha	Outside town limits, western part, 10.2 km	Pine forest, varying topography	Lodge, skiing/jogging trails (2.0, 3.0, 6.0 and 11.4 km) lights, orienteering

[a] Measured from the respondents place of residence.

maintenance costs of the areas was to be collected from the users and not covered by taxes because of the recent budget cuts by the town council.

The payment card technique was used because of the preliminary nature of the study. The payment card presents an array of potential WTP amounts to the respondent, who is asked to identify his/her maximum WTP for the good. The method is thought to be less burdensome for the respondent, because the card provides visual assistance. The weakness of the method is that answers may be influenced by the range presented (Boyle and Bishop, 1988; Mitchell and Carson, 1993). Furthermore, the design of a bid-vector for discrete choice questions would have been too difficult without any previous experience of the level of the WTP.

The sample was split into two subsamples to test for the payment vehicle. Half of the visitors were asked to pay an entrance fee per month and half a seasonal fee for the use of recreation areas. The summer season was defined to be five months (May–September) and the winter season seven months (October–April). The question was: "What would you be willing to pay for a month (or season) to use this recreation area?". A payment card with a scale from 0 to 300 FIM/month (0–1100 FIM/season, FIM = 0.17 Ecu) was used. The values on the card were presented with a segment of a line divided in 10 FIM (25 FIM) intervals. The question mode also allowed the respondents to specify a larger amount if they wished to.

The second WTP question was connected to the ongoing general town planning project, where the town structure was condensed by seeking additional building sites for housing inside the present housing districts. All the respondents were asked to state their WTP to prevent the development of forested parks in the town for housing purposes. Two potential areas were chosen from two of the main housing districts. Each household was asked to state their WTP for one of the areas. It was explained to the respondents that the areas were owned by a private developer.

In this WTP question, the town was split into three regions: The residents in the northern and western region were asked to pay for a change in their own housing district and the southern region was asked to pay for a change in another area i.e. in the western region. The first potential construction area (size 50 ha) in the western part, Noljakka, was located in the middle of the housing area (Fig. 3). The second area which was larger (102 ha) was located in Rantakylä in the northern town border and expanded beyond the present housing area. The question presented was "how much additional tax would your household be willing to pay annually during the next three years in order to help the town to buy the land and maintain it as a green space". A payment card with a scale of 0 FIM to 1500 FIM was used.

The zero responses were classified into two categories: true WTP = 0 and protest bids, depending on peoples' motives. Protest zero occurs when the respondents resist a feature in the scenario. For instance the respondent opposes to pay in a certain form or refuses to place monetary values on non-marketed goods (Freeman III, 1993).

The fourth part of the questionnaire dealt with socio-economic variables describing the respondent.

The response rate of the survey was high, 68.0%. However, some of the questionnaires were not complete and therefore, the amount of accepted questionnaires was 64.8%. The representativeness of the data was tested and found to be statistically representative of the whole population, i.e. the residents of Joensuu,

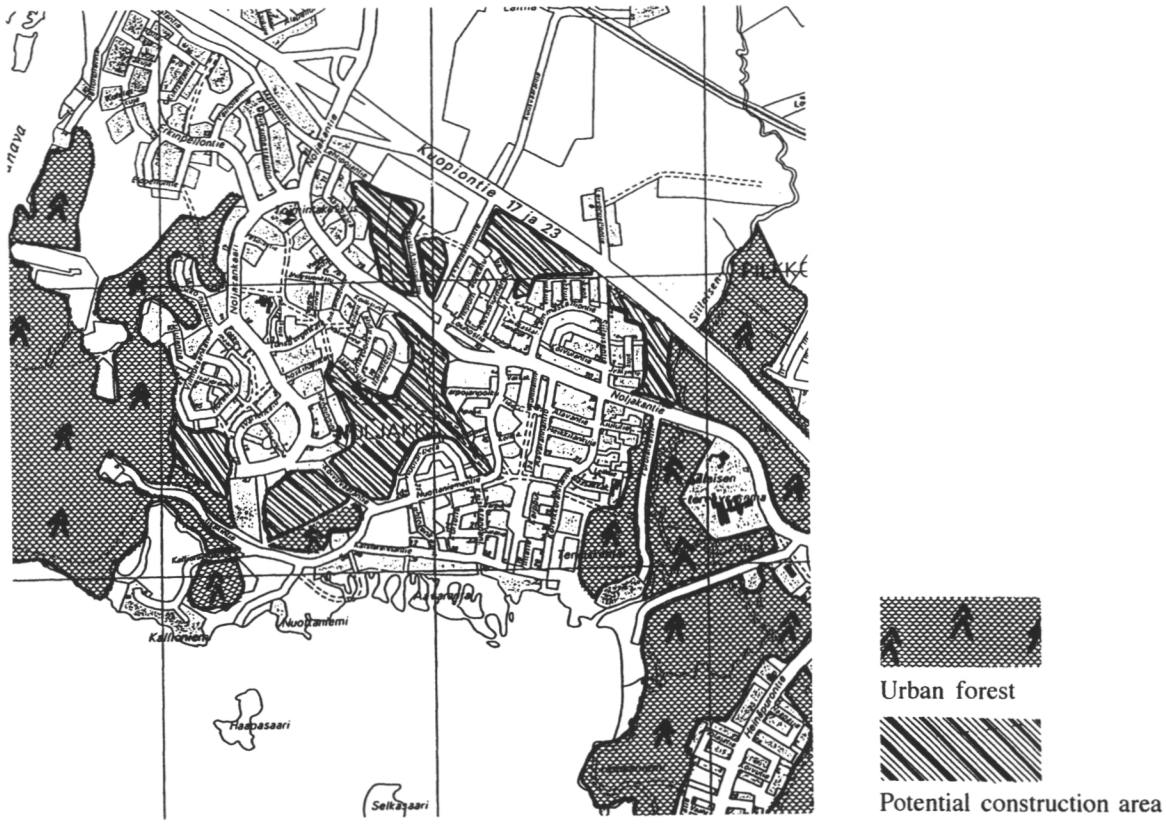

Fig. 3. The potential construction areas were illustrated with a map to the respondents. In Noljakka housing district the conversion area consisted of several smaller forested parks. Part of the third map attached to the survey.

according to sex and age distribution, education, housing type and place of residence.

The statistical analyses were made using SPSS and LIMDEP-software. The effect of socio-economic variables on WTP was analysed by linear regression and tobit models. Theoretically, the tobit model (censored regression model) is better suited for analyzing the data, because the estimates received by OLS techniques may be biased in the case when the dependent variable is limited in its range (WTP is 0 or positive). The estimation of the model is usually undertaken by maximum likelihood techniques (Maddala, 1983; Kennedy, 1992). The validity of WTP answers were assessed using two techniques: first, regression analysis was used to explain WTP. The observations that exceeded standardized residual value 3.0 were discarded as outliers. Second, the questionnaires were checked to see whether the stated WTP was too high with respect to the stated income. The respondents whose WTP answers were more than 5% of their income were discarded as outliers.

3. Results

The urban forests in Joensuu are actively used for recreation purposes. One-third of the respondents visit the urban forests 2–3 times per week and 80% visit an urban forest at least once a week. In addition, 18% of the residents visited the areas daily. The short visits were typical: the duration of the visit was usually from 1/2 h to 1 h (32% of the visits) or less than half an hour (42%). Exercise (40%) and relaxation (36%) were the most typical motives for outdoor recreation. In gen-

Table 2
Willingness to pay (WTP) a monthly fee for the use of forested recreation areas (users)

Recreation area (Nr. of respondents)	Willing to pay (%)	WTP = 0%	Protests or cannot state (%)	Mean WTP FIM/month[a]	Amount of users among residents (%)	Recreation value/ season milj. FIM[b]
Repokallio summer (39)	82.1	5.1	12.8	46	21.6	2.51
Repokallio winter (32)	75.0	9.4	15.6	53	20.1	1.93
Linnunlahti summer (80)	75.0	6.2	18.8	51	46.0	5.94
Linnunlahti winter (63)	70.0	9.5	20.6	42	34.9	2.64
Lykynlampi summer (40)	67.5	10.0	22.5	47	20.4	2.43
Lykynlampi winter (39)	64.1	15.4	20.5	50	21.3	1.92

[a] Protests are not included.
[b] Summer season May–September; winter season October–April.

eral, the respondents had a positive attitude towards urban forests. Most of the respondents (56%) felt that urban forests caused no negative effects in the town.

The majority of the visitors were willing to pay for the use of wooded recreation areas. The amount of positive bids for monthly payments varied from 64% to 82% of visitors depending of the area and season (Table 2). The amount of positive bids for the seasonal fee varied from 69% to 83% (Table 3). A small proportion of the users stated their true WTP as zero; 5–15% depending on the area, season and type of fee. The amount of protest bids varied between 5 and 22%. Although there was no statistical difference found between different response categories for seasonal and monthly payments, the amount of protest answers was higher for the monthly payment. The main motives for true zero WTP were either the possibility to use substitute areas or economic reasons. The main reasons for protest bids were either that the question was not meaningful or that the respondents felt that it was difficult to express their valuations in monetary terms (Fig. 4).

Two-thirds of the visitors stated their WTP between 25 FIM and 200 FIM per season (10–50 FIM/ month). The visitors' average WTP for seasonal payments varied between 108 and 141 FIM (42–53 FIM/month) depending of the area and season. Accordingly, the WTP for the whole year varied from 238 FIM/year to 278 FIM/year using seasonal fees. The aggregate recreational value was calculated multiplying the average WTP in the area by the amount of users among residents. The recreational value for the whole year was 1.79 milj. FIM in Repokallio area, in the most intensively used recreation area Linnunlahti, it was 4.04 milj. FIM and in Lykynlampi area it was 1.94 milj. FIM (Table 2).

Using monthly payments results in distinctly higher WTP estimates for the whole year (549–601 FIM/ year) as well as higher aggregate benefit estimates for the different areas (4.35–8.58 milj. FIM/year) assuming that the people would use the areas every month (Table 3).

The second WTP question dealt with converting forested parks into another land use (Fig. 5). Approxi-

Table 3
Willingness to pay (WTP) a seasonal fee for the use of forested recreation areas (users)

Recreation area (Nr. of respondents)	Willing to pay (%)	WTP = 0%	Protests or cannot state (%)	Mean WTP FIM/season[a]	Amount of users among residents, (%)	Recreation value/ season milj. FIM[b]
Repokallio summer (36)	83.4	11.1	5.5	130	21.6	1.01
Repokallio winter (38)	76.4	10.5	13.1	108	20.1	0.78
Linnunlahti summer (85)	73.0	12.9	14.1	139	46.0	2.31
Linnunlahti winter (64)	68.8	12.5	18.7	137	34.9	1.73
Lykynlampi summer (38)	71.0	13.2	15.8	117	20.4	0.86
Lykynlampi winter (40)	72.5	10.0	17.5	141	21.3	1.08

[a] Protests are not included.
[b] Summer season May–September; winter season October–April.

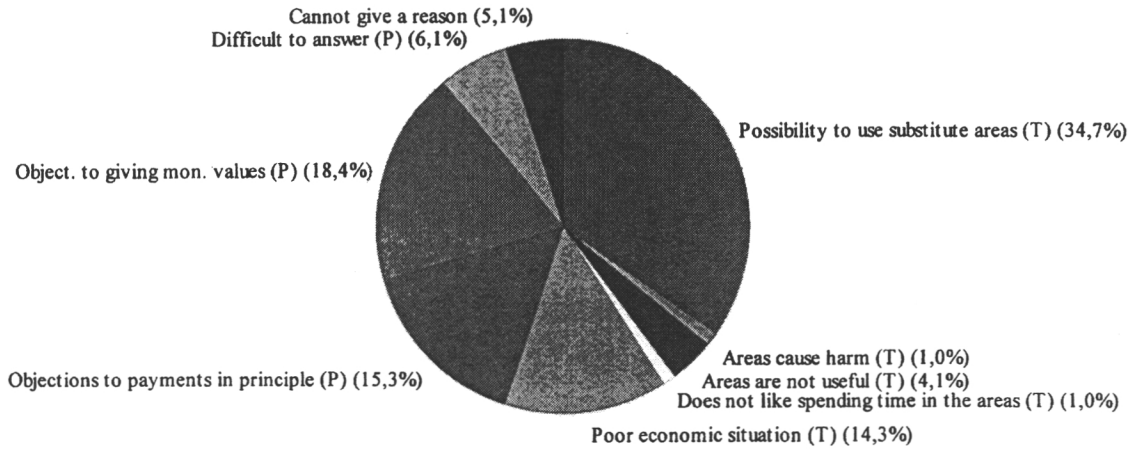

Fig. 4. Reasons for true zero WTP (T) and protest bids (P) concerning recreation areas ($n = 107$, 100%).

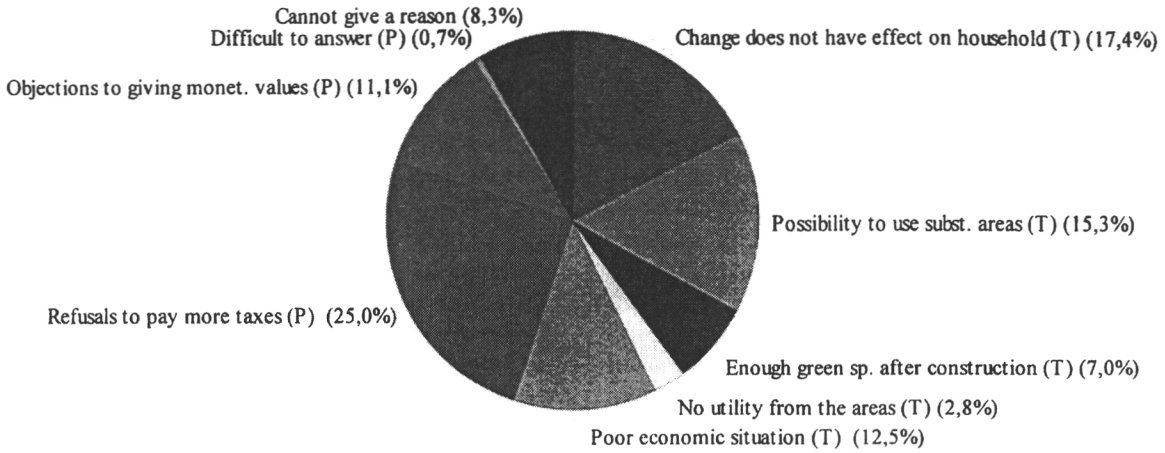

Fig. 5. Reasons for true zero WTP (T) and protest bids (P) concerning forested parks ($n = 144$, 100%).

mately half of the respondents were willing to pay during the next three years to prevent the reduction of forested parks in the housing area. The amount of respondents willing to pay something varied from 45% to 55% depending on the area (Table 4). The average WTP for the different areas varied from 126 FIM to 206 FIM. The lowest WTP was found among the residents living in the southern part of the town, which was least affected by the proposed construction. The 5% trimmed mean was calculated in order to find a conservative estimate for peoples' average WTP. The estimates varied between 86 and 162 FIM/year.

The amount of true zero WTP varied from 23% to 30% depending on the area The main reasons for true zero WTP were either that the respondents were not affected by the suggested land-use change, or they had the possibility to use substitute areas or that there were enough green spaces in the town after construction. Furthermore, the amount of protest bids varied between 19 and 25%. These respondents objected to the economic valuation of amenities, but could

Table 4
Willingness to pay for preventing construction of green spaces

Part of the town	Willing to pay%	WTP = 0%	Protests or cannot state (%)	Mean WTP FIM/year[a] (median)	5% trimmed mean WTP FIM/year[a]
Westerm ($n = 121$)	55.4	23.1	21.5	206 (100)	162 mk/v
Eastern ($n = 98$)	55.1	25.5	19.4	190 (100)	166 mk/v
Southern ($n = 84$)	45.2	29.8	25.0	126 (100)	86 mk/v

[a] Protests are not included, payments for 3 years.

not state their valuations in monetary terms or refused to pay more taxes.

The aggregate WTP was calculated for different parts of the town multiplying the mean WTP by the number of households in the particular town area. The highest aggregate willingess to pay (1.79 milj. FIM) for preventing the construction was found in the western part of the town, where potential construction areas were located in the middle of the housing areas The total WTP for preventing construction was 3.81 milj. FIM in the whole town area (Table 5).

A linear regression and a tobit model were calculated to explain the WTP for forested parks in the housing districts (Table 6). The protest bids were excluded from the analysis. Since the residuals in the model explaining WTP were heteroskedastic, the independent variable in the final models was the square-root of the stated willingness to pay. In both the models, the use of the areas and a view to the forest from the apartment were significantly positive explanatory variables for the households willingness to pay. Having a view had a higher positive influence on respondent's WTP than the recreational use of the area. The effect of income had the positive sign a priori expected, but was not statistically significant in the tobit model at the 10% level. In addition, the distance from the apartment to the potential construction area was not entered this model, due to its high correlation with the variables describing the use of and the possible view to the area. In the model, where these two latter variables were excluded, the distance to the potential construction area was found to be a signifi-

Table 5
Aggregate willingness to pay for preventing construction of green spaces

Part of the town	Mean WTP FIM/year[a]	Number of households	Total WTP/year/ha (FIM/ha)	Total WTP/year[a] (milj.FIM)
Western	206	8704	37360	1.79
Eastern	190	6330	11240	1.20
Southern	126	6502	17067	0.82
Total WTP				3.81

[a] Protests are not included, payments for 3 years.

Table 6
Regression and tobit models for WTP for preventing the construction of green spaces (dependent variable sqrt (WTP))

Independent variable	Coefficient	*T*-ratio	Coefficient	*T*-ratio
Income	$2417^{a}10^{-4}$	1.80	$2.764^{a}10^{-4}$	1.376
Age	−0.122	−3.18	−0.194	−3.238
View (D)	4.754	2.62	6.605	2.502
Use of the area (D)	4.353	3.25	6.194	3.070
Constant	10.176	4.97	8.779	2.846
	Linear model Adj. $R^2 = 0.15$		Tobit model. Log-likelihood = −634.19	

[a] D = 0–1 variable ($n = 227$).

cant explananatory variable for the household's WTP at the 5% level. Sex, family type or size, as well as education level or housing type, did not have statistically significant influence of WTP.

4. Discussion

The purpose of this study was to measure the benefits of urban forests in monetary terms using the CVM. The high response rate and intensive recreational use of wooded green spaces in the study town indicate high appreciation of urban forests, which is also a general feature in Nordic recreation studies (Jensen, 1995). Typically, in Finland, it is rather difficult to formulate willingness-to-pay questions concerning forest use due to right of public access (Bostedt, 1995a; Mäntymaa, 1997). Nevertheless, in this study the scenario presented was generally accepted rather well. Most visitors were willing to pay for the use of the forested recreation areas and the number of protest bids was rather low. About 19% of respondents did not answer the question. Carson (1991) reports item non-responses from 20% to 30% to be typical in a CV study.

The effect of the two different payment formats, monthly and seasonal fees, on the WTP were different. People were willing to pay smaller amounts of money more often than bigger sums less often. This resulted in higher annual monetary values using WTP/month for the recreation areas than when using seasonal payments. The same result was also found by Elsasser (1994) in a study dealing with the recreational use of forests in Germany. Which, then, are the correct figures and which of them should be used in calculating the total value of the recreational use of the areas?

We are here dealing with an embedding problem, which is also called part-whole bias (Kahneman and Knetch, 1992; Hanemann, 1994). This means that respondents may value the asset in question at a level of aggregation which is at variance with that intended by the researcher. For example, respondent may not consider the time horizon of the payment or they may not distinguish between personal/household payments. The phenomenon is typically found in measuring the non-use values of environmental commodities, where WTP for a single species or for the whole ecosystem may be approximately the same. However, the result that the aggregated seasonal fee is lower than the monthly fee is understood to derive from the uncertainty of the future use of the good. People who buy a season ticket run the risk of not using the area every month and, therefore, a lower WTP per season is logical. A conservative choice would be to use these lower WTP estimates in cost benefit analysis.

The WTP question concerning forested parks was ascertained from all the respondents. The scenario presented in the questionnaire can be considered to be realistic, because the suggested change in the amount of green space was connected to an on-going town planning project where additional building sites were sought inside the present housing districts. The item non-response was a low 11% indicating that the formulation of the question was successful. Approximately half of the respondents were willing to pay to prevent the decrease of urban forests in the housing area. A higher amount of positive bids occurred when the potential construction area was located near the living place. In addition, a view to the forest had an even larger positive influence on people's willingness to pay than the use of the area. This refers to the importance of the urban forests in the home environment where substitute areas are difficult to find. Furthermore, the distance to the potential construction area also explained the willingness to pay. The relationship between WTP and distance from the areas was found to be non-linear. In this study people living less than 4 km from the area were found to pay more than those who lived further away.

There are only a few previous studies dealing with monetary values of urban forests. The results are similar to a HPM study conducted by Tyrväinen in the same study town (1997). The decreasing distance to a forested recreation area, as well as the increasing relative amount of green spaces, had a positive influence on house prices. In study in West Germany, Elsasser (1994) found that forests near bigger cities are valued higher than the remote ones. Most of the forest recreational visits take place in urban forests and using substitute areas, therefore, means higher travel costs.

The level of income did not seem to have an influence on peoples' willingness to pay. This implies that the green spaces are not a superior good, but rather

an essential part of the everyday life in the study town. This can be concluded from the high use of and positive attitudes towards urban forests. The same income effect has been found in several valuation studies dealing with nature conservation. These studies have shown that the protection of bio-diversity is not a luxury good (Pope III and Jones, 1990; Veisten et al., 1993).

To avoid the payment vehicle bias, payment procedures such as taxes and entrance fees are normally to be avoided (Cummings et al., 1986). Nevertheless, in Finland it is difficult to describe a credible payment scenario without their use, because these payment formats are the most common and realistic in Finnish conditions. In this study, however, the use of tax as a payment vehicle may have increased the amount of protest bids.

In addition, in this question the presence of the embedding problem may also have affected the WTP estimates: although the potential construction areas were of a different size in the housing districts, the average willingness to pay did not vary very much between the areas. This raises the question as to whether the WTP was partly understood as a general question concerning converting green spaces into housing. However, the result obtained is logical and can be explained by looking at the differences of the valued areas. The smaller construction area (Noljakka) was located in the western part of the town near to the town centre. The other area (Rantakylä) in the eastern part of the town was bigger, but located on the outskirts of the town. The results demonstrate that peoples' WTP follows a law of decreasing marginal utility. This means that people are willing to pay less for each additional hectare to be protected. The same type of result has been found in studies dealing with nature conservation (Pope III and Jones, 1990; Loomis et al., 1993).

It is also necessary to look at the presence of self-selection bias, which means that people interested in the issue or in using the forests answer the survey more often than the non-interested or non-users (Whitehead, 1991). This may lead to a result that, for example, the amount of forest use is greater than it is in reality. This is important, as use-intensities play an essential role when aggregate benefits are calculated for the recreation areas. In this study, however, the rather high response rate decreases the effect of the possible bias. The motives for not answering or use-intensities can be determined afterwards by a follow-up survey (e.g. Fredman, 1994). In this study the survey was not, however, considered to be necessary.

The question of the degree to which CV estimates are accurate representations of respondents true willingness to pay is often raised (Mitchell and Carson, 1993). The weakness of the method is that responses are based on hypothetical and not actual behaviour. In general, it seems that there is considerable validity in the estimated use values. In contrast, concerns regarding the validity of estimates of non-use values remain (Bishop and Heberlein, 1990; Arrow et al., 1993; Portney, 1994). Most values attached to urban green spaces are, however, direct or indirect use-values, e.g. pleasant landscape, peace and quiet, observation of wildlife as well as recreational benefits, suggesting that CV is a proper method for assessing the benefits (Tyrväinen, 1994). Furthermore, the credibility of the method is increased because the results can be verified with HPM.

CV can be used, for example, for estimating peoples' willingness to pay for establishing new wooded green spaces. Suitable case areas can be easily found in different countries. For example, in Finland they include housing areas built in the 1970s that lack trees and other vegetation. Furthermore, it is probable that the suitable management of urban forests will increase the benefits derived from different types of areas. CV could be used to ascertain people's WTP for the upkeep of or for the increase of the protective and aesthetic functions of urban forests. This approach has been tested in production forests by Bostedt and Mattson (1995b) who found that modifying forest management practises increased the recreational value for tourism.

Since the CV method is difficult to implement without avoiding various types of design problems, each particular study needs to be scrutinized carefully and to be adapted to the circumstances of each study town or area. In an urban setting, people are probably more accustomed to pay for their leisure time and therefore payments for outdoor recreation are more acceptable than in other forest areas. However, the preferences may be easier revealed if respondents are asked to compare urban forest benefits with the use of other public services instead of being asked to pay directly.

5. Use of the CV estimates

The use of CV survey results in decision making has different levels: they may be used to stimulate public awareness of potential urban forest benefits, to influence or identify decisions throught cost–benefit analysis, or just to justify decisions in urban land-use planning and policy making. The extent and purpose of the use of CV survey results varies across countries. In Europe, the more ambitious purposes are often connected with lower policy levels (public projects). In contrast, the use of the CV estimates in national policy decisions has been so far negligible (e.g. Kuik et al., 1992). At present, for example, the environmental impact assessment (EIA) procedure required in city planning does not include monetary valuation.

The value of urban forest benefits could be concretizised by comparing the estimated benefits to, for example, the up-keep costs of the areas or the value of the land in alternative use. The results of this study show e.g. that the monetary benefits of urban forest are much higher than the present maintenance costs. The stated amount of WTP for preventing the construction of green spaces was to be collected during the next three years, 1995–1997. The value of aggregated WTP (1995) is 10.57 million FIM at 5% discount rate. The average maintenance costs of forested parks in Joensuu (1991–1995) is 10 152 FIM/ha/year, and the present management interval in urban forests is between 5 and 10 years. (Joensuun kaupungin teknninen virasto, 1996). Thus, the residents' total WTP for the parks would cover their management costs for the next 34–67 years depending on the management intensity – assuming that the raise of management costs and interest rates is the same. Accordingly, for example, the annual aggregate recreation value of Repokallio area is 10–20 times higher than the annual management costs using lower WTP estimate (mean WTP/season).

Furthermore, management decisions often concern trade-offs between timber production and recreational benefits – in particular at the urban fringe. Many municipalities in Finland treat the forested areas within city limits as a source for timber and income (Löfström, 1998). Therefore, it is relevant to compare the value of the areas in timber production to the amenity benefits of green areas.

The value of the land in forestry use can be calculated by using the summation approach most commonly used for valuing forestry in Finland since 1960s (Oksanen-Peltola, 1994). In this method, the value of the forest is estimated based on the value of the land and the value of the present timber stock. The timber stock is divided into different age classes for which an expectation value is calculated normally using 3–5% interest rate. However, in practise, these values are cut by 30–50% to cover taxation and the management costs and to reach the actual market price level (Kiinteistöjen arviointikäsikirja, 1991; Oksanen-Peltola, 1994).

The value of the potential construction areas in forestry was calculated using multiple-use forest management planning system (MONSU). The system includes the summation approach in the valuation of forest property (Pukkala, 1998). Forest inventory data (1997) received from the North Carelian District Forestry Board was used. The average timber volume in the areas was rather high: in Noljakka 194 m^3/ha and in Rantakylä 145 m^3/ha. The present value (1997) of Noljakka construction area in forestry was 1.13 million FIM and the residents' total WTP was 8.23 million FIM (1997) using 5% interest rate. On this basis the amenity benefits of urban forests were 7.3 times higher than the value of the area in timber production. If the aggregate WTP from the southern part of the town is excluded from the total WTP for the areas, the amenity benefits are five times higher than the estimated benefits from timber production. Furthermore, the Rantakylä area was twice as big as Noljakka area and was located at the urban fringe. However, the amenity benefits were still twice as high as the timber production benefits. Furthermore, it has to be kept in mind that the recreational use of these areas does not completely exclude timber production but rather decreases the received economic benefits and vice versa.

Finally, the results of the study can be used in analysing the environmental impacts of land-use alternatives in town planning. The main question in urban setting is more often where to build than whether to build at all. The loss of amenity values should be included in the analysis when choosing the best land-use alternative from the point of view of society. The estimated non-priced benefits should be compared to the increase in costs when providing the building sites somewhere else.

Theoretically the total economic value of these benefits can be measured e.g. with contingent valuation and partially using hedonic pricing method. The total value of a certain area depends of its location, size, quality, use intensity and the amount of substitute areas. In general, the more scarce the resource becomes the higher the value is per hectare. The relatively low value of green spaces in this study was thought to be due to the abundance of green areas in the town, and also because the suggested forested areas for construction were rather large.

Acknowledgements

This work has been supported by the University of Joensuu, Faculty of Forestry. In particular, we wish to thank Prof. Seppo Kellomäki for his interest and support for the research. Furthermore, Drs. Anni Huhtala, Heikki Pajuoja and Ville Ovaskainen from Finnish Forest Research Institute have given valuable comments during the preparation of the article. Several researchers of the Faculty of Forestry and the Department of Economics at University of Joensuu have helped during the work. The technical department of Joensuu City, and in particular chief gardener Kai Ahmio, planner Irene Martiskainen and city forester Matti Viirret have been helpful with providing the information needed. Our warmest thanks to all those who contributed to the completion of this work.

Appendix A

What is an urban forest

Urban forests are wooded areas located within town limits or close to town (2–6 km). The areas constitute of natural forest vegetation and provide everyday recreation opportunities for residents. Urban forests can be divided into different categories: *Forested parks* are often rather small areas located inside housing districts and provide landscaping as well as recreation possibilities. *Recreation areas* are larger wooded areas with recreation facilities and are often located further away from the town center. *Protection forests* are narrow forested belts e.g. between housing and main roads. According to this definition constructed parks are not urban forests.

Examples of urban forests	Examples of areas which are not urban forests
Forested area with skiing and jogging trails.	Constructed park with lawn.
Forested area with cycling or walking route.	Childrens playground with trees.
Narrow belt of forest vegetation between houses.	
Forested area between housing and a road.	

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III

PROPERTY PRICES AND URBAN FOREST AMENITIES

Liisa Tyrväinen[1] and Antti Miettinen[2]

ABSTRACT

Quantitative information on residents' valuations attached to urban forests is needed for assessing urban land-use. The aim of this study is to value non-priced urban forest amenities by comparing dwelling prices and specific amounts of amenities associated with dwelling units. The empirical study is based on data from the sales of terraced houses in the district of Salo in Finland. According to the estimation results a one kilometre increase in the distance to the nearest forested area leads to an average 5.9 per cent decrease in the market price of the dwelling. Dwellings with a view onto forests are on average 4.9 per cent more expensive than dwellings with otherwise similar characteristics.

Keywords: Amenity benefits, hedonic price method (HPM), dwelling prices, town planning, urban forests.

[1] Liisa Tyrväinen
University of Joensuu, Faculty of Forestry,
P.O. Box 111, 80101 Joensuu, Finland,
E-mail: liisa.tyrvainen@forest.joensuu.fi
[2] Antti Miettinen
University of Joensuu, Department of Economics
P.O. Box 111, 80101 Joensuu, Finland

1. INTRODUCTION

At the present time in Europe, there is growing and wide-ranging demand for green areas, as a result of growth in populations, increased leisure-time, and rising environmental awareness [8, 42]. The quality of the urban environment is increasingly recognized as a key ingredient in the economic regeneration of European cities [53]. However, at the same time, the major trends are cuts in the budgets for green areas and increased pressures caused by urban development and expansion [cf. 25, 42]. Although, there is no precise knowledge about the role played by green spaces in the quality of urban life, the benefits of urban forests are recognised to be many [cf. 23, 37, 46, 51]. They include amenities that are aesthetic, ecological and economic in nature, as well as those that have a physical or psychological effect on human health, such as pollution control, noise abatement and the provision of recreational opportunities.

The cost of supplying urban forests can be calculated in a relatively straightforward way, but the benefits are more difficult to estimate. Most urban forest benefits do not have a market price. Therefore they are difficult to include in assessment procedures for the various land-use alternatives. The planning and maintenance of green spaces have seldom received enough attention in urban planning and decision-making, with the consequence that quantitative information on the benefits and residents' valuations is needed [57].

Nordic towns offer good facilities for outdoor recreation and close contact with nature, especially from the general perspective of other Western countries [22]. Trees and forests, as a dominant element of the vegetation, form an essential part of the visual image of a typical Nordic town. Several recreational studies report that participation in outdoor activities is high in all of the Nordic countries, and urban forests play a key environmental role in their popularity [cf. 17, 22, 52]. The structure of urban green spaces in Finland and their significance for the Finns have their own special features. One particular feature of the green areas is their 'natural state': most green spaces are formed from preserved areas of the natural landscape, often in the form of forest vegetation.

At present, in Finland there is no legal requirement to assess the value of the externalities of urban land use, so that, for example, the Environmental Impact Assessment (EIA) procedure required in city planning does not include monetary valuation [28]. Furthermore, most municipalities do not have any specified urban forest policy [25, 31]. However, comparing the urban forest benefits with the provision and management costs of the areas could serve as a tool in the formulation of appropriate urban land-use policy. Furthermore, monetary estimates of environmental benefits help in justifying, for instance, the improvement of degraded environments that can be found in many housing areas built particularly in the 1970s.

Thus far, quantitative research regarding urban green spaces in Europe has been limited [8]. Monetary valuation of the urban forest amenities would be a way of concretizing and measuring commensurately the benefits of residents. The resultant use of estimates of the benefits in decision-making would affect several different ways. At a minimum level they might stimulate public awareness of potential values lost in the vanishing of green spaces. At a more ambitious level, their advantage lies in their ability to influence or identify decisions through cost-benefit analysis at project level [e.g. 26]. The latter level may be most appropriate in the case of urban forests, since local conditions vary between cities and towns.

One possibility for measuring urban forest amenities in monetary terms is to examine how much people are paying for such benefits in their housing. The hedonic price method (HPM) estimates the value of environmental benefits from the prices of related market transactions. The method is usually termed a revealed preference method in order to distinguish it from methods such as the contingent valuation method (CVM), which is based on intended rather than actual behaviour and which is normally termed a stated preference method. The most common application of the HPM is in the housing market. The selling price of a dwelling reflects characteristics of the dwelling such as the number of rooms, age of building, size of garden, etc. Furthermore, the selling price also reflects locational and environmental features such as proximity to shops, schools, the view onto or access to a wooded park or watercourse etc. [cf. 45, 56]. Therefore, if a household wishes to enjoy a view onto a forest or a park or to have easy access to wooded recreation areas, it will buy this type of house and pay a premium for it.

A hedonic price function can be estimated from data concerning the prices and attributes of housing. There are, however, several issues involved in conducting a comprehensive HPM study, which have resulted in an abundant literature on the subject [e.g. 9, 12, 19, 45]. The analysis requires large data sets, which are labourious to collect. In addition, empirical applications should address some major problems such as the functional form of hedonic equation and multicollinearity among the explanatory variables.

In Europe about 200 studies now exist dealing with the valuation of environmental goods. Most have been undertaken in the United Kingdom, Norway and Sweden. Their main focus has been on the non-use values of environmental amenities and most are studies concerning travel cost and contingent valuation methods [41]. Some HP studies were made in the 1970s and 1980s both in the USA and Europe [1, 10, 38, 39, 40], but only a few examples of contemporary applications of hedonic price method.

In Finland Tyrväinen [59] conducted a HPM study in which the diminishing distance to a forested recreation area, as well as the increasing relative amount of green spaces, had a positive influence on house prices. However, the effect of forested parks on apartments prices remained unclear owing to

the abundant supply of urban forests. The range of variable values remained small since most of the apartments (78 per cent) were located at a distance of 100 metres or less from a forested area. In consequence, the first condition for capitalization, i.e. adequate variation within the variable, was not fulfilled [54]. Thus, additional research was necessary to see whether HPM would better capture these benefits under different conditions.

The purpose of this study is (1) to search for variables suitable for describing 'close home' forest benefits, and (2) to estimate the monetary value of urban forest benefits reflected in dwelling prices. This paper therefore presents the results of an empirical study conducted in the district of Salo in southwest Finland.

2. URBAN FOREST BENEFITS AND HEDONIC MODELS

In valuing urban forests by means of hedonic price method one of the main problems in empirical applications is that the amenities are difficult to define and measure. In most studies the variables measuring urban forest amenities are either missing or approximative [cf. 27, 62]. In a study conducted in the U.K. by Willis and Garrod [63] two of the most important environmental attributes were proximity of woodland and proximity of water. However, the measurements of the amount of woodland and proportions of tree species were made using square kilometre units, and there was not precise information about location of houses with respect to the forested areas.

It must also be added that some indicators included in the hedonic models measuring, for example, air quality are probably difficult to perceive. Therefore the extent to which such indicators actually affected decision-making is questionable [4, 5, 16]. Another related example is traffic noise, the level of which may depend, for instance, on time of the day. Therefore buyers visiting at different times of day may have different impressions of the noise problem [61]. Urban forests, instead, as an environmental quality indicator have the advantage of being a visible element of urban landscape. Furthermore wooded green spaces also contribute to clean air and tranquillity in a built-up environment.

One goal of this study is to find proper variables that measure urban forest amenities from the perspective of a house-buyer. In practise, a good starting point is to imagine how residents perceive urban forests and receive the associated benefits from the perspective of their homes and also from the perspective of the surrounding environment. The benefits associated with urban forests can be derived theoretically from urban forest functions [37, 46, 58]. According to Schroeder [51], aesthetic enjoyment is probably the greatest benefit of urban forests.

The property value technique consists, theoretically speaking, of two stages [cf. 11, 12, 45, 47]. At the first stage, implicit prices for different housing characteristics are estimated. Here, variation in selling prices of dwellings is explained by the characteristics

of housing. One can use these implicit prices directly to evaluate the benefits or losses arising from marginal changes in the supply of environmental goods. This procedure will apply when the environmental change affects only a restricted area and a small number of people. In this case, the prices of dwelling affected will adjust to the level of dwellings with similar characteristics, but the hedonic equation will remain unchanged. If dwellings are owner-occupied, the environmental improvement (degradation) will provide a capital gain (loss) for those living in the area [20, 45].

The assumption of marginal changes applies in the majority of cases involving urban forests: where green spaces are converted into another use or new areas are established, the spatial impact on dwelling prices in the housing area will be restricted. The main losses or received benefits will be experienced by nearby inhabitants, while the impact diminishes the farther away residents are located. In consequence, the direct use of implicit prices in valuation using the hedonic model is justified.

In contrast, the use of price estimates is more problematic if the change in question covers the whole urban area or a large part of it. This is the case, for example, in air quality projects where restrictions on pollution affect large areas and large proportions of the population [cf. 4, 14,]. Accordingly, further assumptions, such as constant marginal benefits of the households, have to be made or, if the required assumptions do not apply, a second stage of analysis is required [cf. 20, 45]. In this second stage, information about implicit prices and data concerning environmental quality are combined to identify the inverse demand functions of characteristics. Owing to the strict requirements of the data and the econometric problems connected with the second stage, most empirical valuation studies have used only the first-step hedonic regression model [34, 36, 62]. In this case the use of the implicit prices often results in less accurate estimates of the value of the environmental characteristics.

Several econometric issues and problems arise in the estimation of the hedonic models. For example, the functional form of the hedonic price equation cannot be specified purely on theoretical grounds. In consequence, the form of the equation must be determined empirically within the housing market [19, 45, 47]. The hedonic price function is typically nonlinear, since it is a joint envelope function of a family consisting of both buyers' value and sellers' offer functions. The only exception when the hedonic price function becomes linear occurs if it is possible to repack the characteristics of housing without incurring any costs.

In an influential article Halvorsen and Pollakowski [19] allowed the data to determine the most appropriate functional form for hedonic price equation. They used the following quadratic Box-Cox functional form:

$$P^{(\theta)} = \alpha_0 + \sum_{i=1}^{m} \alpha_i Z_i^{(\lambda)} + \tfrac{1}{2} \sum_{i=1}^{m} \sum_{j=1}^{m} \gamma_{ij} Z_i^{(\lambda)} Z_j^{(\lambda)}, \qquad (1)$$

where P is price of dwelling, the Z_i are characteristics attached to housing, and $\gamma_{ij} = \gamma_{ji}$. $P^{(\theta)}$ and $Z_i^{(\lambda)}$ are Box-Cox transformations,

$$P^{(\theta)} = \begin{cases} \dfrac{P^{\theta} - 1}{\theta}, & \text{if } \theta \neq 0, \\ \ln P, & \text{if } \theta = 0, \end{cases}$$

and

$$Z_i^{(\lambda)} = \begin{cases} \dfrac{Z_i^{\lambda} - 1}{\lambda}, & \text{if } \lambda \neq 0, \\ \ln Z_i, & \text{if } \lambda = 0. \end{cases}$$

As the logarithmic transformation is defined only over positive values, all values of transformed variables must be greater than zero. Special cases of the quadratic Box-Cox (1) include log-linear, linear, and semilog, among many others. The semilog form, for example, is obtained by imposing the restrictions $\theta = 0$, $\lambda = 1$, and $\gamma_{ij} = 0$, for all i, j. To test whether a particular functional form is appropriate, the restrictions corresponding to that functional form may be tested using the asymptotic likelihood ratio test statistic. [7, 13]

The approach proposed by Halvorsen and Pollakowski [19] has also received criticism [6, 9, 43, 45]. Cassel and Mendelsohn [6], for example, were sceptical about the power of quadratic Box-Cox functional form since (i) the best fitting criterion does not necessarily lead to more accurate estimates of characteristic prices; (ii) the functional form may be inappropriate for predictions; and (iii) the transformations result in complex estimates of slopes and elasticities which are often too strenuous to be used correctly in policy analysis. They also noted that Box and Cox [3] warned against the use of the transformation when the transformed dependent variable is of primary interest, since any nonlinear transformation of the dependent variable will introduce bias. Furthermore, the more parameters there are in the model, the larger will be the variance around each parameter and the more the precision of each parameter will be reduced.

Indeed, it seems that the use of the flexible functional form may significantly complicate the interpretation of the results [45]. Because of the problems described above, the usual practice has often been simply to assume some arbitrary functional form, such as linear, log-linear or, most frequently, semilog [2, 19, 27]. Based on their Monte Carlo experiments, Cropper et al. [9] proposed that the linear Box-Cox functional form may be the most useful. Palmquist [45] suggests that the environmental variable could be transformed by a separate transformation parameter in the estimation of the hedonic model.

Furthermore, the relationship between the dwelling price and an independent variable is not necessarily monotonic. According to Laakso [27], non-monotonic relationships are typical of variables such as a distance from the dwelling to local externality. He suggested that continuous independent variables could be transformed into dummy variables if the data set is large. Another possibility to study the shape of the relationship between

variables is to estimate spline functions [27, 32].

Besides the functional form of the hedonic price equation, also other econometric problems require special attention. One of these issues is the choice of appropriate variables in the models. Theoretically, the price equation should include all the housing characteristics included in the utility functions of households. It is common to classify the explanatory variables into structural, locational, environmental and socio-economic variables. The choice of variables in empirical studies has restrictions such as the availability of data and multicollinearity. In practice, the scope of the study as well as the data restrictions have been the main factors that have been defined the chosen variables. According to Laakso [27], the number and quality of explanatory variables vary considerably between the different studies. In Laakso's review of eighteen hedonic price studies the number of explanatory variables in the models varied from three [30] to thirty [44].

In hedonic models some explanatory variables are often multicollinear. In consequence, estimating accurate and stable regression coefficients may be difficult. One solution to the problem is to omit a highly collinear variable from the model, provided this does not lead to serious specification bias. For example Ohlsfeldt [43] implies that restricting the number of variables may also make the interpretation of results easier. Of course, it is also possible to use some other multivariate statistical method than regression analysis [45].

Moreover, according to Goodman [14], the price structures of hedonic models are not as stable as one would hope: estimates from market to market, or from year to year, may differ significantly. In empirical work, aggregating the data from different time periods to obtain enough observations is often necessary. This is, however, questionable if the housing market has received significant shocks over the time period [45]. Hence, temporal stability of estimated parameters has to be studied when aggregating data.

Goodman [14] also contemplates the possibility of spatial autocorrelation The error terms may be spatially correlated if some relevant variable, typically local externality, is excluded from the regression model. The second form of spatial autocorrelation is more complicated. It may occur if positive error terms in the sale of houses at one location may noticeably influence sales prices at nearby locations, and less so at more distant locations.

3. DATA

The empirical study was conducted in the district of Salo, which is located 110 kilometres to the northwest of Helsinki. The area was chosen because there were enough housing market transactions during the period of study and also a sufficient variation within the environmental quality. The district of Salo consists of two municipalities, Salo and Halikko. Salo is a town with 23,000 inhabi-

tants (1996) and the municipality of Halikko (9,000 inhabitants) is located on the northern border of the town of Salo itself. Halikko is an integral part of the housing market in the region as many people who live in Halikko work in Salo. The biggest employer in the region is the Nokia Mobile Phones company, which has a production plant in Salo.

Salo itself is an old commercial centre within a wide river valley. The main features in the landscape are open fields and forested eskers between the fields. The river Salo runs through the town centre and both housing and industry are concentrated along the river. The buildings in the town centre are typically not higher than three storeys. In most of the housing areas detached houses or terraced houses predominate. Therefore, the general profile of the town is flat. The town of Salo owns approximately 1.100 hectares of forest, the majority of which (74 per cent), is found outside the area included in the town plan. The green areas near the town centre are few and are found along the riverbanks. Most of the forested areas are found in the urban fringe located on hills which start abruptly from the valley. Housing has expanded into these hill areas only in recent decades [50].

The relative number of green areas in Salo has substantially increased over the last decade. In 1986 the green areas represented around 10 per cent of the planned town area, amounting to some 190 hectares of green spaces, 82 per cent of which were forested and 18 per cent constructed parks [48]. In 1996 the green spaces covered 17.3 per cent (356 ha) of the planned town area. Eighty-one per cent of the green areas were forested and 19 per cent (67 ha) were constructed parks or shelterbelts [49]. The increase in green areas has been brought about by land acquisition and town planning as well as by the active construction of parks.

An inventory of the urban forest areas in the municipalities was made using the town plans and black and white aerial photographs from year 1987 on a scale of 1 : 5.000, which were available from the Geographical Data Centre of the National Land Survey of Finland in Helsinki. The minimum size classified as a wooded green space was 0.3 hectares. Neither the town of Salo nor the municipality of Halikko has urban forest management plans and so detailed information concerning tree species or the age distribution of the forests was not available. Overall, the urban forests in the district of Salo are quite fragmented and different in respect of both tree species and age-class distribution. Most areas are pine-dominated, but some soils are very fertile. In those areas species such as oak, linden, maple and hazelnut are frequent.

The dwelling sales sample was collected from owner-occupied terraced house sales in Salo and Halikko. Unencumbered selling prices and basic structural data concerning the characteristics of dwellings have been collected from stamp duty record files charged on housing share transactions. Thus, the data consists of all apartment sales in terraced housing over three years in the mid-1980s. There are both new and old dwellings in the sample.

The number of housing share transactions in the final sample is 590. Seventy-two observations had to be ignored because information concerning the view from the windows of the dwellings concerned could not be determined precisely in the field investigation. Furthermore, another seventeen entries were rejected as the selling price was distinctively lower than the general price level in the housing market, probably due to transactions between family members.

The data collection was restricted to terraced houses. This type of housing was chosen because the characteristics of such housing vary less than those of detached houses. Blocks of flats were also excluded from the analysis because they were mostly situated in the town centre where variation in the environmental characteristics is insufficient. The sample included only dwellings which had a maximum of five rooms.

Because price fluctuations have been strong in the Finnish housing market since 1987 due to liberalisation of financial markets and an increase in interest rates, the data used in this analysis has been taken only from the reasonably stable period of 1984-86. The data from different time periods has been combined by converting the nominal selling prices to the 1983 price level using price index for terraced housing in southern Finland (for towns outside the Helsinki area). The base year of the index is 1983, and the index is produced quarterly by Statistics Finland.

The explanatory variables and their expected signs are presented in Table I. Four different variables measuring urban forest amenities were used with respect to each dwelling. These environmental variables were chosen according to the theory of urban forest benefits and the results of the previous study [59].

(i) *The distance to the nearest wooded recreational area* measures mainly the recreational opportunities in the housing area, although these large forests also have protective and aesthetic functions. In the mid-1980s only two housing areas in Salo had a wooded recreational area with facilities such as skiing and jogging trails. The distance to either of those areas has been measured along the streets, cycle paths or pavements.

(ii) *The direct distance to the nearest forested area* (i.e. forest park) was measured from each terraced house to the edge of the forested area. These forested areas were small, ranging from 0.3 hectares to several hectares, or narrow strips of forest land within the housing district. They are important for screening and pollution control, and have psychological effects with regard to noise abatement and improvement of the urban landscape.

(iii) *The relative amount of forested areas in the housing district* mainly describes the amount of space (construction density) in the housing area, and to a certain extent the general visual landscape in the particular area. In addition, this variable encapsulate partly the technical benefits that urban forests provide (i.e. noise and pollution control). The amount of forested areas was measured on a map of the town by means of a planimeter.

Table I. The explanatory variables and their expected effects on sales price

Explanatory variable	Expected sign*)	Explanatory variable	Expected sign*)
Floor area of the dwelling	+	Distance to the centre of Salo	—
Number of rooms	+	Distance to the Nokia factory	—
Kitchenette = 0, Kitchen = 1	+	Distance to the local shopping centre	—
Internal sauna, 0 = no, 1 = yes	+	Distance to the nearest school	—
Roof type, 0 = flat roof, 1 = ridge roof	+	Distance to the indoor swimming pool	—
Brick house, 0 = no, 1 = yes	?	Distance to the nearest wooded recreation area	—
Age of the building	—	Direct distance to the nearest forested area	—
Yard size (lot size divided by number of dwellings in the housing company)	+	Relative amount of forested areas in housing district	+
Municipality, 0 = Salo, 1 = Halikko	?	View of forest, 0 = no, 1 = yes	+
Low status housing area, i.e. Ollikkala 1, 0 = no, 1 = yes	—	View of park, 0 = no, 1 = yes	+

*) + increasing/ - reducing effect on the selling price.
? indicates an a priori undetermined sign.

(iv) *The view from the dwelling window* was classified into five categories: (1) the view over construction areas, (2) the forest view, (3) the view onto a constructed park, (4) distant views (e.g. a view overlooking a field), and (5) other (i.e. a view consisting of various features from the previous classes). The view belonged to a particular class if more than 50 per cent of the direct view from the window belonged to the specific class.

All distances, e.g. distances from the dwellings to the town centre (Salo Market Square), were measured on maps of the town (1:10,000 scale) by means of a map-meter, with an estimated accuracy to the closest 100 metres. The only exception was made in the case of distances to the nearest forested areas, which were measured in the field to the closest 10 metres if there was a view onto forest from the dwelling concerned.

Information on the status of housing areas was obtained by telephone inquiry from local real estate agents. The Ollikkala housing district was distinguished from others as a low status area. Most of Ollikkala was built in the 1970s, and the proportion of blocks of flats is larger than in the other housing districts. The average price of each type of dwelling was clearly lower there than elsewhere. Information about public and private services for 1985-86 was obtained from the Department of City Planning and the Department of Park Services.

Although water is usually an appreciated feature in the housing area, no separate variables measuring such benefits were included in the model. The main recreational harbour on the River Salo is located close to the market square. In consequence, the variable measuring distance to the town centre can also be considered to serve as a proxy for recreational benefits received from the river. In addition, river views are rare from the terraced house apartments because the river is narrow and the landscape flat.

Data on renovations of dwellings was not available. Therefore the age of a building serves as a proxy for the condition of the apartment in question. The age variable has been calculated in the following way: age of building = transaction year - construction year of building.

4. ESTIMATION RESULTS

The basic idea of the following estimations of hedonic price equations is to study the relationship between the real selling price of dwelling and the urban forest amenities. To define the functional form of the hedonic equation, the following linear Box-Cox model was fitted to the dwelling level data of terraced house sales in Salo and Halikko:

$$P^{(\lambda)} = \alpha_0 + \sum_{i=1}^{3} \alpha_i Z_i^{(\lambda)} + \alpha_4 Z_4^{(\theta)} + \alpha_5 Z_5 + \sum_{j=1}^{3} \beta_j D_j + e, \qquad (2)$$

where P is real unencumbered selling price for the housing company unit in a terraced house. $P^{(\lambda)}$, $Z_i^{(\lambda)}$ (i=1,2,3), and $Z_4^{(\theta)}$ are Box-Cox transformations as described in section 2.

The variables included in the model (2) were selected on the basis of several estimation trials and information on the multicollinearity of the explanatory variables. Those variables that did not enter with statistically significant coefficients were omitted from the equation. In hedonic price equation (2), there are five quantitative explanatory variables, Z_i (i = 1,2,..,5), measuring: floor area of the dwelling, distance to the centre of Salo, distance to the local shopping centre, distance to the nearest forested area, and age of the building.

Note that the variable Z_4, measuring distance to a forest park, is transformed by the separate transformation parameter, θ. The other transformation parameter, λ, is constrained to be the same across all other transformed variables except Z_4. Furthermore, the variable Z_5, measuring the age of building at the time of the transaction, is untransformed, because the sample included both new and old houses. The equation (2) has three qualitative explanatory variables, D_j (j = 1,2,3), indicating municipality, facade material and the possible forest view from the dwelling window. e is the stochastic error term.

The results of maximum likelihood estimation are presented in Appendix 1. The estimated Box-Cox regression is clearly statistically significant. The estimated value for the transformation parameter λ is 0.09 and the estimated value for the transformation parameter θ is 0.57. Those values are so close to zero that is worth testing whether the log-linear functional form ($\lambda = \theta = 0$) is appropri-

ate for hedonic price equation. Hence, it is postulated that:

$$H_0 : \lambda = \theta = 0 \text{ vs. } H_1 : \lambda \neq \theta \neq 0.$$

Under the null hypothesis, the likelihood ratio, LR = $2[L_{max}(\lambda,\theta) - L_{max}(\lambda^*,\theta^*)]$, is asymptotically distributed as a χ^2 random variable with two degrees of freedom. Substituting the values of the unrestricted and restricted log likelihood functions in the likelihood ratio, the value of the test statistic LR is 2[-6830.43 - (-6832.27)] = 3.68. Assuming α = 5 per cent, the upper percentage point of the χ^2 distribution with two degrees of freedom is 5.99. Since the value of the test statistic, 3.68, is smaller than the critical value, 5.99, the null hypothesis may be accepted at the 0.05 level.

It turns out that according to the asymptotic likelihood ratio test statistic, also the functional form where $\lambda = 0$ and $\theta = 1$ may be accepted to the hedonic price equation at the 0.05 level. This is possible because the testing procedure is only partially nested [19]. In fact the value of the log likelihood function (-6832.20) when $\hat{\lambda} = 0$ and $\hat{\theta} = 1$ is greater than the resulting value of the log likelihood function (-6832.27) when $\hat{\lambda} = \hat{\theta} = 0$.

Although either of those special cases could be accepted to the functional form for the hedonic price equation, the special case where $\lambda = 0$ and $\theta = 1$ is slightly better according to the statistical criteria used. Thus, we may next estimate a model where variables P and Z_i (i = 1,2,3) are linear in logarithms, and where the relation between the selling price and the variable Z_4 measuring distance to a forest park is semilogaritmic.

The hedonic equation to be estimated applying the method of ordinary least squares is

$$\ln P = \alpha_0 + \sum_{i=1}^{3} \alpha_i \ln Z_i + \alpha_4 Z_4 + \alpha_5 Z_5 + \sum_{j=1}^{3} \beta_j D_j + e. \qquad (3)$$

Since several variables included in the model (3) are intercorrelated, we detect multicollinearity among explanatory variables once more. The variable related most to other explanatory variables is logarithmic distance to the centre of Salo. The other explanatory variables explain 78 per cent of the variation in the log of distance to the centre of Salo. [1]

Furthermore, due to expansion of housing, the coefficient of correlation between the variables logarithmic distance to the centre of Salo and age of building is -0.60. Fortunately the variables measuring the urban forest amenities are not highly related to other explanatory variables. Naturally, the variables measuring distance to the nearest forested area and the forest view are related themselves.

The average distance to the nearest forested area from dwellings with a view onto forest is only 30 metres, whereas from those

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[1] The other values of R^2 in auxiliary regressions are: $R^2_{\text{Age of the building}} = 0.66$; $R^2_{\text{Municipality}} = 0.62$; $R^2_{\ln \text{ (distance to the local shopping centre)}} = 0.39$; $R^2_{\text{Brick house}} = 0.37$; $R^2_{\text{Distance to the nearest forested area}} = 0.25$; $R^2_{\text{View to forest}} = 0.22$ and $R^2_{\ln \text{ (floor area of the dwelling)}} = 0.21$.

Table II Hedonic Price Equation. Semilogarithmic relationship between the dwelling price and distance to the nearest forested area

Dependent variable

ln (unencumbered real selling price for a dwelling in a terraced house)

Explanatory variables	**Estimated coefficient**	**Standard error**	***t*-ratio**
ln (floor area of the dwelling, m^2)	0.779	0.0201	38.71
ln (distance to the centre of Salo, km)	-0.111	0.0228	-4.87
ln (distance to the local shopping centre, km)	-0.033	0.0113	-2.96
Distance to the nearest forested area (forest park), km	-0.057	0.0171	-3.37
Age of the building, years	-0.015	0.0012	-12.32
Municipality 0 = Salo 1 = Halikko	0.046	0.0206	2.24
Brick house 0 = No 1 = Yes	0.068	0.0156	4.33
View to forest 0 = No 1 = Yes	0.048	0.0143	3.37
Constant	9.082	0.0883	102.91

adj $R^2 = 0.87$, n = 590, df = 581, $F_{9,581} = 544{,}720.69$, Durbin-Watson = 1.91

dwellings that have no view overlooking a forest the average distance to the nearest forested area is 365 metres. This suggests that these variables measure different amenities and the use of both variables in the price equation is justified.

To detect spatial autocorrelation, the data was ordered in housing districts. The errors in the regression model (3) are not serially correlated.[2] But, according to the heteroscedasticity tests[3], the error variance of model (3)

[2] The Runs test, also known as the Geary test.
H_0: Observed sequence of 590 residuals is random, i.e. no autocorrelation
H_1: Observed sequence of 590 residuals is not random, i.e. serial correlation
The number of runs is 248, and the number of positive (negative) residuals is 323 (267). Since the number of runs falls inside the 95 per cent confidence interval (269.77, 316.91), we can conclude that there is no autocorrelation.

is not homogeneous. Therefore, a new equation where a heteroscedasticity-consistent covariance matrix was used in order to correct the estimates for an unknown form of heteroscedasticity was estimated [64]. The estimation results are given in Table II.

The estimated regression is clearly statistically significant. The adjusted R^2 is high. The independent variables explain about 87 per cent of the variation in the log of real selling price. According to the estimation results, the partial elasticity of dwelling price with respect to the floor area of the dwelling is about 0.78. Hence, holding the other characteristics of housing constant, a one per cent increase in the floor area of a dwelling leads to the average of 0.78 per cent increase in the selling price of the dwelling.

When the distance from the house to the centre of Salo increases by one per cent, the selling price decreases on the average by 0.11 per cent. Similarly, when the distance from the residence to the local shopping centre increases by one per cent, the selling price decreases on the average by 0.03 per cent.

The relation between dwelling price and age of the building is semilogarithmic. A one year increase in the age of the building leads to a 1.5 per cent decrease in the selling price. Controlling the other characteristics of housing, the dwelling units in Halikko are, on average, 4.7 per cent more expensive than in Salo. Houses made by brick are 7.0 percent more expensive than houses made by other construction materials (e.g. wood or concrete).

The model includes two variables measuring urban forest amenities. The first one is distance to forest park. According to the estimation results, an increase of one kilometre in the distance to the nearest forested area leads to an average decrease of 5.9 per cent in the market price of the dwelling. The relation between dwelling price and the distance to the nearest forested area is depicted in Figure 1.

The second variable measuring an urban forest amenity is view onto forest. Dwellings with a view onto forest are on average 4.9 per cent more expensive than dwellings with otherwise similar characteristics.[4] According to the estimation results 95% confidence interval

[3] Glejser test, where the absolute value of OLS regression residual is explained by all explanatory variables in the model (3).
H_0: The error variance is homoscedastic vs. H_1: Heteroscedasticity in the error variance
Since the value of the test statistics, 61.21, exceeds the critical value $\chi^2_{0.05}(8) = 15.51$, one can reject the null hypothesis.
Breusch-Bagan-Godfrey test, where the squared OLS regression residuals are explained by all explanatory variables of the model (3).
H_0: The error variance is homoscedastic vs. H_1: Heteroscedasticity in the error variance
Since the value of the test statistic, 49.38, exceeds the critical value $\chi^2_{0.05}(8) = 15.51$, one can reject the null hypothesis, and conclude that there is heteroscedasticity in the error variance.

[4] The percentage change of an urban forest amenity is calculated by taking the antilog (to base e) of the estimated coefficient, from which one is substracted. In the case of the first variable, the antilog of the estimated coefficient, 0.057469, is 1.059152. Thus the relative change is (1.059152 - 1 = 0.059152), or 5.9 per cent. In the case of the second variable, the antilog of the estimated dummy coefficient, 0.048274, is 0.049458. Therefore the relative change is 4.9 per cent.

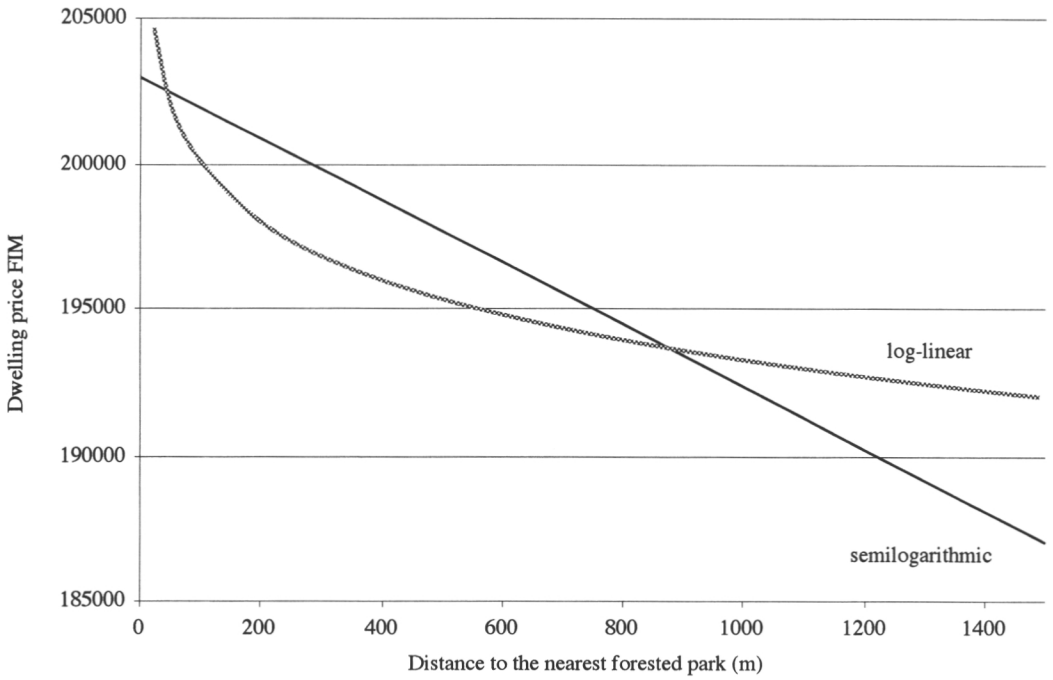

Figure 1. Effect of distance to the nearest forested area on dwelling price. Both semilogarithmic and log-linear relationship between the dwelling price and the independent variable. The model was corrected by adding a correction factor equal to $e^{1+\frac{\delta^2}{2}}$ to the equation [29].

for the variable measuring distance to the nearest forested area is (-0.091 — -0.024) and for the variable view onto forest (0.020 — 0.076).

As discussed earlier in theoretic terms, the assumption of marginal changes applies in the majority of cases concerning urban forests. Forested parks have a restricted spatial impacts on dwelling prices because the forested areas are small and the main benefits are received by the nearby residents. Moreover, according to the asymptotic likelihood ratio test statistics, logarithmic transformation of the park distance was also acceptable. Thus, both forms of relationship between dwelling price and park distance, the semilogarithmic and the log-linear, are presented in Figure 1.

Also a model where the distance to forested park was classified using dummy variables was estimated. The dummy variables describing proximity of a forested park were constructed so that the comparison level was the distance of between 1.0 and 1.5 km. According to the estimation results reported in Table III, distances up to 600 metres have a significant positive effect on the price of dwellings. If the distance is more than 600

Table III Hedonic Price Equation. The use of dummy variables measuring distance to the nearest forested area

Dependent variable

ln (unencumbered real selling price for a dwelling in a terraced house)

Explanatory variables	**Estimated coefficient**	**Standard error**	***t*-ratio**
ln (floor area of the dwelling, m^2)	0.781	0.0202	38.58
ln (distance to the centre of Salo, km)	-0.106	0.0222	-4.76
ln (distance to the local shopping centre, km)	-0.035	0.0118	-2.96
Age of the building, years	-0.015	0.0012	-12.43
Municipality			
0 = Salo	...	...	...
1 = Halikko	0.043	0.0207	2.09
Brick house			
0 = No	...	...	...
1 = Yes	0.069	0.0154	4.46
View to forest			
0 = No	...	...	...
1 = Yes	0.042	0.0182	2.29
Distance to the nearest forested area (forest park)			
1 km or more (base category)	...	...	...
0.005 - 0.099 km	0.073	0.0199	3.67
0.100 - 0.299 km	0.057	0.0225	2.54
0.300 - 0.599 km	0.046	0.0233	1.99
0.600 - 0.999 km	0.041	0.0228	1.80
Constant	9.001	0.0878	102.56

adj $R^2 = 0.87$, n = 590, df = 581, $F_{9,581} = 406{,}823.65$, Durbin-Watson = 1.90

metres the effect on price is not statistically significant at 5 per cent risk level. As expected, the effect of distance on price decreased when distance increases (Fig. 2).

Until now, we have assumed that the hedonic equation is stable with respect to time during the estimation period 1984-86. To test the temporal stability of the estimated parameters, the years 1985 and 1986 were distinguished from the year 1984 using two dummy variables, D85 and D86. The estimation results suggest that the aggregation of data from the different time periods was generally justified (Appendix 2). Apparently because of sampling fluctuations, the partial elasticity of real selling price in 1984 with respect to distance to the nearest forested area does not differ statistically significantly from

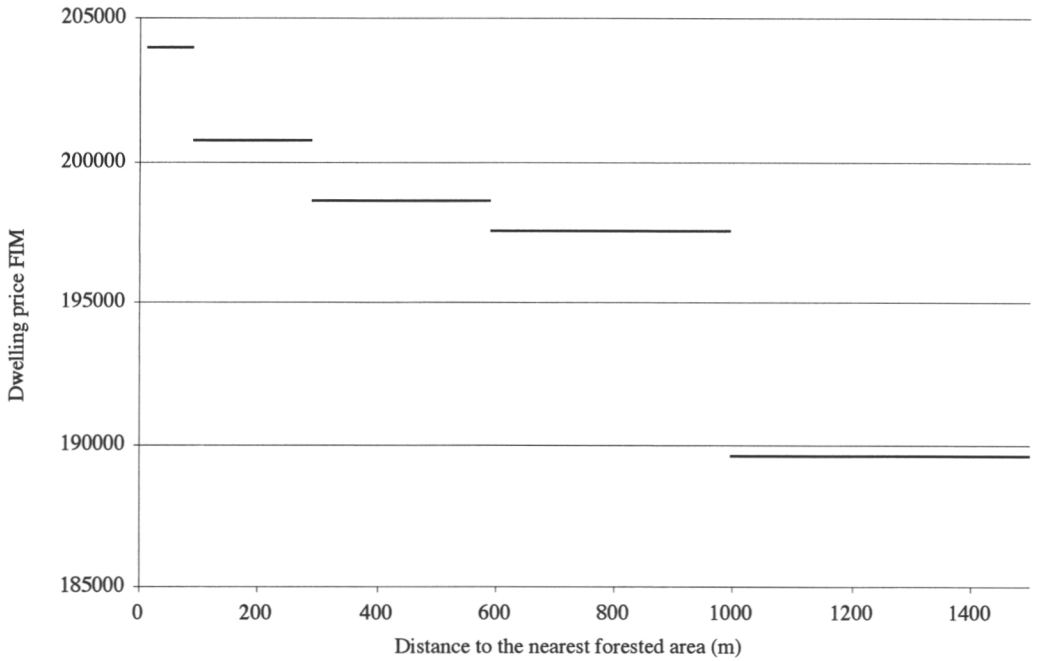

Figure 2. Effect of distance to the nearest forested area (as the qualitative variable) on dwelling price.

zero. In 1985 and 1986 the relationship between the selling price of dwellings and distance to the nearest forested area is clearly negative. Furthermore, the price ratios between Salo and Halikko and between the brick houses and the other houses have not been stable during the period 1984-86.

5. DISCUSSION

The purpose of this study was to measure the demand for urban forest benefits in monetary terms. The main aim was to estimate the value of amenity benefits attached to housing. Moreover, the aim was to search for suitable variables for describing the amenity benefits of forests in hedonic models. The empirical study was based on data from the sale of terraced houses in the district of Salo in southwest Finland.

The results show that on the housing market of Salo residents have to pay 4.9 per cent more in order to obtain a dwelling with a forest view. In addition, proximity to forested parks was found to have a significant positive effect on house prices. According to the semilog model, an increase in distance of one kilometre reduced the average price of a dwelling by 5.9 per cent. However, according to the price model, where the distance to a forested park was logarithmic or established as a dummy variable, the effect was strongest up to a distance of 300 metres, after which price changes were smaller.

The results suggest that distance to forested parks has a price effect as long as the areas are within walking distance from home. Urban recreational studies also report that the most intensive use of such areas occurs near the home environment [cf. 17, 22, 52]. Furthermore, the impact of forests on the price of building sites has been taken into account in the pricing principles applied to sites in the town of Salo itself. Sites that are adjacent to parks are at most 30 per cent more expensive than the average [55].

In contrast to the findings of a previous study conducted in Joensuu [59], larger recreational areas did not have a significant impact in this study. In Joensuu larger forested recreational areas are regarded as attractive and intensively used [60]. The result is explained by the differences in the supply of recreational areas in the two towns under study. Proximity to a recreational area may not have been as relevant a variable in Salo as in Joensuu, since by the mid-1980s the recreational opportunities in Salo were too scarce to be captured in the models —there were only two rather small recreational areas in the town. In Joensuu, in contrast, there were several larger wooded recreational areas with facilities within the town limits.

To some extent the significant variables in the model were different from those used in the study conducted in Joensuu [59]. This was partly due to the features of the local housing markets and partly due to differences in the geographical locations. For example, in contrast to the findings in the Joensuu study, roof-type did not seem to have an effect on property prices in the district of Salo. One reason is that the winter season in Salo is shorter and the typical problems of flat roofs caused by excessive snow are much smaller in southern Finland: Joensuu receives approximately 70 cm of snowcover every year while in Salo the figure is only 20 cm [35]. Nevertheless, it has to be noted that cultural differences and architectural valuation attached to housing may differ between regions. It also has to be noted that explanatory variables also reflect features of housing that are different from what they explicitly purport to measure, e.g. the distance to the town centre in the case of Salo also encompasses benefits accruing from the proximity of water, the age of buildings functions as a proxy for the historical value and the condition of dwellings, and so on.

Furthermore, most houses in the data (97 per cent) were relatively new, i.e. less than 40 years old. In consequence, increasing age was found to continuously reduce the selling price of a dwelling since little historical or architectural value could be attached to such buildings. In many cases, in particular in central Europe, values of this kind are essential, and the form of dependency between age and price is non-monotonic.

In many cities the urban structure is complex. There may, for example, be several commercial centres and large employers in different parts of the town, and so construction of price models becomes complicated. This study was conducted in a single-centred medium-sized town, and it was simplified by the fact that standard dwelling types were

used and that there was no significant traffic noise or pollution. The aim was to standardise the features of dwellings as much as possible so as to reveal the impact of the environment on prices. The data included the majority of the relevant variables influencing the price of dwellings in terraced housing in the town.

Previous studies of the economic value of urban forests also report on significant positive effects on house prices, but they have focused on individual trees and thus make comparisons difficult [cf. 1, 39, 40]. The basic feature of the hedonic models is that they are local, i.e. based on local housing markets. In spite of local differences between the towns, the results of this study provide a good gauge of valuations of urban forests in similar-sized towns. In Finland, as in the other Nordic countries, a wooded environment is in general appreciated, a fact which is witnessed to by the large number of holiday homes as well as by the present trend to live in scattered settlements even within in the area of Helsinki. In central Europe, however, landscape preferences and demands for urban greens differ as a result of cultural differences and the local history of land use.

The present study has been conducted on the basis of data assembled in the mid-1980s precisely because of the price fluctuations since 1987 in the Finnish housing markets. However, it would also be relevant to consider whether valuations have changed since then. Recent debates and increased urban forest conflicts suggest that their importance has increased rather than decreased during the past decade [cf. 15, 24]. The City of Helsinki has introduced a participatory planning approach to better handle the conflicts arising from urban forest management. In the USA, in the same period, urban/forest interface conflicts have been listed among the top emerging issues in forestry [21]. Although many local features and changes in the housing market may have shifted the hedonic equilibrium function, the above-mentioned change in attitudes also suggests that at urban forests are currently appreciated and are paid for in housing. The results of this study have been reported as relative. Although the total amount of green spaces in Salo has increased over the past decade, it is suggested that the relative importance of urban forests remains at least the same today as in the mid-1980s.

6. USE OF THE RESULTS

The main use of the method developed and the price models is in the economic evaluation of urban plans, where the costs of, for instance, allocating housing are normally considered. In normal practice, this evaluation includes the establishment and operational costs of new housing areas and covers both private and public costs. The location alternatives are often either to allocate new housing to existing green areas near town centres or to establish new area on urban fringes. In the latter case the concomitant increase in (private) transportation costs will be included in the calculations. In addition, the former case causes negative externality for people living

near construction areas in the form of loss of green space benefits, which in their turn should, like transportation costs, also be included in the assessment procedure. Although the urban land converted to other uses is public, the losses are private.

It must also be added that the quality of many housing areas built in particular in the 1970s is poor [cf. 15, 18, 33]. Space was often reserved for green areas but these areas have little vegetation or maintenance. Understanding that the establishment of new green areas raises the property prices helps in justifying greening projects. It has to be noted that improvements takes time and woody plants grow only very slowly in northern Europe. Hence, capitalization of green space investment in property prices has to be gradual and theoretically reaches its highest level only when the trees themselves are mature and healthy. In addition, the models may also serve as a tool for argument in court whenever monetary compensation is claimed for the loss of (for instance) a forest view as a result of construction, e.g. in cases where a housebuyer has bought a view onto forest which subsequently is converted to some other use.

The use of the estimated price models can be illustrated by calculating monetary value of a forest park using the semilogarithmic model (Table II, Fig 1.). According to the results, Salo residents are willing to pay 4.9 per cent more in order to obtain a dwelling with a forest view. It is assumed that size of the park is one hectare and it is circular. The number of homes next to the park is 35 given that average size of a lot is 400 m^2 (10m x 40 m)[5]. The value of the view is calculated the following way: The total value of apartments is calculated by multiplying the average size of an apartment in terraced house, 90 m^2, with the number of homes (35) and with the average price per square metre. The average price of an apartment in a terraced house in Salo is 4225 mk/m^2 (1996 /Statistical centre). The total value of apartments with a view to the park is 13.31 mil. FIM. The value of the view is 4.9 per cent of this figure, which is 0.65 mil. FIM (0,110 EUR).

Moreover, according the semilogarithmic model an increase in distance of one kilometre reduced the average price of a dwelling by 5.9 per cent. It is assumed that the price effect is zero at one kilometre distance. Furthermore, the price effect is calculated only up to 600 metres, because it is a relevant assumption in a case of a small park. It is also assumed that the park is the only one within 600 metres from homes. The size of the housing area influenced by the park is 1.344 km^2. The total amount of apartments is calculated using rather low construction efficiency 0.1, which the average used in small-house residential areas in Salo.

The total surface of constructions in the area is calculated by multiplying the size of the housing area (1.344 km^2) with construction efficiency (0.1). The received figure (134 400 m^2) is multiplied with relative amount of

[5] The length of the park edge (circumference) is 354.5 m ($2\pi r$, r = 56.42 m).

living area in a construction (0.8) to calculate the total floor surface of apartments, 107 520 m^2. Now, the total value of apartments is 454.27 mil. FIM, which is calculated by multiplying the total surface of the apartments 107 520 m^2 with their average price per square metre, 4225 FIM/m^2.

The aggregate price effect of the park across the housing area can theoretically be calculated using the general formula for the volume of the solid of revolution:

$$V = \int_a^b \pi[f(x)]^2 dx \qquad (4)$$

However, although the form of dependency between dwelling price and the distance to a park is not linear, Figure 1 illustrates that their relationship is close to linear between 0–1000 meters. Therefore, the aggregate value of the park reflected to dwelling prices can be calculated geometrically using Guildin's law (1577-1643) i.e. the volume of the solid of revolution equals the area of the object times the distance travelled by its centre of gravity. Calculated this way, the value of the park is 22.17 mil. FIM, which is calculated to be 4.88 % from the total value of apartments (Fig. 3.).

When the value of the view is added to this figure, the total value of the park is 22.82 mil. FIM (3.84 mil. EUR). If conversion of the park into other use is considered this value should be compared to increased costs when providing the building sites somewhere else.

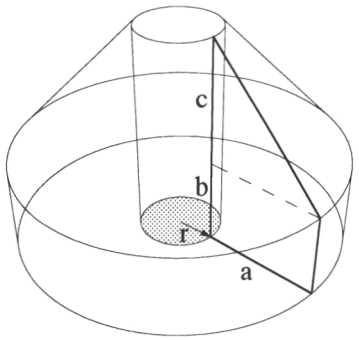

Figure 3. The price effect across housing area can be calculated using the formula for the volume of solid of revolution $2\pi(r + \frac{a}{3})\frac{ac}{2} + 2\pi(r + \frac{a}{2})ab$, where r = 0.056 km, a = 0.6 km, b = 2.36 %, c = 3.54 % and $b + c$ = 5.9 %

If the construction efficiencies are higher (0.3-0.4), i.e. there would be mostly blocks of flats instead of small houses in the area, the estimated value of the park would also be considerably higher, approximately 66–89 mil. FIM. Here it should be stressed that social and ecological carrying capacity of the green area is limited. After a certain limit the high use of the park becomes a nuisance for the nearby habitants, which may decrease

property values. The value of park capitalized in property prices can be calculated similarly using any other price model. In this example it was assumed that the park was the only one influencing the apartment price within 600 metres. This applies in situations where parks are few. In practice different type of green areas may influence apartment prices, which should be also taken into consideration in further calculations.

7. CONCLUSIONS

The results clearly show that urban forests are an environmental amenity and that people are paying for such benefits through property prices. This study also shows that intangible values of green areas can actually be measured and concretized, which provides more solid grounds for arguing for better environmental planning.

However, the construction of a hedonic price model that follows the hedonic theory is demanding. The main problems are those of gathering data and also of the multicollinearity of variables. Moreover, the variables need to correspond to the way in which house buyers perceive such benefits. The advantage of urban forests as a neighbourhood quality indicator is that they are a clearly visible element of the urban landscape. Nevertheless, selecting the proper variables describing the urban forest benefits is problematic, because they are difficult to classify and measure quantitatively. Compromises have to be made between the multiple benefits of urban forests, the number of variables, and their measurability. As the variables may often be themselves correlated, the researcher has to choose those variables that are thought to measure the different benefits. In some cases this is difficult, since many forested areas produce multiple benefits such as pollution control, screening and aesthetic attractions. In the present study, views and distances are suggested as descriptions of different benefits received from urban forests although it is difficult to avoid overlapping completely. At present, information on the values that residents attach to forests remains still insufficient.

It is also suggested that the monetary values calculated for green spaces represent the lower limit of the monetary value of the areas since the method captures only the values attached to housing. Excluded are, for example non-use values as well as recreational benefits experienced by visitors not living in the area. Furthermore, HPM measures only the valuations made by people who can afford to pay for the amenities.

Collecting data for this study was time-consuming, but in future data on house prices will be more readily available from price registers. Moreover, recent innovations in GIS and computer technology with numerical town maps are facilitating the automation of measurements for this kind of study. Many communities in Finland are making digital inventories of green space structure, which greatly eases the collation of precise information on urban greens with respect to housing.

ACKNOWLEDGEMENTS

This work has been supported by the Forestry Faculty at the University of Joensuu. We should like, in particular, to thank Professor Seppo Kellomäki for his interest in and support for the project in all its stages. Research Assistants Minna Kontkanen and Harri Silvennoinen collected the data with care and precision. In addition, Dr Jyrki Kangas, Dr Timo Pukkala, Dr Seppo Laakso, and Dr Tarmo Räty have provided valuable comments during the preparation of this article. Several other researchers in the Forestry Faculty and the Department of Economics at the University of Joensuu have also provided valuable assistance. Both the Department of Town Planning and the Park Office of the town of Salo have provided invaluable information when required. We like to express our warmest thanks to all who have contributed to the completion of this study.

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APPENDIX 1

Hedonic Price Equation. Linear Box-Cox transformations.

Transformed (λ = 0.09) dependent variable

Unencumbered real selling price for a dwelling in a terraced house

Transformed (λ= 0.09) explanatory variables	**Estimated coefficient**	**Standard error**	***t*-ratio**
Floor area of the dwelling, m^2	1.604	0.0381	42.10
Distance to the centre of Salo, km	-0.333	0.0563	-5.91
Distance to the local shopping centre, km	-0.100	0.0289	-3.47
Transformed (θ= 0.57) explanatory variable			
Distance to the nearest forested area (forest park), km	-0.116	0.0330	-3.51
Untransformed explanatory variables			
Age of the building, years	-0.044	0.0030	-14.68
Municipality			
0 = Salo	...	...	...
1 = Halikko	0.173	0.0630	2.75
Brick house			
0 = No	...	...	...
1 = Yes	0.209	0.0410	5.10
View to forest			
0 = No	...	...	...
1 = Yes	0.137	0.0439	3.12
Constant	14.321	0.2189	65.43

adj R^2 = 0.87, n = 590, $F_{9,590}$ = 205,906.27, log likelihood = -6830.43

APPENDIX 2

Temporal stability of estimated parametres.

Dependent variable

ln (unencumbered real selling price for a dwelling in a terraced house)

Explanatory variables	**Estimated coefficient**	**Standard error**	**t-ratio**
ln (floor area of the dwelling, m^2)	0.780	0.0366	21.29
D85 x ln (floor area of the dwelling, m^2)	0.024	0.0503	0.47
D86 x ln (floor area of the dwelling, m^2)	-0.043	0.0458	-0.93
ln (distance to the centre of Salo, km)	-0.107	0.0509	-2.10
D85 x ln (distance to the centre of Salo, km)	0.004	0.0615	0.06
D86 x ln (distance to the centre of Salo, km)	-0.031	0.0612	-0.50
ln (distance to the local shopping centre, km)	-0.036	0.0252	-1.43
D85 x ln (distance to the local shopping centre, km)	0.005	0.0285	0.18
D86 x ln (distance to the local shopping centre, km)	-0.003	0.0323	-0.10
Distance to the nearest forested area (forest park), km	-0.000	0.0262	-0.01
D85 x distance to the nearest forested area (forest park), km	-0.108	0.0382	-2.83
D86 x distance to the nearest forested area (forest park), km	-0.075	0.0393	-1.90
Age of the building, years	-0.014	0.0022	-6.70
D85 x age of the building, years	-0.002	0.0035	-0.54
D86 x age of the building, years	-0.003	0.0028	-0.91
Municipality			
Salo (base category)			
Halikko	0.122	0.0421	2.89
D85 x Halikko	-0.131	0.0526	-2.49
D86 x Halikko	-0.066	0.0513	-1.28
Construction material of the building			
Wood (base category)			
Brick	0.155	0.0259	5.97
D85 x brick	-0.161	0.0417	-3.87
D86 x brick	-0.136	0.0324	-4.21
View to forest			
No (base category)			
Yes	0.044	0.0285	1.56
D85 x yes	0.026	0.0367	0.71
D86 x yes	0.001	0.0352	0.02
Constant	8.973	0.1631	55.03
D85	0.079	0.2238	0.35
D86	0.375	0.2045	1.83

adj $R^2 = 0.88$, n = 590, df = 563 , $F_{27,563} = 201{,}759.94$, Durbin-Watson = 1.89

IV

URBAN FOREST BENEFITS AND ECONOMIC VALUATION IN FINLAND

Liisa Tyrväinen[1]

ABSTRACT

Condensing the town structure is seen as a general solution for achieving the goals of sustainable urban development, but thus far little consideration has been given to its impacts on green areas. This paper describes economic valuation studies of urban forests conducted in Joensuu and Salo, Finland. The purpose of this investigation was to study the valuation of urban forests in two different urban environments, where the supply of green areas was distinctively different. The aims were to study the attitudes towards and benefits related to the use of urban forests and, in particular, to measure the valuations in monetary terms using contingent valuation, i.e. measure the residents' willingness to pay for larger wooded recreation areas and for small forested parks.

According to the results urban forests were seen in both towns as clearly producing positive benefits rather than causing negative effects. A large part of the respondents could not state any negative feature of urban forests or the features were related to the management of the areas rather than their existence. The main values were related to nature and social functions as well as the mitigation of the urban climate. In contrast, timber production achieved a distinctively low priority in both study towns. The results stress the importance of defining urban forest policies in Finland because multi-purpose objectives in forest management are still rare in municipalities.

More than two-thirds of the respondents were willing to pay for the use of recreation areas. Good location and active management raised the average WTP. Moreover, approximately half of the respondents were willing to pay for preventing construction in urban forests. The results also show that the monetary value of amenity benefits in recreation areas is much higher than the present maintenance costs. Furthermore, the examples concerning the advantageousness of construction on green areas suggest that a limit could be found where the infill of housing areas is not worthwhile from the point of view of society, if the losses of green space benefits are taken into account.

Keywords: amenity values, contingent valuation, green space benefits, urban forestry, economic valuation

[1] Liisa Tyrväinen
University of Joensuu, Faculty of Forestry
c/o FFRI, P.O. Box 18, SF-01301 Vantaa
liisa.tyrvainen@metla.fi

1. INTRODUCTION

Narrowly defined economic aspects have dominated the discussion of urban development, but the criteria for environmental quality have been much less discussed (e.g. Vuolanto & Tuhkanen 1982, Vilkuna 1992). Still today urban forests are often treated as reserves for future building sites. Condensing the town structure, i.e. infill of present housing areas, has been seen as a general solution for achieving the goals of sustainable development in urban environment. The main targets of the policy are savings in transportation costs and in the use of natural resources and energy (e.g. Lahti & Rauhala 1994, Jalkanen et al. 1997). At the same time environmental quality is seen to be one of the key factors in creating a positive image of a town (Vilkuna 1992, Lahti et al. 1996). It is, however, unclear how compact city policies and the sustainable use of green areas can be successfully combined.

Infill of the residential areas will often cause changes in the amount and quality of green areas, which is often opposed by local residents. To a large extent the conflict falls into the category of environmental disputes called NIMBY (not in my backyard), which occur when the environmental costs of a development project are geographically concentrated and the benefits are realised elsewhere (Lee 1991, Johnson et al. 1994). In the case of infill the local environmental costs include, for example, reduced property values or the loss of recreation opportunities.

Theoretically, the value of the green area depends of the amount and type of use and the availability of substitute areas. At the municipal level the key question in urban development is where to build rather than whether to build. Usually there is more than one potential land-use option. The loss of amenity value of green areas should be included in the analysis when choosing the best land-use alternative from the point of view of society. Thus far little consideration has been given to the consequences of condensing on the quality of the environment, in particular, the impacts on the amount and quality of green areas.

Planning and design of urban greens cannot be founded solely on economics and natural sciences, but one has to include human values. Different research methods provide different information on residents' valuations. Much of the previous research has focused on recreation demand (Jaatinen 1974, Saastamoinen & Sievänen 1981, 1993, Gåsdal 1993, Jensen 1995, 1998). This type of research provides information which is useful in land use planning and in the management of the areas. Another common approach is landscape preference research, which provides information on the desired characteristics of the forests for management and design in the areas (e.g. Karhu & Kellomäki 1980, Savolainen & Kellomäki 1981, Hultman 1983, Tyrväinen & Ihalainen 1999). Although these methods are useful, they do not give a direct answer if the demand and supply are in balance in economic terms.

Although urban forests are reported to produce multiple benefits, it is unclear to what extent people experience negative effects, and how important they are. For example, the residents of a home located next to a public park receive benefits from their proximity to the park, but they may also experience noise and congestion. Furthermore, tall trees near properties may

cause shading or maintenance problems. At present, there is little exact information on the type of values people attach to urban forests.

The economic valuation provides monetary values for non-priced urban forest amenities. This enables the comparison of provision costs and received benefits both at the land use planning and management levels. In fact, both economic and traditional recreation research (visitor surveys, etc.) measure the demand for recreation services, but at different levels. The methods can, however, easily be combined in surveys.

The contingent valuation method (CVM) is the most widely used method in valuing environmental assets. Theoretically the method measures the total value of urban forest benefits. Information regarding people's valuations is collected by asking respondents to state their willingness to pay for some change in the provision of the public good or the minimum compensation demanded (Carson 1991, Mitchell & Carson 1995). The problems of survey design have been widely discussed in the literature (e.g. Carson 1991, Mitchell & Carson 1993, Arrow et al. 1993).

The WTP question mode has several variants and includes dichotomous choice (DC), iterative bidding, open-ended (OE) and payment card. In the open-ended mode, respondents are asked what is their maximum WTP, but no value is suggested to them. The close-ended procedure requires a yes or no answer from the respondent to pre-specified bid amounts. The DC question is argued to be more similar to an actual purchase or voting decision and therefore, more familiar and easier to answer than OE questions. However, the open-ended format has been shown to be a conservative choice and does not generate overbidding (Kriström 1993, Kealy & Turner 1993). The payment card method is a variant of the open-ended question mode, where an array of potential WTP amounts is presented to the respondent, who is asked to identify his/her maximum WTP for the benefit. It is thought to be less burdensome to respondents, because it provides visual assistance. The weakness of the method is that answers may be influenced by the range presented and it is vulnerable to strategic response, since the people can state a very large or a very small sum (Boyle & Bishop 1988, Mitchell & Carson 1993, Johansson et al. 1995). According to Johansson et al. (1995) no technique has thus far proved superior to another and a suitable question format is also dependent on the asset in question and the general arrangements of the survey.

There have only been a few CVM applications in Europe to measure the value of urban forests in monetary terms. In the US Dwyer et al. (1989) measured the WTP of urban dwellers for trees in urban recreation areas. Bishop (1992) in the UK and Elsasser (1994) in Germany have applied the method to recreational use of forests at the urban fringe. In Finland, the CV method has been used for estimating the benefits of regional recreation areas on the outskirts of Helsinki (Sievänen et al. 1991). Here, visitors to the Luukkaa recreation area (north of Helsinki) were asked to pay a hypothetical entrance fee.

The purpose of this investigation was to study the valuation of urban forests in two different urban environments, where the supply of green areas was distinctively different. The aim was to study the attitudes towards and the perceived benefits related

to the use and existence of urban forests. In particular, the aim was to measure the valuations in monetary terms, i.e. the residents' willingness to pay for wooded recreation areas and small forested parks contributing to the quality of the home environment.

2. MATERIAL AND METHODS

The study towns

The study towns, Joensuu and Salo, are both medium size towns in Finland, but located in rather different landscapes and, therefore, also have a different supply of urban forests. Joensuu is a town of 48 000 inhabitants in North Carelia, in eastern Finland. The general landscape in Joensuu is rather flat and the typical landscape features are water and abundant urban forests. Joensuu is bounded on the south and southwest by Lake Pyhäselkä, and the River Pielisjoki runs through the town centre. Green areas represent 34 percent of the town area, the majority of which are forested parks preserved from natural forest vegetation. The dominant tree species on 69 percent of the forest areas is Scots pine and most of the areas are middle-aged (60 to 70 years old) forest stands. The town has two main wooded recreation areas within town limits. In addition, most of the housing areas have some sort of wooded recreation area with facilities such as skiing and jogging trails.

Salo is a town of 23 000 inhabitants in southwestern Finland. It is an old commercial centre in a large river valley, and the main features in the landscape are open fields and forested eskers between the fields. The River Salo runs through the town centre and both housing and industry are concentrated along the river. The town of Salo has considerably less urban forests than Joensuu, and a large part of the housing is located on former agricultural land. The municipality owns approximately 1 100 hectares of forests, the majority of which (74%), is found outside the area included in the town plan. The green areas near the town centre are few and are situated along the river. Most of the forested areas are found at the urban fringe, located on hills starting abruptly from the valley. The housing has expanded in these hills areas only during recent decades (Salon... 1988).

In 1996 the green spaces covered 17.3 percent (356 hectares) of the planned town area. During the last decade greening projects have substantially increased the amount of green areas. In 1986 the amount of green areas was only 10 percent. Today the majority (81%) of the green areas is forested and 19 percent (67 hectares) is constructed parks or shelter belts (Salon... 1996). Recreation possibilities on municipal land within city limits are few. Therefore a part of the trails for skiing and jogging has been established in private forests and maintained by the town's park office.

The surveys

The CVM questionnaire was sent out in Spring 1995 in Joensuu and during Autumn 1996 in Salo to 500 randomly chosen residents between 15–75 years of age. The samples were drawn from the database of the Finnish Official Register of Persons and Addresses. In both towns two follow-up letters were sent to increase the responses. The questionnaires were pretested before the main surveys; some 80 respondents in two housing districts were

involved in the test in Joensuu and 40 respondents in Salo. A smaller amount of people in Salo were thought to be adequate because the survey had been previously tested in Joensuu. The purpose of the tests was to see whether the questionnaire was logical and, in particular, if the WTP questions were understood correctly. The comprehension of the definition of urban forest was pre-tested in Joensuu using different questions.

The final questionnaires consisted of four different parts (Fig. 1). When designing the survey care was taken to make it interesting for the non-users of urban forests as well. First, respondents were asked to consider the benefits of urban forests and their use. Subsequently, people were told to express their valuations in monetary terms. The first part of survey consisted of instructions for answering, the definition of urban forests with examples (Appendix 1) and the attached three maps illustrating urban forests were explained. The first map presented the size and locations of all urban forests (minimum size 0.5 hectares) in the town. The second showed the three main recreation areas for which people were asked to state their WTP. The third map presented potential construction areas, i.e. particular green spaces in the housing district.

The second part of the survey consisted of general questions concerning attitudes towards urban forests and the use of these forests. The first two questions dealt with the benefits and negative effects of urban forests. The next seven concerned the use of different areas and the type of recreation activity. The questions in these two parts of the survey were similar in both study towns.

The third part included two questions involving the willingness to pay (Fig. 1),

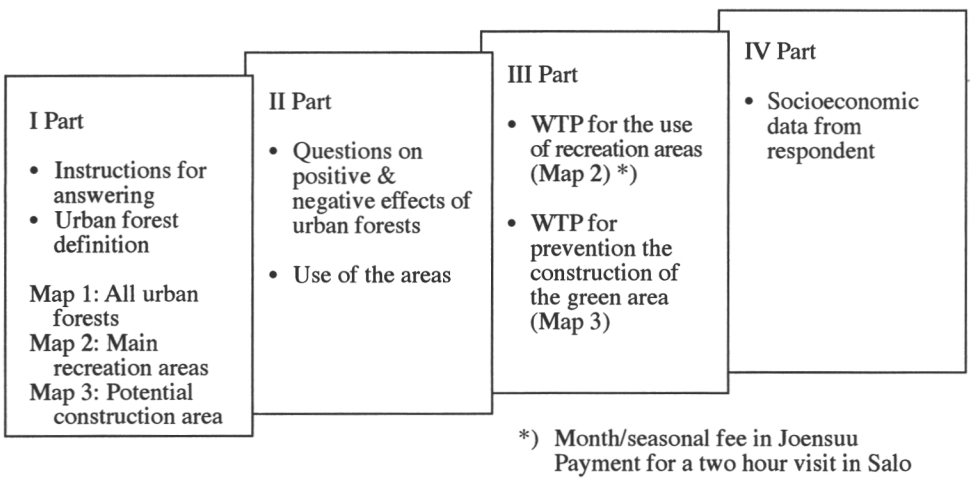

Figure 1. Structure of the survey.

which were designed to fit the different conditions in the study towns. First, the actual users were asked to state their WTP for the use of the three main wooded recreation areas in the town. In Joensuu two of the areas are located inside city limits and in Salo all the areas are found at the urban fringe outside administrative area of the town. The respondents were asked to imagine a situation where free access to and use of the areas was denied. It was explained that the maintenance costs of the areas would be collected from the users and not be covered by taxes because of recent cuts by the town council in park office budget.

In the study a payment card method was chosen for use, because it provides visual assistance to the respondent. The values on the card were presented by means of a line segment divided in intervals. The question mode also allowed the respondents to specify a larger amount if they so wished. The sample in Joensuu was split into two subsamples. Half of the visitors were asked to pay an entrance fee per month and half a seasonal fee for the use of recreation areas. People were asked to state their willingness to pay separately for the summer (May–September) and winter seasons (October–April). The question was: "What would you be willing to pay for a month (or season) to use this recreation area?". A payment card with a scale of 0 to 300 FIM/month (0 to 1100 FIM/season, FIM = 0.17 EUR) was used.

In Salo the actual users (visitors) were asked their WTP for a two-hour visit to the area. The reason for using a different question mode in Salo was that the people were expected to use the areas less intensively than residents of Joensuu and therefore a payment per visit was thought easier to comprehend. A payment card with a scale of 0 to 150 FIM was used. The summer was defined as seven months and winter season five months.

The second WTP question was connected to ongoing town planning projects, where new housing areas were planned for forested areas. All respondents were asked to state their WTP to prevent the development of forested parks in the town for housing purposes. The potential areas in both towns were chosen after discussions with planners in the town planning office in order to present a relevant situation for the residents. Each household was asked to state their WTP for one of the potential construction areas presented in the attached map. In Joensuu it was explained that the areas were owned by a private developer and the land would be bought by the town. In Salo it was explained that the town needed additional money to buy an alternative land area for housing purposes if this area was not used. The funds were to be collected through taxes. The question was: 'How much additional tax would your household be willing to pay annually during the next three years in order to help the town buy the land (or preserve the land) and maintain it as a green space". A payment card with a scale of 0 FIM to 1500 FIM was used.

The zero responses were classified into two categories: true WTP=0 and protest bids, depending on people's motives. Protest zero occurs when the respondent resists a feature in the scenario. For instance, the respondent objects to paying in a certain way or refuses to place monetary values on non-marketed goods (Freeman 1993).

Table 1. Description of recreation areas in Joensuu and Salo

Recreation area Joensuu (J) Salo (S)	Size (ha)	Location, average dist. (km)	Forests/landscape	Facilities
Repokallio (J)	86	Eastern part of town, 4.8 km *)	Mixed forest, varying topography	nature trail, skiing/jogging trail (1.3 and 3.9 km), lights
Linnunlahti (J)	45	town centre 3.5 km *)	pine forest, flat terrain	nature trail, skiing/jogging trail (1.7 and 3.7 km), lights
Lykynlampi (J)	200	outside town limits, western part, 10.2 km *)	pine forest, varying topography	lodge, skiing/jogging trails (2, 3, 6 and 11.4 km) lights, orienteering
Tupuri (S)	160	Eastern part of town, 4 km **)	Pine forest, flat terrain,	skiing/jogging trails (10, 2 and 3 km), lights 2 and 3 km
Maalu (S) (privately owned)	110	Eastern part of town, outside town limits, 6 km **)	mixed forest, varying topography, used for timber production	skiing/jogging trails (6 and 10 km), lights 6 km
Kankare (S) (privately owned)	30	Southeastern part of town, 4 km **)	mixed forest, varying topography, intensive timber production	skiing/jogging trail 4 km, lack of maintenance

*) measured from the respondent's place of residence
**) measured from the town centre

The fourth part of the questionnaire dealt with socio-economic variables describing the respondent.

Description of the case study areas

The forest recreation areas differed with respect to size and location in the towns (Table 1). In Joensuu, the largest area, Lykynlampi, was located outside town limits and the smallest, but most frequently used, the Linnunlahti area, is located in the town centre. All the recreation areas are owned by the town and managed by the town park office (Table 1).

In Salo, the recreation areas are located at a distance of 4 to 6 kilometres from the town centre. The Tupuri area, closest to the town centre, was the most used recreation area in the town. The area is owned by the town but the two other areas are privately owned. Maalu, located in the east, outside town limits, was a potential new skiing centre, and there were ongoing negotiations with landowners and the town. The smallest area, Kankare, located in the south-east, was in intensive timber production. Forest management, in particular the regeneration of forest stands, has had an impact on the landscape. In addition, the trails had not recently been maintained (Table 1).

In the second WTP question dealing with converting green areas into housing, the town of Joensuu was split equally into

Table 2. Description of potential construction areas in Salo and in Joensuu.

Construction area	Size (ha)	Location, average dist. (km)*)	Forests / Landscape
Noljakka (J)	50	Western part of town, 2 km	Mixed forest, mature forests, fertile forest sites
Rantakylä (J)	102	Northern part of town, 4 km	Pine-dominant forest, flat terrain, middle-aged stands (50-60 yrs)
Anjala (S)	87	Eastern part of town, 5 km	Pine-dominant forest, varying topography
Isohärjämäki (S)	59	Northeastern part of town, 4 km	mixed forest, herb-rich forests, varying topography
Utiskamäki (S)	29	Southern part of town, 4 km	Coniferous forest, varying topography, open bedrock

*) measured from the town centre

three regions. There were two potential construction areas presented in the town. Residents in the northern and western region were asked to pay for a change in their own or nearby housing district, Noljakka or Rantakylä, and the southern region was asked to pay for a change in western region, i.e. in Noljakka.

The Noljakka construction area (size 50 ha) was located in the middle of the housing area, two kilometres west of the town centre. The development proposal meant condensing the current town structure. The second area was larger (102 ha) and located in Rantakylä, at the urban fringe, on the northern town border. This area was one of the suggested development areas in the current general town plan proposal and expanded the present housing area. (Table 2.)

In Salo, the town was also divided into three subareas, each of which had a potential construction area (Table 2). Due to the condensed town structure and low amount of forest areas within city limits, all potential housing development areas were located at the urban fringe. The largest potential construction area, Anjala, was located in the eastern part of town, five kilometres from the centre. The second area, Isohärjämäki (59 ha), located in the northeast, is the only larger undeveloped forest area left in northern part of town. It was a suggested housing development area which had raised intense public discussion in the town in 1996. This discussion resulted in an alteration of the original town plan by increasing the amount of green spaces to remain in the areas. It was expected that this area would receive the highest willingness to pay values. The third and smallest construction area, Utiskamäki, was located in the south. It has to be noted that in each area small forested green spaces were to remain.

Response rate and statistical analysis

The response rate of the survey in Joensuu was high, 68.0 percent. However, some of the questionnaires were not complete and therefore, the amount of accepted questionnaires was 64.8 percent. The repre-

sentativeness of the data was tested and found to be statistically representative of the whole population, i.e. the residents of Joensuu, according to sex and age distribution, education, housing type and place of residence.

The response rate of the survey in Salo was moderate, 47.0 percent and the final amount of accepted questionnaires was 44.8 percent. The data was found to be statistically representative of the whole population, i.e. the residents of Salo, according to sex and age distribution and education. The people living in blocks of flats were not representative and the amount of people living in terraced houses exceeded their share of the whole population. Moreover, families with children were more interested in the survey than families without children, who were underrepresented in the data. More than 40 percent of the respondents stated living in a 100 metre radius of a forest area, which suggests that people living close to forests may have been more active in answering the survey. In Salo the inquiry was repeated in June 1996 in respect to the second WTP question after a mistake was found in the range of values in the payment card. The second round resulted in an 80 percent response rate compared to the first round.

The statistical analyses were made using SPSS-software. The validity of WTP answers was assessed using two techniques; first, regression analysis was used to explain WTP. The observations that exceeded the standardized residual value 3.0 were discarded as outliers. Second, the questionnaires were checked to see whether the respondents had, in general, answered the survey logically and if the stated WTP was too high in respect to the stated income. The respondents whose WTP answers were more than 5 percent of their income were discarded as outliers.

3. RESULTS

Attitudes towards urban forests

In general, the respondents had a positive attitude towards urban forests in both study towns. The three most valued categories of urban forest functions were the same. The benefits related to nature were valued most; over 40 percent of the respondents believed it to be the most important function in both towns. Moreover, social values, i.e. outdoor activities and exercise were considered to be important. In Joensuu 36 percent and in Salo 32 percent of the respondents stated these values to be the most important. Furthermore, the benefits attached to climate, such as wind protection and pollution mitigation and noise abatement, were also considered to be important (Fig. 2).

Larger differences between the towns were found in architectural values (screening, raising property values). In Salo, these values were more important (9%) than in Joensuu (1%), because in Salo many housing areas are constructed on former agricultural land, i.e. an open landscape, where vegetation provides the necessary greening of the built landscape. The economic value, i.e timber production, function of forests received a distinctively low priority in both study towns (Fig. 2).

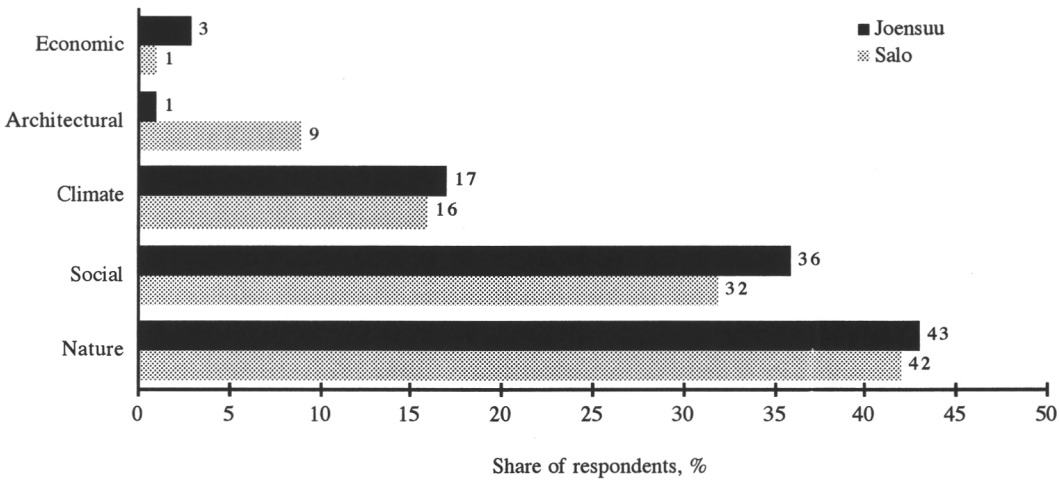

Figure 2. Main values of urban forests in Salo and Joensuu.

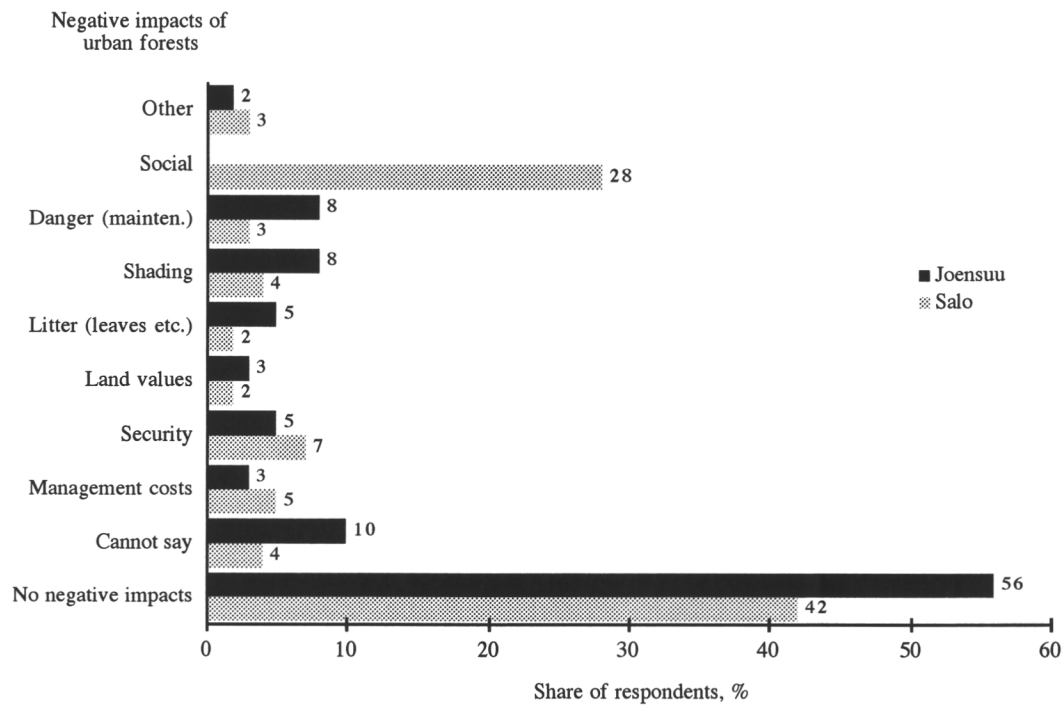

Figure 3. Main negative impacts of urban forests in Salo and Joensuu.

Table 3. Willingness to pay (WTP) a monthly fee for the use of forested recreation areas in Joensuu (users)

Recreation area (Nr of respondents)	Willing to pay %	WTP = 0 %	Protests or cannot say %	Mean WTPFIM /month *)
Repokallio summer (39)	82.1	5.1	12.8	46
Repokallio winter (32)	75.0	9.4	15.6	53
Linnunlahti summer (80)	75.0	6.2	18.8	51
Linnunlahti winter (63)	70.0	9.5	20.5	42
Lykynlampi summer (40)	67.5	10.0	22.5	47
Lykynlampi winter (39)	64.1	15.4	20.5	50

*) protests not included
Summer season May–Sept., winter season Oct.–April

The majority of residents in Joensuu (66%) and respondents in Salo (46%) felt that urban forests caused no negative effects in the town or could not state their opinion (Fig. 3). The main categories of the first mentioned negative effects in Salo were attraction of antisocial people (28%), security (7%) and maintenance costs (5%). In Joensuu, where the majority of forests are mature conifer forests often located near houses, the main categories of negative effects were different: shading (8%), danger of falling branches, etc. (8%), litter (5%) and security (5 %).

Urban forest use

The rate of urban forest use was high in both study towns; most of the respondents, in Joensuu 96.3 percent and in Salo 84.5 percent, reported having used urban forests during the past year. The residents were more active in Joensuu: 73 percent of respondents stated visiting an urban forest at least once a week. In Salo only half of the respondents used the areas weekly. Moreover, one-third of the residents in Joensuu and one-fifth in Salo used the areas 2–3 times per week (Appendix 2). In Joensuu, the respondents were also asked to estimate how often they use urban forests for through passage. Almost 60 percent of the people stated their use of the areas for this purpose.

Short visits to urban forests were typical in both towns: the duration of a visit was usually 1/2 to 1 hour. However, the visits in Joensuu were on the average longer: more than one-third of the respondents spent more than one hour during a visit. In contrast, the share of longer visits among Salo residents was only 21 percent (Appendix 2). In Salo forest use was most active in the four parts of the town where the largest forest recreation areas were located.

Willingness to pay for recreation areas

The majority of the visitors were willing to pay for the use of wooded recreation areas. In Joensuu the share of visitors willing to pay varied from 64 to 82 percent depending on the area. The mean WTP ranged from 42–53 FIM/month[1] depending on area and season (Table 3). The lowest willingness to pay was at the Lykyn-

[1]The mean WTP values were calculated for actual users including positive and true zero bids.

Table 4. Willingness to pay (WTP) for a two-hour visit to forested recreation areas in Salo (users)

Recreation area season (n)	Willing to pay %	WTP = 0 %	Protests or cannot say %	Mean WTP FIM/visit*)
Tupuri summer (89)	77.5	10.1	12.4	16.5
Tupuri winter (93)	79.6	11.8	8.6	15.5
Maalu summer (29)	65.5	13.8	20.7	16.7
Maalu winter (43)	76.7	11.6	11.7	16.2
Kankare summer (19)	63.2	21.0	15.8	9.1
Kankare winter (22)	72.8	13.6	13.6	11.3

*) protests not included
summer season April–Oct., winter season Nov–March.

lampi area in winter. The area is located outside of town, 10 km from the centre, and is actively used for skiing; it is, however, rather easy to find other areas for skiing in the Joensuu region.

In Salo the amount of people willing to pay for recreation was in the same range as in Joensuu, between 63–80 percent. The visitors' mean WTP ranged from 9 to 17 FIM for a two-hour visit (Table 4). The smallest share of visitors were willing to pay for a visit to the Kankare recreation area, which was the smallest and had the poorest trail system.

In Salo non-users were asked to state a reason for not using these recreation areas. Half of the respondents noted long distance as the main reason and more than one-third preferred other areas.

The zero responses were classified into two categories: true WTP=0 and protest bids, depending on people's motives. The amount of zero WTP varied from 10 to 21 percent in Salo and from 5 to 15 percent (monthly fee) in Joensuu. In Salo the main motives were the possibility of using substitute areas (18.5%) or no interest in using the area during a particular season (37%). In Joensuu the main reasons for zero WTP were either the availability of substitute areas (35%) or economic reasons (14%, low income, unemployment). The amount of protest bids varied between 9–16 percent in Salo and 13–23 percent in Joensuu. The amount of protest answers was higher during the summer season, when substitute areas are easier to find. The main reasons for protest bids were either that the question was not meaningful or that it was difficult to express valuations in monetary terms. The reasons for zero WTP in Joensuu are reported in detail in the study of Tyrväinen & Väänänen (1998).

The monthly fees in Joensuu can be compared with the Salo figures by calculating the recreation value per visitor/month: the average WTP is multiplied by the average number of visits/month/person in each area. In Salo the use value per visitor in different areas ranged from 31 to 76 FIM/month. The recreation value in Tupuri was twice as high as in other areas, because of the best management and location. The WTP in Joensuu for the monthly fee (42–53 FIM/month) falls within this range (Table 5).

Table 5. Recreation value of forested recreation areas

summer (winter)	Tupuri s (w)	Maalu s (w)	Kankare s (w)	Repokallio s (w)	Linnunlahti s (w)	Lykynlampi s (w)
Use value/ visitor/ month FIM *)	76 **) (68)	37 **) (53)	31 **) (34)	46 (53)	51 (42)	47 (50)
Proportion of users among residents %	39.8 (42.0)	13.2 (20.5)	8.5 (8.8)	21.6 (20.1)	46.0 (34.9)	20.4 (21.3)
Recreation value / season mil. FIM	4.17 (1.97)	0.68 (0.76)	0.37 (0.21)	2.51 (1.93)	5.94 (2.64)	2.43 (1.92)
Annual recreation value mil. FIM	6.14	1.44	0.58	4.44	8.58	4.35

*) protests excluded
**) mean WTP/visit x average number of visits/month

Similarly, the aggregate recreation value per season can be calculated using the data on use intensities and the mean WTP for the areas (Table 5). The highest value in Joensuu was in the Linnunlahti recreation area, which is the largest and most intensively used area in the town. The benefits are calculated to be 8.58 mil. FIM/year[2]. Here, it is assumed that people would use the areas every month. However, a more conservative estimate is achieved by using seasonal rather than monthly fees. With these figures the estimated value is considerably lower, 4.04 mil. FIM/year (Tyrväinen & Väänänen 1998). In Salo the value of the Tupuri area is estimated to be 6.14 mil. FIM/year, which is the most intensively used and best equipped area in the town. The lowest annual value was in Kankare, which was the smallest and poorly maintained, only 0.58 mil. FIM/year.

Willingness to pay to prevent construction of green areas

The second WTP question dealt with converting forested parks to another land use purpose. In Joensuu approximately half of the respondents were willing to pay something during the following three years to prevent the reduction of forested parks in the housing area. The amount of respondents willing to pay varied from 45 to 55 percent depending on the area. The average WTP varied from 126 to 206 FIM /year/household (Table 6). The lowest WTP was found among residents living in the southern part of the town, which was least affected by the proposed construction. The highest aggregate WTP was in Noljakka 1,79 mil. FIM/year, where the development scenario meant condensing the housing area.

In Salo from 48 to 66 percent of respondents were willing to pay to prevent the construction depending on the area.

[2] In computing the aggregate figures in Joensuu, the number of actual users was calculated by multiplying the proportion of users in the sample with the number of whole population i.e. residents between 15–75 years of age. Recreation value per season was calculated by multiplying the mean WTP/season with the number of actual users. The annual recreation value was received by summing up the benefits from summer and winter season.

The average WTP varied from 74 to 169 FIM/year/household. The highest WTP was found in the case of Isohärjänmäki, which was the largest remaining forest area, located in the northern part of the town. The household's aggregate annual WTP for this area was 0.65 mil. FIM. In Salo the item 'nonresponse' was only 7 percent and in Joensuu 6 percent, which implies that in general the scenario presented was received rather well.

The zero bids were classified into the same two categories as in the previous question. In Joensuu the amount of true zero WTP varied from 23 to 30 percent depending on the area The highest amount of zero bids was found in the southern part of town. The main reasons for true zero WTP were either that respondents were not affected by the suggested land use change (17%), had the possibility of using substitute areas (15%) or poor economic situation (13%). The amount of protest bids varied between 19–25 percent. These respondents refused to pay more taxes (25%) or objected to the economic valuation of urban forest amenities (11%).

In Salo the amount of true zero responses ranged between 20–41 percent. The main reasons for being unwilling to pay were enough green spaces after construction (30%), no use of the area (12%) and economic reasons (12%). Furthermore, the amount of protest answers ranged from 11 to 17 percent. More than half of these respondents refused to pay more taxes and the rest of respondents found it difficult to express their valuations in monetary terms.

4. DISCUSSION

Validity of the results

One of the main results of this study is that urban forests are seen more as producing multiple benefits than causing negative

Table 6. Household's WTP for preventing construction in forested parks in Salo (n=222) and in Joensuu (n=303).

Construction area (n)	Willing to pay, %	WTP = 0 %	Protests or cannot say %	Mean WTP FIM/year **)	Aggregate WTP/year mil. FIM
Anjala (S) (75)	48.0	41.3	10.6	152*)	0.58***)
Isohärjämäki (S) (67)	66.2	19.9	13.9	169*)	0.65***)
Utiskamäki (S) (80)	62.5	20.0	17.5	74*)	0.28***)
Joensuu western (121)	55.4	23.1	21.5	206	1.79***)
Joensuu eastern (98)	55.1	25.5	19.4	190	1.20***)
Joensuu southern (84)	45.2	29.8	25.0	126	0.82***)

*) results with corrected payment card

**) protests excluded, payments for three years

***) one-third of the households in Salo, amount of households in the town region in Joensuu

Total nr of households in Joensuu 21536 and in Salo 11520.

externalities. This confirms the validity of willingness to pay questions in this context. The main value was related to nature, which was seen to be more important than physical exercise (jogging and skiing). This is in line with many Nordic studies; most visitors come for peace and quiet, to see beautiful forest landscapes and wildlife (e.g. Bennet et al. 1981, Grahn 1991, Jensen 1995). Furthermore, a large part of the respondents could not state any negative feature of urban forests or the effects mentioned were related more to the management of the areas than to their existence.

In Joensuu dense, mature conifer forests obstruct light all year round and create shading problems. Forests are often located close to houses, which causes problems of litter and falling branches. The problems can be mitigated by management, for example, by planting or favouring deciduous and low growing trees near houses. Furthermore, frequent thinning would be necessary for areas located near housing in particular, on the south side of houses to increase light in gardens and apartments.

In Sweden, Falck (1994) has suggested creating step-shaped forest edges close to gardens. This means an approximately 30-metre long edge with low trees and bushes close to the gardens or house and successively higher trees towards the rising high forest. This is, however, possible only in the management of larger forest areas adjacent to housing and not in narrow forest belts, which often exist between buildings. In management a balance between different benefits, i.e. screening and shading as well as pollution control and aesthetics, should be found.

The security problems raised in Salo are also related to maintenance. The key factor for security is visibility, which requires active management of the understorey and gives the impression that the area is controlled. According to Burgess (1995) security problems are often raised in towns in the UK which typically have rather limited forests resources. Although people enjoy woodlands, their enjoyment is tempered by fears and gives rise to an ambiguity regarding their use. However, crime statistics in the UK show that physical attacks are rare in the woods, and that such concerns are often based on perceptions rather than reality. In this case, management and design were also suggested for use in improving the perceived safety in urban fringe woodlands (Burgess 1995).

The fact that the valuations were similar in both towns in spite of different cultural and landscape conditions suggests that values attached to urban forests are also very similar in other towns in Finland. Furthermore, differences in Finland appear to be small compared to the rest of Europe, where clear cultural differences are found to exist (e.g Konijnendijk 1999). According to Silvennoinen (1992) forests have a special meaning to Finns and are somewhat 'self evident' due to the cultural heritage. In Södeslätt, Sweden, where the adaption of foreign factory workers to their new environment was studied, Finns were the group that did not adapt well to this new environment lacking larger forest areas. They missed their walking and skiing tours in the forests, which had previously been part of their everyday life (Grahn 1991).

One of the key components in assessing the validity of the results is the accuracy of the use-intensities that play an es-

sential role when aggregate benefits are calculated. The average number of visits in Salo was 85/year/resident; in Joensuu it was higher, 110 visits/year/resident. The results are in line with previous studies in Finland; according to Sievänen (1993) the average use of urban outdoor recreation is 72 visits/year. In comparison, the use activity is higher in both study towns, but the scope is also different; here the use of small forest patches inside city limits is also included. Furthermore, the estimated WTP is credible compared to the study of Sievänen et al. (1991), who calculated the average WTP for a visit to a regional recreational area to be about 12 FIM. This is within the range of values for a visit in Salo, 9–17 FIM/visit. In comparison of the results the different travel costs to the areas and the time difference between the surveys have to be kept in mind.

Furthermore, one question involves whether the payment card biased the estimates and whether other payment formats, such as dichotomous choice, should be used in the future. Theoretically the question of maximum WTP provides a more accurate estimate compared to the discrete choice question. Boyle et al. (1996) compared open-ended and dichotomous choice formats with three different data sets and found differences. Since it is difficult to know what the 'true' values were, the conclusion was that either open-ended underestimated values or dichotomous choice bid structures may lead to systematic overestimates. Furthermore, according to Ready et al. (1996) the observed behaviour may be attributable in part to yea-saying by DC respondents. In this study, due to the payment card method the values presented are thought to be conservative and therefore 'safe' for use in the cost-benefits analysis.

However, one of the longstanding criticisms of the CVM is that the stated WTP may be a poor indicator of actual WTP. Criterion validity tests of CVM compare the hypothetical WTP to actual cash payments. Field and laboratory experiments show a difference between payments (e.g. Cummings et al. 1995). A recent study by Loomis et al. (1996), however, indicates that although the payments are not equal, the differences are smaller than in other experiments, where hypothetical WTP may have been two times larger than the actual WTP. They concluded the large differences in previous studies to be caused by poor survey design.

Policy implications

The high appreciation of the amenity benefits of urban forests and the low priority given to the timber production function stress the importance and need for multi-objective urban forest policies and management plans in Finnish municipalities. According to Löfström (1999), most municipalities have a forest plan, but in general multiple objectives are lacking in their management. Two-thirds of municipal forests are dedicated to timber production and the share of recreational forests is about 16 percent (Löfström 1990). Today, some largest cities apply participatory planning of urban forests, but only Helsinki has introduced specified policy for all green areas. In Joensuu, however, a new forest plan has been recently introduced where forests are classified according to the main use types (park forests, protection forests and timber production areas). For the first time, through public hearings, public consultation has also been part of

the planning process. In contrast, there is no management plan for urban forests in Salo.

At the municipal level it is necessary to assess whether the provision of recreation services is in balance with the demand of the areas and their management. The use of urban forests was higher in Joensuu than in Salo, which is thought mainly to be due to better supply and not to cultural differences. In Salo, the main reason for not using the areas was their remoteness. Previous research also concludes that people's need for recreation appears when the possibility exists. According to Grahn (1991) existing green spaces inspire residents to participate in different activities, which are beneficial both physically and psychologically. Several studies show that increasing distance to recreation areas decreases their use (Jaatinen 1974, Kardell & Pehrson 1978, Sievänen 1984, Grahn 1991). Furthermore, in both surveys the majority of the respondents were willing to pay for the use of recreation areas. Good location and active management raised the average WTP. Therefore, it can be concluded that with adequate provision and proper management of the areas more people in Salo would use them.

The value of urban forest benefits can be compared to the maintenance costs of the areas or the value of the land in alternative use. The results of this study show, for example, that the monetary benefits of urban forest are much higher than the present maintenance costs. In Joensuu the average maintenance costs of forested parks (1991–1995) is 10 152 FIM/ha/year, and the present management interval in urban forests is 5–10 years (Joensuun... 1996). The aggregate recreation value of the Repokallio area (86 ha) using the lower WTP estimate (mean WTP/season) is 1,79 mil. FIM, which is 10 to 20 times higher than the direct annual management costs of the area.

The estimated costs should also include the maintenance of recreation facilities, which is estimated to be approximately 42 000 FIM/year (Halimaa 1999). Furthermore, the costs should include opportunity cost of land i.e. reduction in timber values due to management adjustments such as prolonged rotation period and small-scale management units required by the recreational use. The commercial value of the annual yield in the Repokallio area is 93 000 FIM, given an average stumpage price in the region, 190 FIM/m^3, (Statistical... 1997) and the mean yield in the town forests, 5.7 m^3/ha/year, is used (Joensuun... 1998). Usually the loss of timber production value in recreation areas compared to commercial forests is between 10–30 % (Komulainen 1995). In Repokallio area the reduction is estimated to be the average, 20 %, which results an annual loss of 18 600 FIM in timber production value. Thus the aggregate recreation value would be still 7 to 12 times higher than the total costs of provision of the recreation services in the area.

In Salo the average maintenance costs for all the forested parks of the town is 1 000 FIM/ha (1994–1998 / Järvinen 1999). Using this figure the average forest management costs in the Tupuri recreation area (160 ha) is estimated to be 160 000 FIM. Furthermore, the annual costs of maintaining the recreation facilities in the area are approximately 40 000 FIM (Salon... 1997). Because there was no inventory data on the urban forests available, the estimation of the reduction in timber values is based in the information on the

mean yield (6.1 m^3/ha/year) in the commercial forests owned by the town. Thus the monetary value of the annual yield in Tupuri area is approximately 175 700 FIM given the mean price of timber 180 FIM/m^3 is used. The relative reduction in timber values is also estimated to be 20 %, market value of which is approximately 35 000 FIM/year. In this way the total costs of providing the recreation services are approximately 235 000 FIM/ year. Since the annual benefits are estimated to be 6.14 mil. FIM, the benefits would be in this case 26 times higher than the costs.

Similarly, in the Kankare recreation area (30 ha) the estimated costs are much lower, 25 000 FIM/year, because the municipality is not responsible for forest management due to private ownership. The annual benefits are estimated to be 580 000 FIM. Accordingly, in this case the benefits are 23 times higher than the costs. These results indicate that on social grounds urban forests are a cost effective concept.

People's willingness to pay to prevent construction can be compared with the price of unimproved land. In Salo the average price of land is approximately 13 FIM/m^2 (130 000 FIM/ha) (Hiltunen 1997). The total size of Isohärjänmäki is 67 ha and the value of the area is 8.71 mil. FIM. The residents' willingness to pay during the following three years is estimated to be 2.05 mil. FIM (1997), using 5 % interest rate. The sum would cover 24 percent of the costs of buying an equivalent area elsewhere. Here it is assumed that one third of the households in Salo would pay to prevent the construction. In practise the Isohärjänmäki area has importance to larger area than the other two potential construction areas; it is the only larger undeveloped forest area left in northern part of the town. Therefore, the estimated total WTP is only a minimum value and in practise the value of the area is probably larger. It must also be noted that in regard to the situation in Salo all the potential development areas were located at the urban fringe instead of infilling the present housing areas, which would affect more people.

In Joensuu, in the Noljakka area, the conversion of urban forest to some other use meant building in the existing green areas. Here, the estimated total WTP for preserving the potential construction area was 8.23 mil. FIM (1997, using 5 % interest rate) during the following three years. The value of the unimproved land for a similar size area is lower, 7.5 mil. FIM, if the average price of building land in Joensuu 150 000 FIM/ha is used. The difference, 0.73 mil. FIM, can, if necessary, be used to cover the increased costs of infrastructure when building at the urban fringe. If the willingness to pay for Noljakka in the southern region is excluded, the total aggregate WTP for preventing the construction is 5.64 FIM. This figure would cover 75 percent of the costs of buying an equivalent area elsewhere. In analysing the results it has to be emphasized that green areas are abundant in the town. However, these examples suggest that a certain limit could be found where condensing is not worthwhile from the point of view of society, if the losses of green space benefits are taken into account.

The amount and quality of urban forests is, in the end, a political question and a matter of whose interests are to prevail in decision-making. The main improvement to the present planning system would be

an awareness of the loss of amenities in condensing existing housing areas. The research results clearly imply the need for well-defined urban green space policies in town and cities. Given the residents' high appreciation of urban forest benefits, it is worth reintroducing a nature-saving construction culture and defining quality criteria for housing environments that are currently inadequate.

Acknowledgements

This work has been funded by the Forestry Faculty at the University of Joensuu. I should like, in particular, to thank Professor Seppo Kellomäki for his interest in the subject and for arranging the financial support for the project.

Furthermore, Drs Timo Pukkala, Heikki Pajuoja and Ville Ovaskainen have provided valuable comments during the research work. Many other researchers, in particular Dr. Anni Huhtala, from Finnish Forest Research Institute as well as Dr. Matti Vainio have given valuable comments concerning the studies. Research assistants Hannu Väänänen and Anne Pitkänen realised the surveys in the study towns and gave many ideas to develop the questionnaires. The Technical Department of Joensuu, and in particular Chief Gardener Kai Ahmio, Planner Irene Martiskainen and City Forester Matti Viirret have been helpful with providing all the needed information. In Salo, I wish to thank in particular, Town Gardener Matti Järvinen, Ms. Ulla Olvio and Mr. Taneli Anttola for providing the background information for the research work.

The special thanks belong to my colleagues in urban forestry, Mr. Cecil Konijnendijk and Dr. Andreas Ottitch who have given constructive comments to improve the article. I also express my gratitude to researcher Irja Löfström of numerous discussions on the research topic which have developed the work. The English language of the manuscript was corrected by Dr Roy Goldblatt.

Finally, I also want to thank my husband, architect Heikki Prokkola, for practical help in preparing the illustrations as well as for many professional discussions. My warmest thanks to all who have contributed to the completion of this study.

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APPENDIX 1.

WHAT IS AN URBAN FOREST

Urban forests are wooded areas located within town limits or close to town (2–6 km). The areas are comprised of natural forest vegetation and provide everyday recreation opportunities for residents. Urban forests can be divided into different categories: **Forested parks** are often rather small areas located inside housing districts and provide landscaping as well as recreation possibilities. **Recreation areas** are larger wooded areas with recreation facilities and are often located further away from the town centre. **Protection forests** are narrow forested belts e.g. between housing and main roads. According to this definition constructed parks are not urban forests.

Examples of urban forests:	Examples of areas which are not urban forests:
▪ Forested area with skiing and jogging trails. ▪ Forested area with cycling or walking route. ▪ Narrow belt of forest vegetation between houses. ▪ Forested area between housing and a road.	▪ Constructed park with lawn. ▪ Children's playground with trees.

APPENDIX 2.

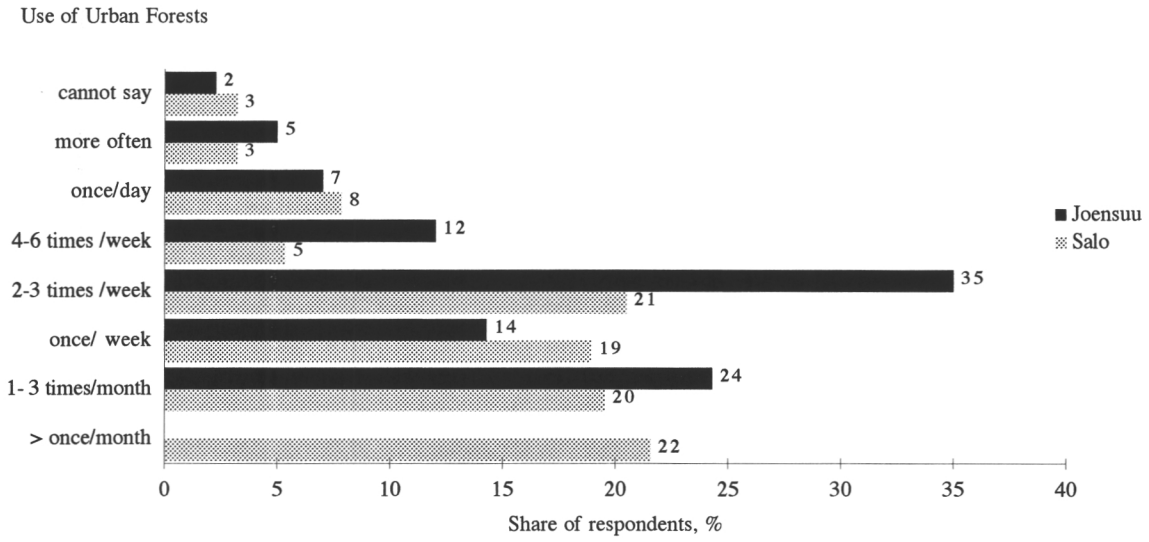

Figure 4. Use intensities of urban forests in Joensuu and Salo.

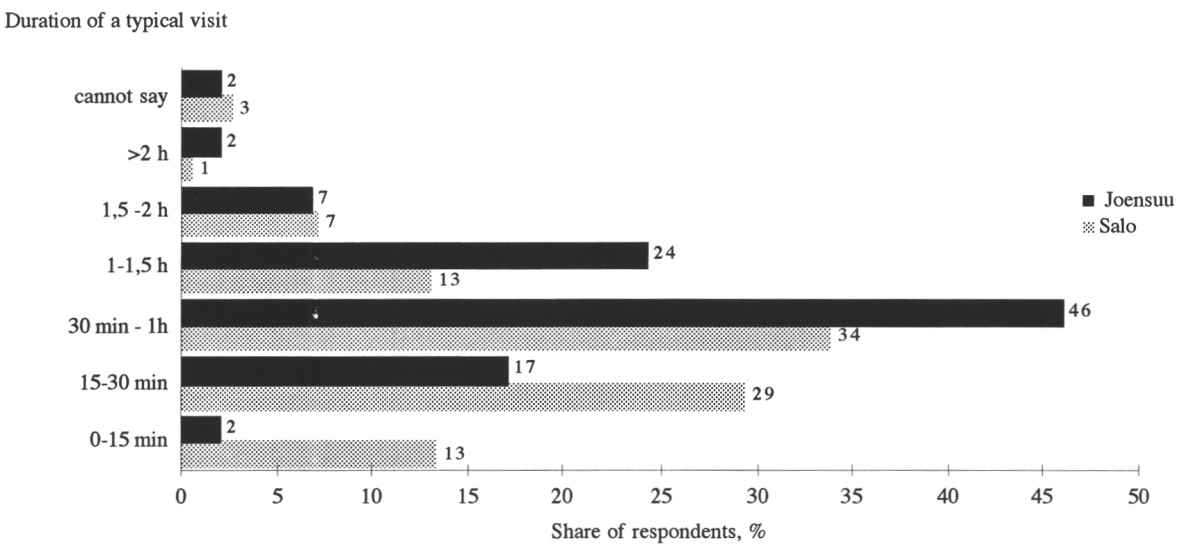

Figure 5. Duration of a typical urban forest visit in Joensuu and Salo.

ISBN 951-40-1688-2
ISSN 0358-4283
Tummavuoren Kirjapaino Oy, Vantaa, 1999