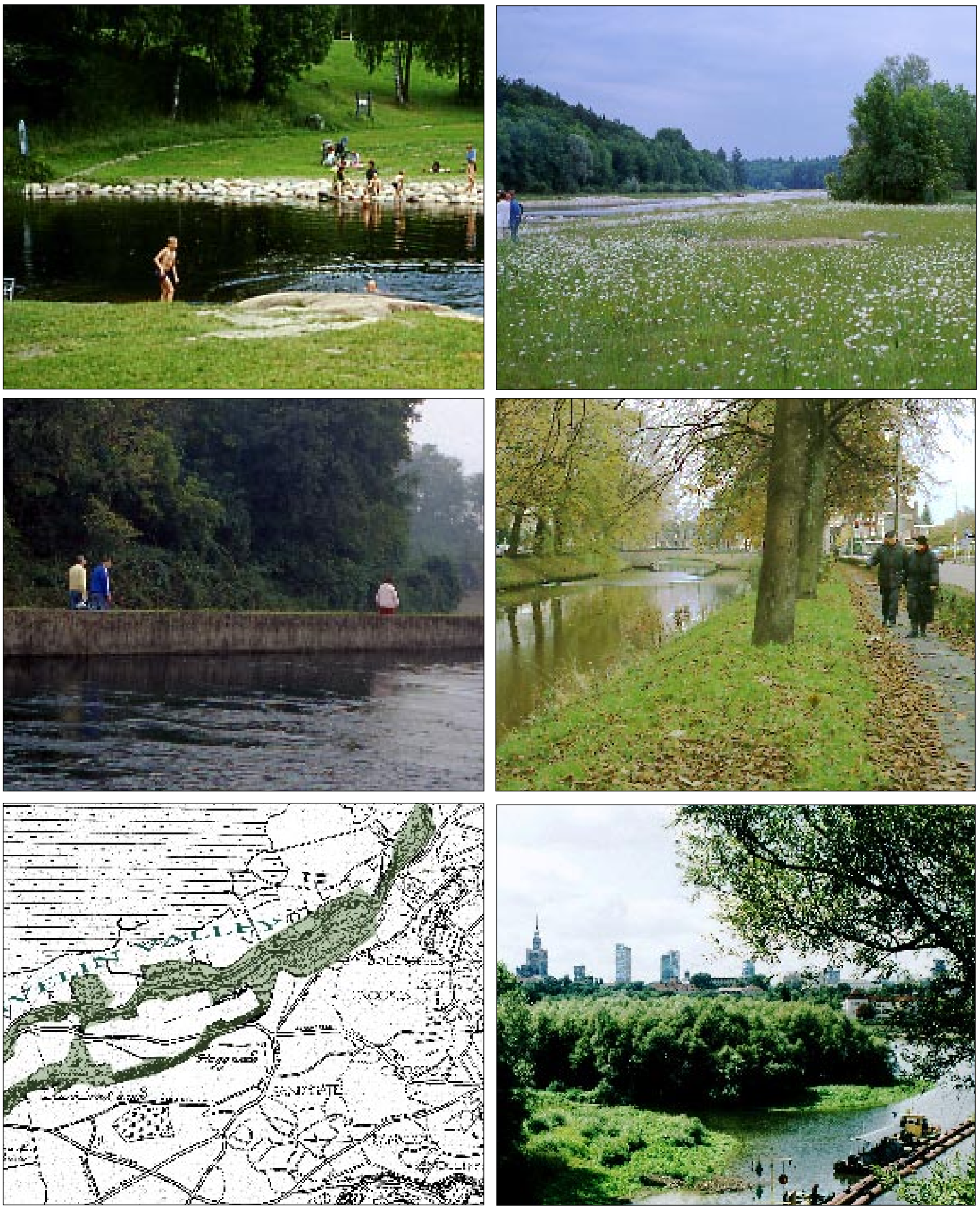

The cities green structures along rivers or canals : Akerselva in Oslo, Isar in Munich, Naviglio Grande in Milan city region, canal surrounding the city centre of Breda, project for Rivelin valley in Sheffield, Vistula in Warsaw

CHAPTER 3

An ecological approach to green structure planning

Members of Working group 1 A :
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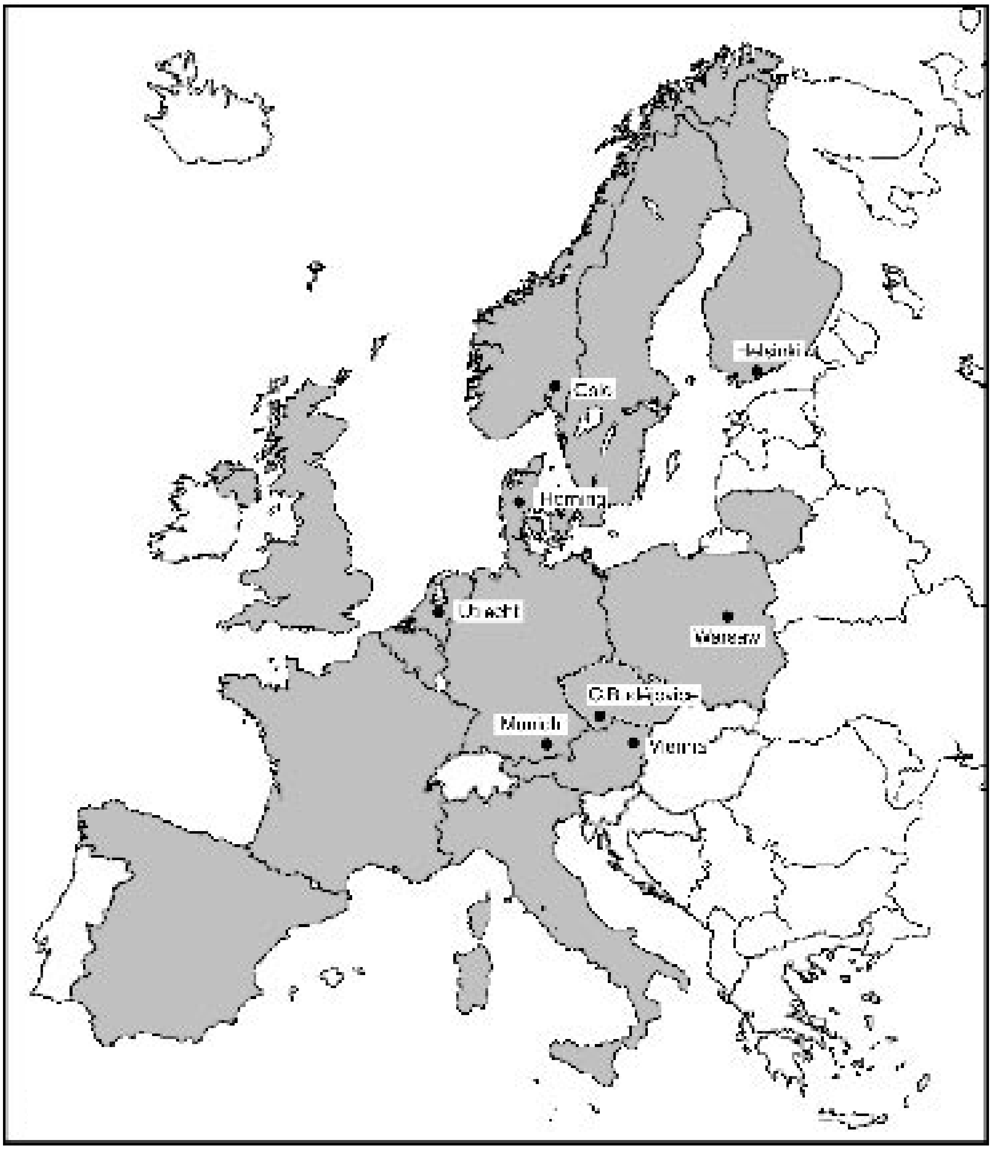

Figure 1.1. “Ecology” case studies of Cost Action C11

1 Introduction

Stephan Pauleit

There is a growing body of evidence on the ecological benefits of green structure in urban areas. Green spaces can serve as habitats for wildlife and enhance natural processes such as water infiltration and flood water retention (Hough 1995, Tjallingii 1995).

Whether green spaces can effectively fulfil these environmental functions depends on a variety of factors such as the overall provision of green spaces, the size, diversity and distribution of green spaces within the city, their history as well as the design and management of the individual green spaces (Gilbert 1989). Creation of green space networks and corridors have been proposed as a strategy to promote connectivity between green spaces for wildlife movement, the management of water in the city and to improve air quality (Barker 1997).

Adopting an ecological approach to green structure planning and management that enhances natural processes can thus contribute to make the urban environment an attractive and healthy place to live, where nature can be enjoyed for the benefit of everyone. It can also contribute to avoid or reduce environmental problems in cities that otherwise require costly engineering solutions such as river engineering or rainwater retention facilities. However, to which extent has such an approach been adopted and how ?

Within COST Action C11, a working group "Ecology and green structure planning" was formed to find out more about the use of ecology in green structure planning in European urban areas. Unlike the human value and planning approaches discussed in this book, the ecological approach focuses on the *urban ecosystem* as a basic set of conditions for both humans and other species. The participants of the ecology working group selected case studies with which they were familiar and where they had access to information from their work in the administration or the involvement in projects and research. Some of the case studies were also visited during the COST Action and this provided an opportunity to gain further insights on site visits and in discussions with city officials.

The selected cities have a wide geographical coverage, although a Mediterranean city is missing (Fig. 1.1). Therefore, environmental conditions for green structure are different but also the ecological functions of the greenstructure, e.g. ists climatic functions, are different. Population size ranges between 60,000 to 1.6 million population but the urban region is usually much larger. Fast growing cities with a strong economy such as Munich and cities with a weaker economy (Warsaw, C. Budejovice) were included, but not declining cities. Therefore, the case studies are not representative for the whole range of urban situations in Europe.

The case studies addressed four questions:

1. How have natural and cultural features influenced the development of greenstruc-

ture in the urban environment?
2. What does this greenstructure mean for biodiversity and environmental functions (i.e. water, climate)?

3. What is presently recorded about ecology in the case study area, by whom, and how?

4. How have ecological goals been set out to influence the planning, design and management processes? Is there any evidence that these goals have effectively influenced the planning processes within the study area?

The first part of this chapter compares the results from the case studies. First, an overview of the green structure in the case study areas is given. The next chapters are concerned with the relation of this green structure with biodiversity, water, climate, as well as the management of organic matter in the city. There is no separate chapter on the role of ecology in green structure planning as each of the thematic chapters already discusses, for instance, whether and how biodiversity goals are set and used in planning in the case study areas. Overall, the main outcomes of the working group are discussed in the general conclusions Part A of the book.
In the frame of the COST Action, the working group could not assess in-depth the situation of ecology in green structure planning in the selected cities and towns. The case studies also differed in the information that could be provided. Therefore, we rather concentrated on presenting those findings from the different case studies that seemed particularly worth of highlighting and acknowledge that there are still many gaps in our knowledge that would need to be addressed in a more systematic study. Still, we believe that the comparison of the case studies provides useful information on how ecology is handled in green structure planning and management, what are the specific problems, but particularly to identify examples of good practice that could also be of interest to other cities.

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2 Green structure patterns

Stephan Pauleit and Ewa Kaliszuk

The chapter aims to characterise the main features of the green structure of the case studies to highlight both common and individual features.

Green structure cover

Urban areas may be imagined as predominantly covered by buildings and paved areas. However, the amount of green spaces can be surprisingly high and surpass that of built-up areas. The importance of green space in the case study cities is presented by the percentage of green areas. For instance, in Vienna, according to land use statistics green spaces cover 49% of the city's surface area (farmland and woodlands on the urban fringe are included) whilst only 33% is classified as built-up. Similarly, two thirds of Oslo's surface area consists of woodlands and farmland. These figures still do not account for the green spaces that can be found within urban land uses such as housing areas. In Munich, a survey of the whole city area showed that all vegetated areas covered almost 60% of the surface area (including farmland). In particular low density housing areas were shown to be important. These green spaces generally do not appear in city green space statistics and are not shown on city maps but they are a part of the urban green structure and can have ecological functions (e.g. as a habitat for wildlife). An ecological approach to green structure planning should be concerned with all of these green spaces and assess how they contribute to biodiversity and other ecological functions in the city.

Green structure layers

Each city has its own, distinctive green structure. Figure 2.1 *(next page)* gives an overview of the major green structure elements in the case study areas. The specific green structure of a city is a result from the interaction of natural and human processes over time. As a result, a great variety of different green spaces can exist in a city and according to their origin three different green structure layers can be distinguished:

1. The pre-urban layer of the natural and cultural landscapes that were already there before the city. This layer includes, for instance, rivers, forests, arable land, wetlands, hay meadows and pastures. These green spaces of the pre-urban landscape can consist of a wide range of different vegetation types, that reflect the natural conditions such as geology, soils and historic farming practices.
   It is particularly this pre-urban layer which distinguishes the greenstructure from one city to the other. For instance, in the two Nordic cities – Oslo and Helsinki –woodlands, wetlands and the sea shore are prominent and they have influenced the pattern of urban development. In the central European cities (Utrecht, Munich, Vienna, C. Budejovice), on the other hand, open farmland is much more important around the cities.

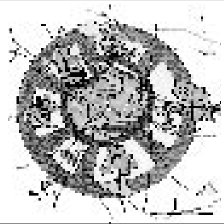
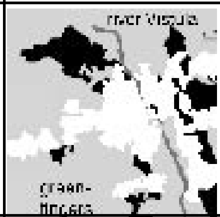
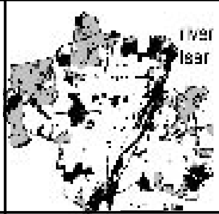
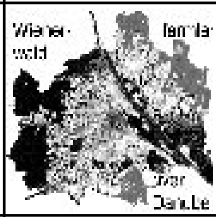
	OSLO	HELSINKI	HERNING	UTRECHT
green structure pattern				
main structure elements	• Sea border • Hills • green ring (woodlands) • Park islands within the city	• Sea border and islands • River Vaanta • Hills • Greenfingers of woodlands, streams and wetlands	• Hills • Green-blue ring (wetlands)	• Historic parks & fortifications • River and canals
challenges	• Stong urban growth • Green space fragmentation • Built over of streams	• Densification • Urban sprawl • Fragmentation of green space • Loss of biodiversity	• Urban development in green space network	• Lack of green space in inner city • Densification • Improving green space quality
	WARSAW	**MUNICH**	**C. BUDEJOVICE**	**VIENNA**
green structure pattern				
main structure elements	• River Vistula • Escarpment • Historic parks • Green corridors • Woodlands	• River floodplain • High banks • Historic parks • Park islands within the city	• Streams • Green wedges	• Green ring woodlands, farmland) • River Danube • Historic parks
challenges	• Densification • Built up of corridors • Low green space quality in residential areas	• Lack of green space in inner city • Densification • Urban sprawl • Fragmentation of natural green structure	• Development of green space network	• Lack of green space in inner city • Management of farmland

Figure 2.1: Green structure patterns of the case studies (white: urban areas; black woodlands; dark grey: water surfaces; light grey: farmland)

Natural features such as hills, and in particular streams, have often a special role in the case study areas in being connected green spaces. For instance, in Oslo, woodlands cover the steep slopes of the hills around the city and the shoreline is an important part of the green structure. In Helsinki, the sea with islands is also an important element of the green structure. Green fingers are reaching into the city. The green fingers were preserved in valleys, wetlands, and on rocky hills that could not be built-up. In other cities (Munich, Utrecht, Vienna, C. Budejovice, Warsaw) streams and floodplains are green space corridors. Where natural constraints were not so not strong, and where no special protection existed such as hunting forests, the pre-urban landscape was mostly built over, and remnants of the pre-urban landscape are fragmented. For instance, in Munich woodlands in the city area are split into 153 woodlands, 70% of which are smaller than 5 Hectares. Another example is Oslo where 60% of the small streams were canalised and/ or have disappeared underground.

2. Urban layer: This layer includes public parks, playing fields, cemeteries but also the green spaces within the different land uses such as gardens in residential areas, green space on institutional grounds, in commercial developments, as well as land where the former use was abandoned (derelict land). The distribution of these green spaces follows the urban development patterns. In many cities, the green space cover is very low in the densely built areas of the inner city and the 19th century extensions but much higher in low density housing areas.

3. Infrastructures such as major roads, railway lines and canals can include important green spaces. Canals are very important in Utrecht as linear green spaces. The railway lines may not be accessible but they kept land from being built over within the city. They can offer an opportunity for creating green space corridors when the railways and adjacent land are not needed anymore. Large green spaces can also be found along motorways, big roads and other linear infrastructures.

The case study areas greatly differ in the amount, composition and distribution of these different green spaces, and therefore it can be assumed, that the conditions are different for biodiversity and other ecological functions of the green structure. Moreover, this green structure is owned, controlled and managed by a variety of different public, institutional and private bodies. For instance, over 70% of the land in Helsinki is owned by the city, including the green spaces. In Munich, public green spaces owned by the city or the Bavarian State cover only some 10% of the city surface.

Figure 2.1 summarises some of the main features of the green structure of the case study cities. The table in this figure also highlights the challenges posed by problems and opportunities. The pressures on urban green structure and the related questions for urban planning belong to different categories:

- The low provision and fragmentation of green space in densely built up urban areas, green spaces are scarce, fragmented and vulnerable to further fragmentation. The opportunities to create new green spaces are limited. These areas are also often characterised by low environmental quality (e.g. air pollution, noise, increased surface water runoff and low biodiversity): How can new green spaces be introduced in these areas to improve the ecological situation?

- In the existing city, urban compaction may lead to a further loss of green spaces. This can mean the building over of public green spaces, informal green spaces, farmland, derelict land and green spaces along transport corridors. Green space is also lost due to intensification of existing urban land uses, for instance in low density housing areas. Compaction policies will further increase the pressure on remaining green spaces. Can planning, design and management of multi-functional green spaces compensate for this loss or does every square metre of green space less in the city mean a loss of its environmental performance? Where are the limits? How can urban compaction be planned in a way so that the ecological quality of the city is increasing rather than decreasing?
- Pre-urban elements of the green structure such as lakes, streams, wetlands are often particularly fragile habitats. Even where they are legally protected this may not be enough for their real preservation because the development of their vicinities has major influence on them. How can green structure planning create favourable conditions for the long-term survival of these habitats and their plant and animal species?
- Urbanisation changes the landscapes around the cities, in particular in the strongly growing urban areas such as Utrecht, Munich, Vienna, Oslo and Helsinki. The character of these landscapes may be negatively affected by urban land uses, dissection by transport infrastructures and a loss and fragmentation of the natural elements of the green structure. However, in landscapes already degraded by intensive farming and commercial forestry, an ecological approach to urban development may also improve green structure qualities. How can ecologically functional and multipurpose green structures for urban fringe landscapes be created that provide a green backbone for the regional city?

Conclusion

Few cities have a sound information base for green structure planning. There is no point in more data gathering for its own sake but it is difficult to protect, plan and manage what is not known. Moreover, good tools are required to make effective use of this information in urban planning and management. The case studies presented some examples how this can be achieved, including methods of ecological mapping and technical tools such as geographic information systems.

The case studies have shown how distinctive and special the green structure of each city is. Each green structure has resulted from different natural conditions, historical development, policy and planning systems as well as ownership structures. Sometimes the same pressures on this green structure from urban development could be observed but the consequences on the green structure and its ecological functions will be different. Therefore, every city needs to find its own specific solutions for green structure planning and management. The next chapter will present main findings of the specific ecological functions of the green structure in the case studies and how these are considered in green structure planning.

3 Biodiversity

Inkeri Vähä-Piikkiö and Olli Maijala

Biodiversity challenges urban land use planning for two issues. Firstly, recent decades of urban ecological research offer a *new image of European urban nature*. Urban nature can still support diverse mosaics of indigenous and valuable habitats and species, in spite of fragmentation, continuous spatial decrease and neglect in urban planning (Sukopp, 1998). Sometimes urban areas can host even higher species numbers than the surrounding countryside, as in Helsinki (Vähä-Piikkiö et al., 2004). Secondly, both the International Convention on Biodiversity (SCBD) 1992 and nature protection legislation in all European countries put ecological responsibilities not only on traditional nature protection but also on land use planning in general (Sukopp, 1998). As urban protection areas are often small, green areas are generally the most important resource for urban biodiversity (Colding et al., 2003). Here, we have a twofold approach to the relationship between urban biodiversity and urban planning. Firstly, as a more general view, we consider how biodiversity is taken into account in urban land use plans and green plans, and secondly, as a more specific view, we are interested in how biodiversity should inform urban green structure planning.

The following 8 European cities and towns offered case descriptions for the working group 1A "Ecological issues": Warsaw, Vienna, Munich, Oslo, Helsinki, Ceské Budejovice, Herning and Utrecht. The full descriptions are found in the COST C 11 website. The planning systems and situations in the cities vary. Four of the cities have an integrated land use plan and the other four have a separate green structure plan level in their planning system. The cases were analysed for their biodiversity perception, information, tools, goals and policy levels, and especially in relation to overall municipal strategies, urban and green planning, and environmental management. Special green planning instruments (ecological account, compensatory principles) from Germany and the Netherlands, were excluded, as the data did not assess their special value for biodiversity goals. These instruments are also under continuous discussion in landscape planning journals.

3.1 Biodiversity information

Something is known everywhere on biodiversity as protected species and habitats. All cities had databases that served well national nature protection: Inventories covered mostly national nature protection areas, NATURA 2000- or directive-protected species and habitats. Some cities had also wider "habitat" inventories, but 5 out of 8 cases used coarse land use or land cover classifications and data, instead of vegetation data connected to biodiversity (Sukopp 1998). Habitat data were mostly occasional or old, missing the potential of monitoring biodiversity development in planning. Warsaw and Helsinki had multi-taxonic approaches. Databases included also variable data on various taxa (organisms) and special habitats. This pool of mixed data seemed like a source of information for environmental education, but offered also possibilities for special indicators for municipal strategies (e.g. Oslo) or operational management projects (like in Herning). Biodiversity information did not seem to be integrated, prioritised or valuated for defining planning goals. It was commonly unclear how this information contributed to strategies for urban planning, protection, management and maintenance. We conclude that generally there are enough data to create local biodiversity policy, but the local biodiversity goal is still missing. Knowledge is lacking especially of the conditions on which species and areas can develop positively. Some of the existing data are also in form or at a scale that is difficult to use in actual urban planning. Because of the very complex nature of biodiversity, good data are not enough – we need interpretations, aggregations and valuations, to give practical guidelines to green structure planning. Based on our cases – as well as current discourses – we are in the actual developing phase of this work (e.g. in Oslo this kind of valuation work is just starting).

3.2 Biodiversity policies in urban planning

We aimed to describe how biodiversity policies (Sairinen 2000) appeared in planning in the 8 cases. We were interested in whether the biodiversity information was directly used as a background material, or in the goal setting for zoning, or in the principles, rules, tools, means and strategies in planning. We also wanted to examine if biodiversity goals were present only in traditional nature protection contexts, or also in land use planning levels. If biodiversity was present in land use planning, how did it appear: in zoning categories, or in special biodiversity planning approaches, in strategic or management planning?

It was found, that firstly, in general, biodiversity data were only used for national nature protection. Secondly, Utrecht and Oslo had separate biodiversity goals among other ecological values in urban or green planning. Thirdly, it appeared that the data and descriptions available were not enough for a deeper analysis on how biodiversity is planned also outside protected areas, especially in green structure and urban built-up areas. For this, more extensive policy-oriented planning research or detailed planning data would have been needed.

Is zoning the very only tool in planning? Zoning was common in the cases, but it raised further questions. How effective are the ecological zones? Which goals do they serve, and how are these goals implemented? How are the different ecological themes combined or prioritised in those zones – which are the principles used? There is a potential conflict with the different green benefits. The material did not offer possibilities to give answers to these questions. However, it is evident that often these difficult issues are not explicitly dealt with in the planning documents, and remain hidden and solved only haphazardly. **Ecological corridors** are widely used, but their value and implementation for enhancing biodiversity should be assessed with natural scientific methods. Modern urban ecology offers new approaches for the assessment of the functionality of mental structure models (e.g. metapopulation theory, population biology).

Effective biodiversity policies wait for becoming an integrated part of urban and green planning practice. In the cases we distinguished two different potential approaches for enhancing biodiversity in urban and green planning. Firstly, some of the cities used sophisticated, traditional sector planning instruments based on **holistic planning concepts** with hierarchical and multi-functional constructions (e.g. "Urban Natural System" (UNS) in Warsaw, Landscape Ecological Strategy in München, USES in C. Budejovice). In these concepts, biodiversity can be added as a new piece in a complicated system, and given the chosen goals and importance. Secondly, many of the cities had various kinds of integrated planning instruments based on – typically quite new – **holistic (environmental) strategies**, like environmental programme (e.g. Helsinki, Herning), diagnostive environment strategy (like Warsaw), green strategy (Utrecht), and strategy for sustainable development (Oslo, and many other cities with Local Agenda21). In these strategies biodiversity can be an explicit issue, with defined local goals. However, among the case cities, Oslo was the only case with contextualised biodiversity policy questions. Oslo has a biodiversity toolbox from strategic goals to individual project management procedures, and they have worked on biodiversity definitions, goals, and interpretations on practical projects of many kinds. However, as the holistic strategy-type of tools are recent, we do not yet know how they are implemented in urban and green planning, or what is their precise effect on urban planning and land use. Vienna and Helsinki do see already that what is omitted or unsolved in land use or green planning, is often re-appearing within environmental management, e.g. as complicated biodiversity questions.

3.3 Biodiversity needs conscious goals and new tools

A conscious biodiversity goal is needed for every urban and green plan. The biodiversity goal of a plan needs to be discussed according to local and national needs, traditions and planning tools. A municipal biodiversity strategy may help (e.g. Oslo), if the strategic goals can be further elaborated within the decisions and processes, e.g. in land use planning.

Viable biodiversity policy needs monitoring. New development is needed to produce an active biodiversity monitoring package from the present databases of latent background information. Local goal setting in planning needs a comparable and repeatable source of biodiversity information. Some common indicators are needed for monitoring development, like number of vegetation types or species numbers of vascular plant flora per square km (e.g. Helsinki). Research is needed for completing European vegetation classification including boreal and urban cultural vegetation types, and to improve habitat valuation. Why are labour-consuming and costly habitat inventories left omitted in land use and green planning, like in Warsaw or in Helsinki?

Biodiversity should be raised on "societal agendas". Biodiversity is a complicated issue that needs to be discussed more and widely to be able to have a stronger position on the important societal agendas. It is important to think about the processes how this discussion can be created and promoted. How is biodiversity interpreted? What are the conscious biodiversity themes, uses, values and definitions? How do they appear in the frames of legislation, in the decision making processes and political discourses, and in the planning instruments and discourses? What kind of societal contracts can be made? The plans are full of societal policies, all of which are valuating in some way or another. It seems that **studies opening green planning traditions, practices and processes are needed** (cf. Laine et al. 2003, Colding et al. 2003).

Outside the case data, Stockholm in Sweden offers an encouraging comparable example to follow: combining local initiatives, applied planning research, development of practical planning tools and national urban green and biodiversity policies – in strong urban pressures (see e.g. Löfvenhaft et al. 2002, Colding et al. 2003). The spatial goals and plans are based on real nature surveys, and the spatial goals are deliberately brought into customary land use planning practices, even on a detailed planning scale.

3.4 How can green structure planning enhance biodiversity?

Green structure planning aims to look at all the various uses and meanings of urban green, analyse and integrate them, and give them a functionally and politically strong coherent context in green structure plans. For biodiversity *this is useful especially for two reasons: firstly*, it gives a seemingly suitable context to plan and visualise the essential structural elements of urban biodiversity networks: the core areas, and the connecting, corridor-type of areas (of which the Stockholm-case is a good example; see Löfvenhaft et al., 2002). *Secondly*, an important aspect related to actors and potentials for enhancing biodiversity is how to combine different green interests, to find allies for a traditionally politically weak issue. In this combination task greenstructure planning may have an important potential role. The Munich and Utrecht cases provide good examples of creating multifunctional projects (like combining green and water projects) to enhance biodiversity.

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4 Green structure and water

Sybrand Tjallingii

A comparison of the cases reveals interesting aspects of the interaction between water and green structure. Water and green have a common history in most cities and usually river valleys play a leading part in this history. Potentially, however, water and green also share a common future. On the one hand, green areas are essential for water management issues like flood control and rainwater retention. On the other, water contributes to the value of green areas for nature, recreation and residential use. This comparison of cases will focus on both the historic and the future dimension of green and water.

4.1 Water structures the urban landscape

Water is not only a carrier of urban green, it structures the whole pattern of built-up areas and open spaces; it carries the urban landscape. Water links urban development to the local landscape with its drainage pattern, rivers and shores. Urban history may be read as the transformation of this pre-urban landscape in a process of interaction between nature and culture. Modern cities bear the traces of this interaction and thus, being one of the key agents, water carries the identity of the city. Each city has its unique local identity. However, in a comparison of the cities involved in this COST action, some distinct categories emerge that may throw light on the different roles of water.

The seashores and harbours generate the identity of Oslo. Helsinki and Marseille. There are marked differences between the Oslo Fjord, the Helsinki archipelago and the Marseille harbour and cliffs, but the cities share the view to the open sea they offer to their citizens going for a walk along the shore.

Rivers dominate the urban landscape in many cities but there are different rivers.

The Isar in Munich and the Vistula in Warsaw behave like fast running braiding rivers, with various channels contained in a floodplain. One of Munich's famous historic parks, the Englische Garten, uses a diverted Isar channel to create a romantic English-landscape-stile public park. Like the Isar on the north side, the Ticino on the south side of the Alps creates a braiding river valley that is the heart of a regional park visited by many people from nearby Milan. But the Ticino does not cut through the city itself. In Warsaw, at a greater distance from the mountains, the Vistula is a less dynamic braiding river. But in the geological history the river has cut a deep valley with steep escarpments on which the city was built. Today, the river valley and the old escarpments, together, carry Warsaw's main green structure.

In less dynamic rivers the water flows more slowly through the plains and starts meandering. The Tiber in Rome is sometimes very dynamic but yet, its wide meanders have created a deep lying attractive greenway for pedestrians and cyclists through the heart of the city. In Utrecht, the old meanders of the Rhine were cut off from the main river but their modified form structures both green structure and street pattern in the

inner city. On some distance from the inner city, the Danube, the Donau Kanal and the floodplain shapes old and new green structures in Vienna. In Ceske Budejovice, the Vltava is the carrier of the local green structure.
Small streams play a role in the green structure of almost all cities. In Sheffield, small streams, running down from the Peak District hills used to have many water mills, providing the energy for the early industries. Today, the streams and valleys are transformed into greenways. The same happened in Oslo and Munich. Other cities like Breda, Helsinki, Herning, Rome, Vienna and Warsaw also have numerous small streams and valleys of which at least some were kept green to become important carriers of green structure.
Shipping canals play their part in the green structure of Sheffield, Utrecht and Milan. Other canals, like those in Munich, were created primarily for water supply of farmland and for watering gardens of castles that, later, became part of the urban green space network. In Mediterranean cities like Marseille and Rome, canals and *aquaducts* became the blood vessels of urban life and were used to feed parks and gardens. Water is an essential element in the gardens as well as in the city itself, as expressed by monuments created at the end of aquaducts like the water castle in Marseille and the Trevi Fountains in Rome.
In some cities, water and inundation was part of a *defence system* and this left us with fortresses and bulwarks that have been turned into beautiful parks in cities like Breda and Utrecht.

4.2 Green areas contribute to water management

Enhancing the potential synergism between green area and water management is a promising field of action for technicians and designers in urban areas (Hough, 1995; Van Engen et al., 1995; Tjallingii, 2000). The traditional technical approach concentrates on rapid removal of storm water by sewers. Presently, many cities explore the options of a more ecological approach based on retention of rainwater and prevention of pollution. On the one hand this change of attitude follows from a better understanding of the role of green areas in the urban water balance. On the other hand urban growth goes with a dramatic increase of hard surfaces, creating peak discharge problems the old sewer systems are unable to cope with. The situation is getting worse as a result of the predicted climatic change, involving higher rainfall and longer dry periods. Dramatic floods and dry summers in recent years have put this issue high on the European agenda.

In the upstream mountains and hills reforestation can be an effective *erosion prevention* strategy. Ceske Budejovice reports this approach as an element of urban green policy. The Czech city also shares with most other case study cities a deliberate policy to keep floodplains open and green for flood control reasons. Some cities, like Breda, Herning, Munich and Utrecht have developed more detailed strategies to combine *storm water storage* and green area design at the district level. On sandy soils with lower groundwater tables the strategy is to use green spaces for rainwater infiltra-

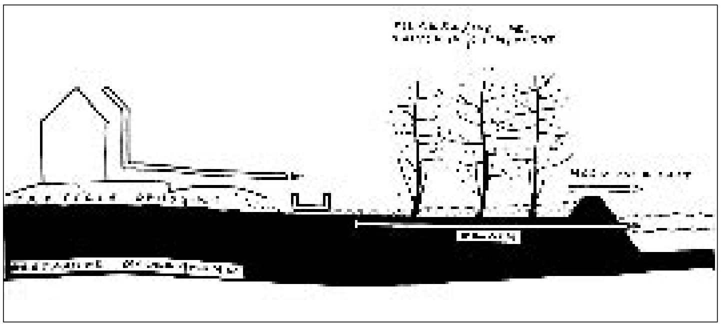

Fig.1.Guiding model for the design of streets and green spaces in Leidsche Rijn Residential Development project. The green area retains rainwater. The overflow leads to the urban surface water system. (Source: H+N+S).

tion leading to *groundwater recharge*. On hard rocks or impermeable clay soils rainwater is stored in ponds and watercourses with fluctuating water tables. This is a *rainwater retention* strategy illustrated by the cross section from the Utrecht Leidsche Rijn project.

The Messestadt Riem project in Munich, describes these and other principles as *ecological building blocks* (Burkhardt & Duhme, 1996). Not only water quantity benefits from the combination of green and blue. Old and new wetlands, from larger marshes to natural riverbanks also contribute to water quality. Discontinued agricultural land-use and drainage around Herning, for example, create a new green-blue ring with new qualities for wildlife, recreation and water storage. Many other projects in Munich, Utrecht, Breda and other cities demonstrate the great potential, both for surface water quality and biodiversity.

4.3 Promising perspectives

Far from giving a complete picture of best practices, the case study cities and the other cities involved in the COST action illustrate the promising perspectives for urban projects that combine green and blue. Water creates conditions for biodiversity, tree growth, scenic beauty, and recreation. Green areas create conditions for healthy water management. At the urban level these projects contribute to green and water structure as key elements of the local urban identity.

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5. Climate and green structure planning

Ewa Kaliszuk and Stephan Pauleit

In urban environments, green spaces have important climatic functions such as providing shadow, windbreaks, reducing the heat island effect and improving air quality (see references, e.g. Givoni, 1991, Von Stülpnagel, 1990). A city's green stucture may enhance these functions. Green corridors, for example, may carry cool and fresh air from neighbouring forested hills into inner cities. The case studies represent only some situations from a wide range of climatic differences.
This chapter gives an overview of whether and how these different climatic functions of the urban green structure are recognised in its planning, design and management. The chapter summarises the findings from the case studies, and presents some examples of good practice for climate conscious green structure planning.

5.1 The role of green structure for climate and air quality

Overall, the information on the role of green structure to improve air quality and climatic conditions provided in the case studies was quite limited. It seems that overall little importance is given to climate considerations in green structure planning. Where information was provided in the case studies, emphasis was placed on air quality and the role of green space corridors to improve ventilation of urban areas. In Oslo, several studies were undertaken to assess the role of green space corridors for ventilation, and Warsaw's system of green corridors is supported by extensive research on air quality (Bednarek 1990, Blazejczyk and Kuchcik 2001).
For Helsinki, the importance of the sea for ventilation was stressed. Moreover, the role of woodlands to reduce air pollution from roads was studied. Detailed guidelines for the design of protective tree belts along the roads were developed. However, there is little evidence of their implementation as the space required is rather used for buildings. Presently, the national states have to face the implementation of legally binding EU air quality directives. Plans for building alongside roads are now being reconsidered and protective measures, including tree planting, might become more important in the next future.

The relation between green spaces and temperature climate was only discussed in a few case studies. Different issues were important in the case study areas. Increased temperature levels in urban areas were only considered as an issue in Central European cities but not in north-west and north Europe. In the latter, shelter in open spaces from cold wind and bad weather is more important.

For the City of Munich information on surface temperatures was obtained from aerial imagery to assess the climatic role of vegetated areas (Fig. 5.1). The results clearly highlighted the climatic importance of green space cover within urban land uses (residential areas, industry and commerce, etc.). An increase of vegetated surface cover by

10% reduced surface temperatures on average by 1°Celsius. Mature stands of trees were particularly effective to mitigate the heat island effect, and therefore should be strictly protected.

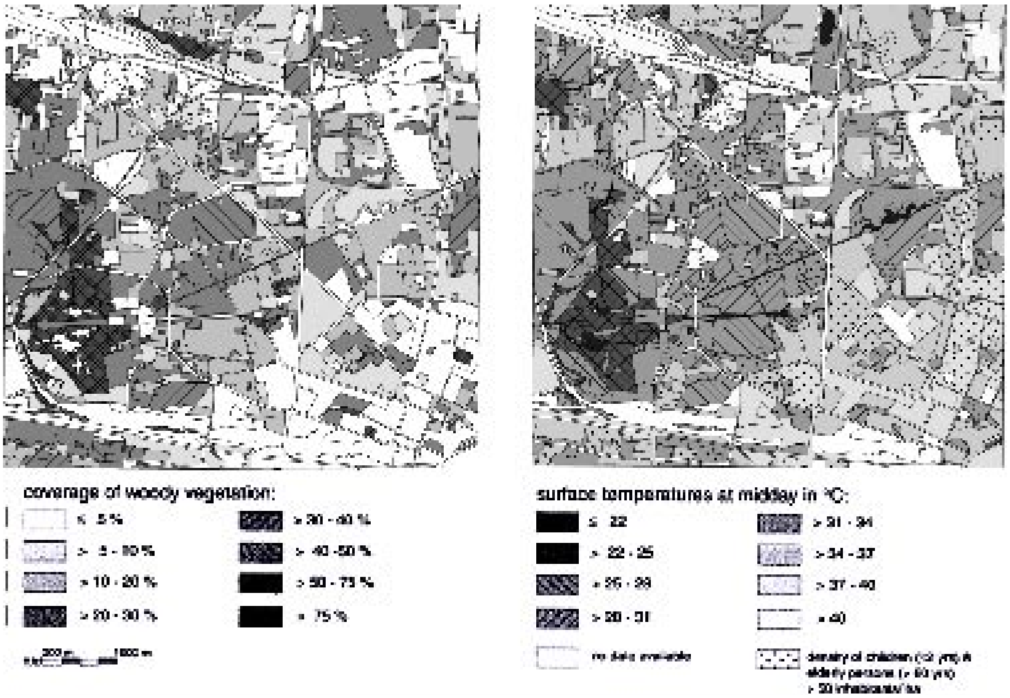

Fig. 5.1: Cover of trees and shrubs in urban land use units and average surface temperatures on a hot summer day. Well treed areas such as parks (Nymphenburg Park, lower left) and low density residential areas (around Nymphenburg Park) are cooler than the densely built up inner city (lower right) and industrial areas (upper right). The density of very young and elderly population served as an indicator for particularly vulnerable areas (source: Pauleit and Duhme, 2000).

5.2 Climatic goals for green structure planning

Air quality is used as an argument to protect green space corridors in Helsinki and Warsaw. Warsaw's system of green corridors for air quality improvement is summarised in Box 5.1. The corridor concept was respected in urban planning in Warsaw until recently but it is now threatened by development projects (Szulczewska and Kaliszuk 2003). In Oslo too, large development projects have been approved although negative consequences for air quality were predicted. The Helsinki case highlighted a dilemma. There is evidence of the beneficial role of green spaces to reduce air pollution, and hence they should be protected. Yet, at the same time, the city advocates densification to reduce carbon dioxide emissions, which would mean the destruction of green space within the city. A similar tension also exists in Munich where the city has adopted a strategy called "compact – urban – green", and likely in many other cities. However, these contradictions are not solved in urban planning. This dilemma deserves more attention in urban planning and design. Potentially, a green finger design will be able to concentrate the climatic function of green spaces and may seduce more citizens to stay in a city with attractive green edges.

Box 5.1: **Environmental functions played an important role in the planning of Warsaw's green fingers**

In Warsaw, green space corridors ('green fingers') were designated in the first legally binding municipal plan of Warsaw elaborated in 1929. These were designed for recreation and to enhance air exchange. This plan has been in force until today. In modern Warsaw, the municipality coordinates the development in its 18 local districts. The green structure plan has proven a very important tool in this respect to maintain a coherent green structure.

In the latest version of the municipal development plan, a distinction has been made between three zones of the green structure: These are called the Ecological Zone, the Ecological Zone- Auxiliary System and the Air Exchange and Regeneration System.

The Air Exchange and Regeneration System protects areas, which create good climatic conditions in Warsaw. It partially covers the ecological zones of predominantly forests and parks, while large wastelands, railroads and highways are designated as major corridors for ventilation. Development and sources of air pollution are strictly controlled. However, current development pressures have led to the building up of some green spaces within this zone.

Specific goals and targets to mitigate the heat island effect through green spaces are nowhere in place in the cases studies. However, there are examples from other cities where climate plays an important role in urban development. For instance, Stuttgart has a climatic strategy (Klima21) and managed to protect green corridors and the hills around the city to improve penetration of cool and clean air into the city. The Messestadt Riem case study is an example where climate considerations were important in shaping the green structure in a large urban development project (Fig. 5.2 *next page*).

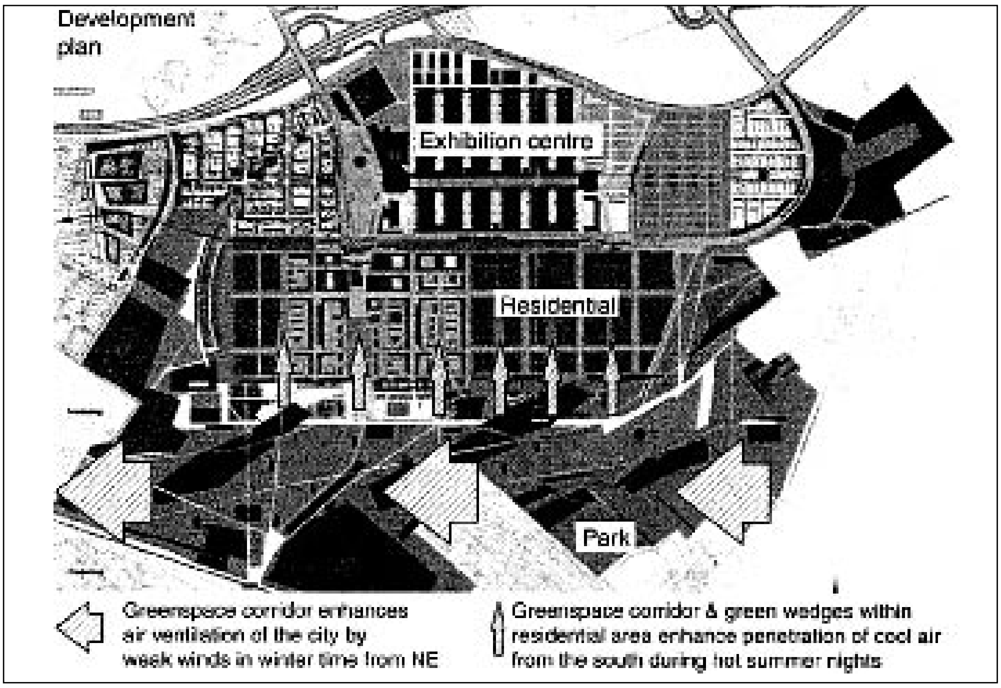

Fig. 5. 2: Climate considerations influenced the urban planning and design of greenstructure in the new neighbourhood Messestadt Riem in Munich. Overall, one third of the development is green space. A large park in the south serves as a corridor to improve ventilation of the inner city but also to reduce air temperatures in the new neighbourhood. Green fingers allow fresh air to penetrate into the residential areas (based on Burkhardt 1996).

5.3 Conclusions

Providing all year around useable green spaces is an important goal for green structure planning. Their design must be sensitive to the local climatic conditions. Moreover, green structure can have a wider importance to improve urban climatic conditions. There is no one "ideal" urban climate but urban climatologists stress the importance of having outdoors a great range of different microclimatic conditions within walking distance (≤150 m; Mayer 1990), while avoiding climatic extremes. A dense network of green spaces, including provision of trees in streets would be important to meet these requirements.

Overall there was little evidence that climate considerations play a significant role in green structure planning, and generally in urban development. Climatic goals and strategies are lacking. However, the case studies provide scientific evidence that provision of green space and in particular that of trees is important to improve climatic conditions in towns and cities. It can be important, for instance to improve air quality by enhancing ventilation, or reduce air temperatures in cities with extended periods of hot summers. Green space on private and institutional land can be equally important than public green space in this respect.

The case studies of Warsaw and Messestadt Riem show how climate considerations can play a role in shaping green corridors on the city and neighbourhood scales, respectively and introducing climatic considerations into the design of green spaces. Tools for climate conscious green structure planning such as the approach used in Munich should be further developed to support the setting of local goals and targets for green structure planning. Human health and comfort studies could be very useful to strengthen urban climate considerations in green structure planning, design and management.

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6. Green structure, farming and organic matter

Eva Erhart

Organic waste represents not only a problem to society, but also a resource in terms of nutrients, energy, and humus. In the management of the urban green structure and in urban agriculture, there is a demand for soil amelioration products and fertilizers. In many cases, organic waste products (e. g. compost) can fulfil these demands and in this way reduce the mining of scarce resources like phosphorus, lime and sphagnum, as well as the energy-intensive production of nitrogen fertilizer.
Only two case studies dealt with the management of organic matter in green structure. In Vienna and Herning, investigations were conducted to which extent the urban green structure can contribute to the sustainable handling of organic waste produced in the municipality.

Key findings of the studies are that organic waste products, e. g. compost, can substitute a significant part of the soil amelioration products and fertilizers currently used in the management of urban green structure and in urban agriculture, respectively. In Vienna, the largest part of the compost produced from organic household wastes is used in agriculture on the municipal agricultural estates. Approx. 850 ha of the agricultural area belong to Vienna`s municipal estates, the remnants of the former imperial estates. In order to realize closed ecological cycles of nutrient flows in at least a part of waste management, a special model for biowaste treatment and use was developed. This made it possible that a part of the estates could change over to organic farming (http://www.bestpractices.org).

In Herning, organic wastes from agriculture are currently the main input into biogas production. Organic wastes from households are incinerated, only a small fraction goes into biogas production. The organic material from private gardens as well as from public green areas goes into composting. From the compost output, approx. 20 % are used in public green areas, the rest is used in private gardens. However, detailed estimates of nutrients contained in the municipality's organic waste showed that artificial fertilisers and sphagnum moss products currently applied in green spaces could be easily substituted by compost produced from organic waste. It was concluded that the ongoing consumption of manufactured fertiliser and sphagnum in parks and gardens was unnecessary and should be replaced by the use of compost based on garden and park waste.
The two studies and in particular the 'best practice' example of Vienna show that organic waste products can fulfil the demands for soil amelioration products and fertilizers that arise in the management of urban green structure and in urban agriculture. Organic farming not only contributes to closing ecological loops, it may also create better conditions for multifunctional land-use and for the preservation of historic landscapes as apart of the urban green structure.

7. Pests and diseases

Irena Hanouskova

Control is the basis of regulations and programmes addressing organisms classified as pests and causing diseases. There is a variety of national and municipal policies for food quality control, health and hygiene and plant protection and for controlling specific organisms like rodents, insects and invading plant species. The emphasis is on cure rather than prevention. Some scientists warn against possible risks of natural habitats in urban areas, but there is little evidence to support this fear. On the contrary, there is a lot of evidence about the positive effects of the natural parts of green stucture on water quality and health. But the fact is that we know very little about creating preventive conditions for pests and a bout the possible role of green structure in preventive strategies. The case studies did not make reference to pest and diseases and the relationship with green structure.

Future research should therefore focus on a better understanding of the development and the spread of both harmful organisms and their natural enemies. Improved understanding can be the basis of improved policies for cure and prevention and may lead to practical guidelines for planners.