URBAN PATTERNS FOR A GREEN ECONOMY **WORKING WITH NATURE**

UN-HABITAT
FOR A BETTER URBAN FUTURE

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Cover photo: The Rio Uberabinha, in Uberlândia, Brazil, functions as a green corridor and incorporates water infrastructure as well as public and private recreational facilities © UN-Habitat/ Alessandro Scotti

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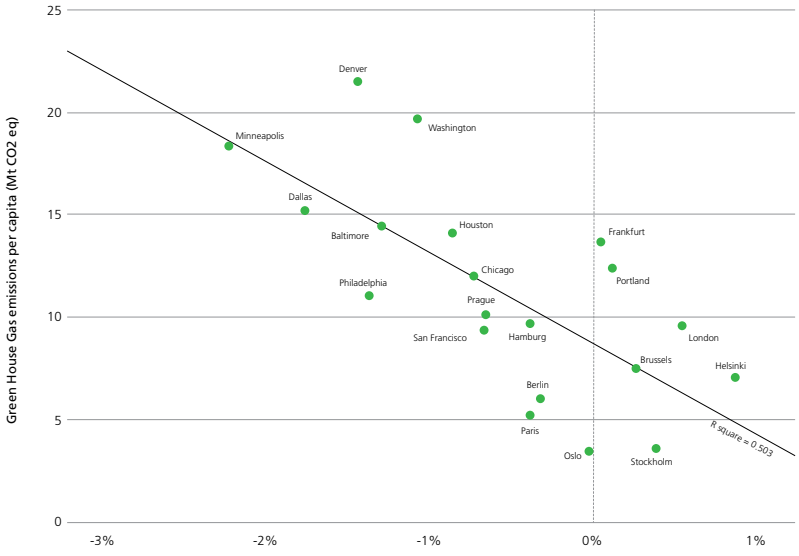
Foreword

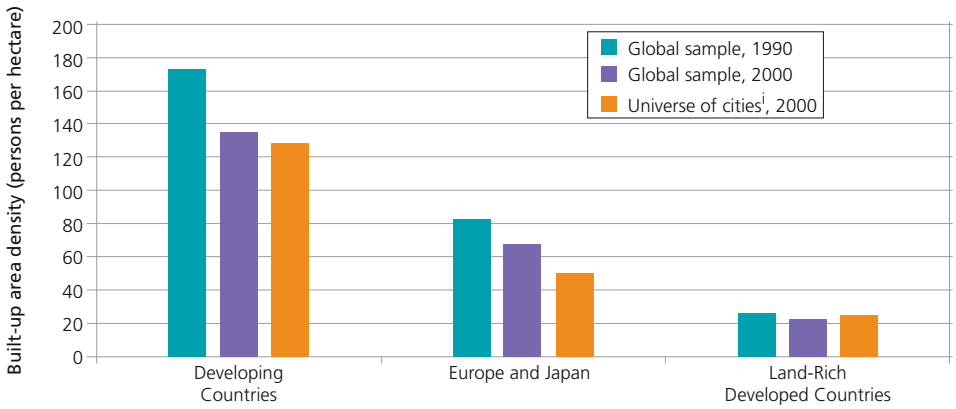
The city is one of the highest pinnacles of human creation. Concentrating so many people in dense, interactive, shared spaces has historically provided distinct advantages, that is, agglomeration advantages. Through agglomeration, cities have the power to innovate, generate wealth, enhance quality of life and accommodate more people within a smaller footprint at lower per-capita resource use and emissions than any other settlement pattern.

Figure I: **Greenhouse gas emissions and containment index for selected metropolitan regions**



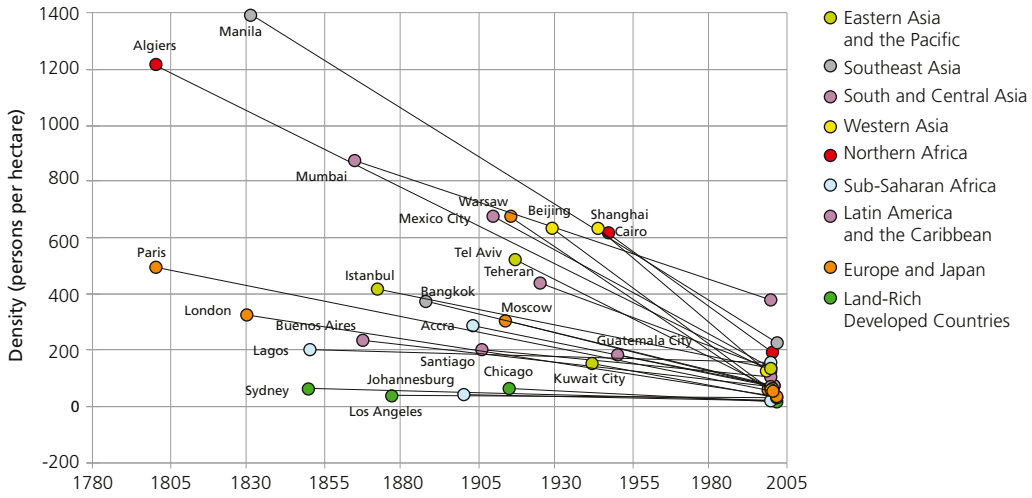
Or so they could. Increasingly, cities are forfeiting many of the benefits that agglomeration has to offer. Two meta-studies of urban land expansion have shown that over the last two decades most cities in the world have become less dense rather than more,[1,2] and are wasting their potential in ways that generate sprawl, congestion and segregation. These patterns are making cities less pleasant and equitable places in which to live. They are also threatening the earth's carrying capacity. And they are most

Figure II: **Average Built-up Area Densities in Three World Regions**



Source: Making Room for a Planet of Cites, by Shlomo Angel, Jason Parent, Daniel L. Civco, and Alejandro M. Blei. © 2011. Lincoln Institute of Land Policy, Cambridge, MA.

Figure III: **The General Decline in Built-Up Area Densities in 25 Representative Cities, 1800-2000**



Source: Making Room for a Planet of Cites, by Shlomo Angel, Jason Parent, Daniel L. Civco, and Alejandro M. Blei. © 2011. Lincoln Institute of Land Policy, Cambridge, MA.

i This refers to 3,646 large cities with a population of over 100,000 or more.

acute in fast-growing cities, particularly those with the lowest institutional capacities, weakest environmental protections and longest infrastructure backlogs.

Increasingly, city managers wish to learn by example. Rather than more theory and principles, they want to know what has worked, what has not, and which lessons are transferrable to their own contexts. There is much information available, but little time. UN-Habitat has developed these "quick guides" for urban practitioners who need condensed resources at their fingertips. The aim is to suggest patterns that can help cities and city-regions regain these inherent advantages in a time of increased uncertainty and unprecedented demographic expansion.

More than half the global population now lives in towns and cities. By the year 2050, UN-Habitat research projects that that figure will rise to two-thirds. This rapid, large-scale concentration of humanity in the world's cities represents new challenges for ingenuity, and numerous opportunities to improve the way in which human habitats are shaped. Most of this population growth will be in the cities of developing countries, which are expected to grow by an additional 1.3 billion people by 2030, compared to 100 million in the cities of the developed world over the same period.[3]

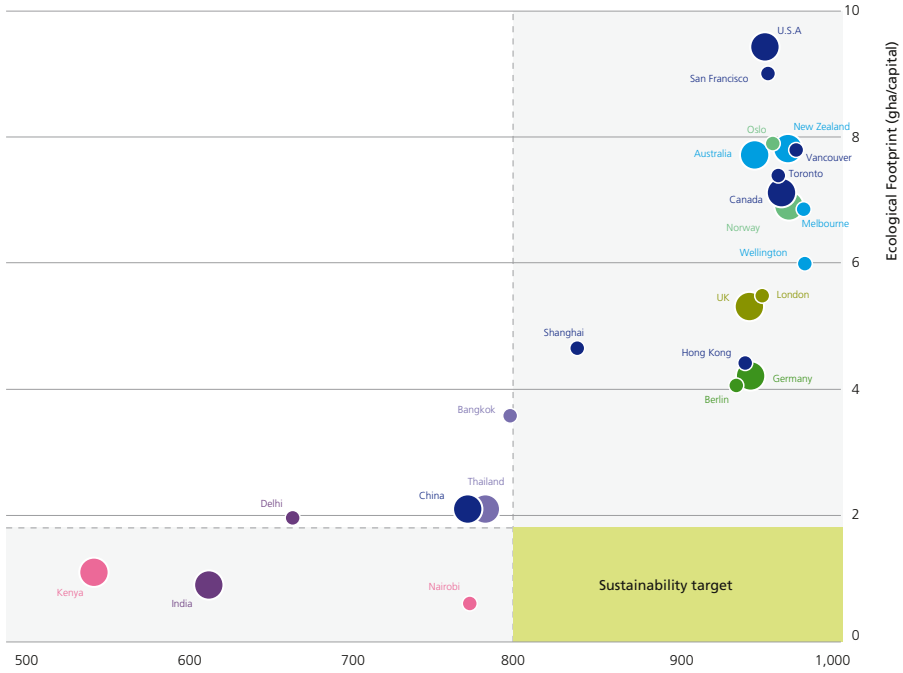
While urban population growth rates are stabilizing in regions which are already predominantly urban (such as Europe, North, South and Central America and Oceania), regions with a higher proportion of rural population (such as Asia and Africa) are likely to see exponential rates of urban population growth in the coming years.[4] Most urbanization is likely to occur in cities relatively unprepared to accommodate these numbers, with potential negative repercussions for quality of life, economic development and the natural environment.

Although the percentage of the urban population living in slums worldwide has decreased, the absolute number of people living in slums continues to grow.[5] No less than 62 per cent of all urban dwellers in sub-Saharan Africa live in slums, compared to Asia where it varies between 24 per cent and 43 per cent, and Latin America and the Caribbean where slums make up 27 per cent of the urban population.[6] If these growing cities are to be socially sustainable, new approaches will be required to integrate the poor so that the urbanization process improves inter-generational equity rather than entrenching socio-spatial fragmentation. Privatized models of service delivery that discriminate between consumers based on their ability to pay threaten to worsen inequalities,[7] and require carefully considered parameters to ensure that the poor are not disadvantaged.

According to a recent World Bank study, urban population growth is likely to result in the significant loss of non-urban land as built environments expand into their surroundings. Cities in developing countries are expected to triple their land area between 2005 and 2030, with each new city dweller converting an average of 160 metres 2 of non-urban land to urban land.[8] Despite slower population growth, cities in industrialized countries are likely to see a 2.5 times growth in city land areas over the same period due to a more rapid decline in average densities when compared to their developing country counterparts.[9] As built environments become less dense and stocks of built up land accumulate, the amount of reproductive and ecologically buffering land available for ecosystems and food production is diminished, reducing the ability of city-regions to support themselves.[10]

While international trade has made it possible for cities to meet their demands for food, water and energy with imports from faraway lands, it is becoming increasingly apparent that the appetite of the world's

Figure IV: **Ecological Footprint and Human Development Index for selected countries and cities**



© *Philipp Rode*

growing and increasingly affluent population is coming up against limitations in the planet's ability to support human life on this scale. It is estimated that our addiction to oil will result in a peak in oil extraction within the next decade, leading to dramatic increases in the costs of fuel, mobility, food and other imports. Greater demand for potable water, combined with changing rainfall patterns, the depletion of aquifers and pollution of groundwater, is likely to see increasing competition for scarce fresh water resources, raising the possibility of conflict in the near future.

The ability of ecosystems to continue providing biotic resources like wood, fish and food, and to absorb manmade wastes - commonly referred to as the earth's "bio-capacity" - is also diminishing. Comparing global ecological footprints to the earth's available capacity shows that, at current rates of resource use, we are exceeding bio-capacity by 30 per cent,[11] and approximately 60 per cent of the ecosystems we depend on for goods and services are being degraded or used in an unsustainable manner.[12] We are living off the planet's natural capital instead of the interest from this capital, and there are already signs of the devastating effect this will have on our societies and economies in depleting fish stocks, loss of fertile soil, shrinking forests and increasingly unpredictable weather patterns.[13]

The global population is reaching a size where cities need to start thinking beyond their immediate interests to consider their role as nodes of human consumption and waste production in a finite planet that is struggling to keep pace with humanity's demands. If cities are to survive, they must acknowledge the warning signs of ecosystem degradation and build their

economies in a manner that respects and rehabilitates the ecosystems on which life depends. If cities are to prosper, they must embrace the challenge of providing shelter and uninterrupted access to water, food and energy and improve quality of life for all of their citizens.

The way in which city spaces, buildings and infrastructural systems are planned, designed and operated influences the extent to which they encroach on natural ecosystems, and locks them into certain modes of consumption from which they struggle to deviate. Urban activities have direct and indirect consequences for the natural environment in the short, medium and long term, and their scale of influence typically extends far beyond the boundaries of what is typically considered to constitute "the city". Managing the indirect, distant and sometimes obscured impacts of city decision making in an increasingly globalized world requires appropriate governance mechanisms that improve cities' accountability for the resources they rely on.

As nexuses of knowledge, infrastructure and governance, cities represent a key opportunity to stimulate larger scale change toward green economies. In a world where cities are increasingly competing against each other economically, where weather patterns are unpredictable and low resource prices can no longer be assumed, cities need to proactively shape their economies and operations in preparation for an uncertain future. To manage risk in a democratic manner, a balance will need to be struck between deliberative decision making processes and centralized master planning. This can be done by empowering planning professionals to respond quickly and effectively to evolving developments without compromising longer term shared visions of a better city[14].

This guide is one of a set of four aimed at inspiring city managers and practitioners to think more broadly about the role of their cities, and to collaborate with experts and interest groups across disciplines and sectors to promote both human and environmental prosperity. The guides are based on the outputs of an expert group meeting hosted by UN-Habitat in February 2011 entitled *What Does the Green Economy Mean for Sustainable Urban Development?* Each guide focuses on one of the following cross-cutting themes:

Working with Nature

With functioning ecosystems forming the foundation for social and economic activity, this guide looks at how built environments can be planned to operate in collaboration with nature. It looks at how to plan cities and regions for ecosystem health, focusing on allowing sufficient space for natural systems to continue providing crucial goods and services like fresh water, food, fuel and waste amelioration.

Leveraging Density

This guide looks at the relationship between built and natural environments from the perspective of cities, and considers how their impact on ecosystem functioning might be reduced by making best use of their land coverage. Planning the growth of cities to achieve appropriate densities and providing alternative forms of mobility to private vehicles help to slow urban expansion onto ecologically sensitive land, and can reduce citizens' demand for scarce resources by sharing them more efficiently.

Optimizing Infrastructure

Considering urban infrastructure as the link between city inhabitants and natural resources, this guide looks at how infrastructural systems can be conceived

differently in order to help all city residents to conserve resources. It introduces new concepts and approaches to the provision of infrastructural services, such as energy, water and waste treatment, and demonstrates how infrastructure investments can act as catalysts for urban sustainability.

Clustering for Competitiveness

Taking a broader perspective, this guide looks at city regions and how they can be more optimally planned to achieve economic objectives in a manner that does not waste local resources. It looks at how competitive advantage can be achieved at a regional scale by encouraging cooperation between cities with complementary areas of specialization. It also considers how innovation for green economic development can be encouraged through the clustering of industries, and through collaborations between government, the private sector and academia.

Each guide contains a selection of case studies from around the world that demonstrate how cities have approached sustainability challenges in a manner befitting the realities of their unique context. Showcasing a wide range of options, the case studies are not aimed at prescribing solutions, but are rather intended to inspire the considered development of contextually relevant approaches in other cities to enhance their sustainability.

Glossary

Biodiversity: the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. (Article 2, Convention on Biological Diversity).

Biodiversity hotspot: A biogeographic region with a significant reservoir of biodiversity that is under threat from humans.

City region: The area within which the connections between one or more cities and the surrounding rural land are intense and functionally (economically, socially, politically and geographically) connected. These areas are typically 80-100 km across and occupy up to 10,000 km².

Ecological/green infrastructure: The structural landscape network made up of vegetated/non-sealed landscape elements and spatial patterns. It provides for range of uses including delivering ecosystem services.

Ecosystem: A biological system that includes both living and non-living organisms.

Ecosystem services: Goods and services produced by nature and shaped by social ecological processes that are beneficial to humans.

Ecological urbanism: A new approach to city development that considers urbanism and the environment in a holistic way.

Habitat: The environment needed for an organism to complete its lifecycle and that could be very large scale.

Landscape change: The dynamic process through which the landscape is transformed either intentionally or unintentionally.

Landscape fragmentation: The decrease of patch area and patch connectivity in a landscape.

Landscape assessment: The mapping and assessment of the landscape in order to provide a comprehensive information base and the coordination of planning tools and strategies in order to inform the process of decision making concerning land use.

Landscape structure/pattern: The spatial arrangement of the various natural and human areas and uses.

Patch: A relatively homogenous area that differs from its surroundings.

Urban compaction: The process that aims to increase built area and residential population densities; to intensify urban economic, social and cultural activities and to manipulate urban size, form and structure and settlement systems in search of the environmental, social and global sustainability benefits that can be derived from concentration of urban functions.

Urban resilience: A city's ability to cope with, and adapt to, natural disasters and changing circumstances.

Urbanization: A process of migration of people that results in population increase in cities with increased urban area and population density.

Contents

The High Line in Manhattan, New York City at West 20th Street, looking downtown (south)
© Wikipedia/Beyond My Ken

Introduction

1

This guide focuses on the effect of unplanned, rapid growth of cities on the functioning of the ecosystems in which they are located. It outlines how development can be guided to ensure the ability of ecosystems to support sustainable human settlement. The pattern of development in a region, properly managed, has a direct bearing on the capability of a city to function effectively and to benefit from ecosystem services. This guide offers a perspective on how to work with the ecological processes in a region. Its focus is specifically at the regional scale but it looks at the need to work across scales; to understand regional systems; and develop principles and measures that can be applied at the regional, city and local scales.

For humankind to thrive, we need to understand how people can work cooperatively with nature and ecosystems to protect and benefit from the earth's natural resources. Biodiversity is essential to sustain the flow of ecosystem services in times of change by supporting the adaptive capacity of the urban system. Cities need to have a resilience that will allow them to anticipate, respond and adapt to uncertain and challenging conditions. This resilience comes from the conscious monitoring and management of resource flows, be it water and energy consumption, waste production and disposal, greenhouse gas emissions, food flows, and conservation and cultivation of ecosystem goods and services.[15] In this guide, the term resilience refers to the ability of a city to adapt to shocks, such as climate change and ecological stresses and scarcities, rather than the broader definition of resilience, which includes economic and social resilience.

Section 2 outlines the sustainability challenges faced by cities and examines how fragmentation of the landscape interrupts ecosystems, reduces habitats and threatens biodiversity. It explains why biodiversity is important and examines why cities should focus on building resilience in order to weather unexpected natural disasters and climate change, and manage resource flows productively. It outlines the concept of Ecosystem Services and their value when managing resources in a region.

Section 3 outlines the concept of the landscape mosaic pattern as an organizing principle for managed regional development. It

summarizes key concepts, such as patches and corridors and ecological urbanism, which underpin the logic and benefits of the landscape mosaic.

Section 4 presents broad principles that can be used to promote the landscape mosaic pattern.

Section 5 looks at the practical steps that need to be taken to implement this approach.

Section 6 includes eight case studies that demonstrate how the landscape mosaic pattern has been used to support biodiversity and increase connectivity, and how ecosystem services have been used to contribute to sustainable city development.

- In New York City, United States, the identification of strategic land patterns and watershed management has resulted in ensuring a supply of clean water. Over a 12-year period, the city bought land and subsidized best management practices for the watershed, avoiding the need for extensive filtration of its upstate water supply. About 90 per cent of the water used in New York City comes from the Delaware-Catskill water system, about 193 km north of the city.

- In Cape Town, South Africa, the city has calculated the contribution of its ecosystem services to its economy, and this is helping to strengthen arguments for investments in environmental protection. Cape Town's natural areas are under pressure from land transformation, pollution and alien invasive species; they need increased investment and management effort. The city's Environmental Management Department assessed the possible return on increased investment in, and protection of, natural assets and this revealed the huge value of ecosystem services

- In Zagreb, Croatia, the city's decision-makers, officials and communities have worked together to protect biodiversity. The city's concerted effort to involve a range of stakeholders in the protection of the area's biodiversity included active participation programmes, which resulted in the recording and monitoring of biodiversity assets.

- In Nueva Vizcaya, the Philippines, an innovative move from a traditional watershed management approach to the country's first watershed co-management model was piloted in the Lower Magat Forest Reserve in 1998. The Memorandum of Agreement (for 25 years and renewable for another 25 years) was between the local government units of Nueva Vizcaya, the Department of Environment and Natural Resources, individuals, associations, cooperatives and corporations. Using this innovative, holistic approach, the local government units were able to protect and manage the watershed in partnership with local communities.

- In Berlin, Germany, the "StEPKlima" has already demonstrated the significance of existing urban green spaces and parks for the improvement of climatic conditions, for centrally placed leisure opportunities, for protection of water resources and for the maintenance of habitat for animals and plants. The ecological benefits that derive from the largest park in the city, the Tiergarten, are a model for future planning and argue for the safeguarding of green spaces. These areas play a key role in adapting to the negative effects of climate change and to the improvement of living conditions in the city.

- In Dar es Salaam, Tanzania, urban agriculture has been developed and promoted as an income earner and

a food source at the subsistence or household level. Food security was highlighted by droughts in the 1970s and 1980s and the government supported urban agriculture in a bid to encourage households to be self-sufficient. The challenge has been to regulate the largely informal urban agricultural activities so that natural systems, such as river valleys and wetlands, are not compromised.

- In Hangzhou, China, the State Council approved the Hangzhou City Master Plan in 2001 to develop a sustainable city that is "prosperous, harmonious, well-equipped and ecological". A key objective of the plan was to build a resource-saving and environmentally friendly city, with the emphasis on environmental protection and expenditure reduction.

- In Seoul, South Korea, the Cheonggyecheon River has been restored and the area around it revitalized. During the 1960s, the Cheonggyecheon River, which ran through the centre of Seoul, was covered in concrete and replaced with a four-lane, elevated freeway as part of a modernization process. With the city authorities changing their focus from accelerated industrialization and modernization to sustainability, health and social responsibility, the restoration of the river was an opportunity for urban renewal. The freeway was dismantled and the Cheonggyecheon Restoration Project created a 5.8 km landscaped green pathway alongside the revitalized Cheonggyecheon stream. The project was completed in 2005.

Section 7 concludes the guide with a summary of the key lessons.

A fertile river valley in the southern part of Tetouan, Morocco, still gives priority to grazing cattle, though the city has recently permitted limited middle class residential development here
© UN-Habitat/Alessandro Scotti

The Challenges of Urbanization

2

Urbanization poses many challenges, but the focus of this guide is on spatial patterns, and the landscape mosaic pattern in particular, because this impacts most fundamentally on ecosystems and associated biodiversity. Other issues related to urbanization, such as poverty, unemployment, transport and housing, for example, are not addressed here. As noted in the Foreword, rapid, unmanaged development often results in a pattern of urban sprawl and/or development on productive and biologically critical areas and habitats, which radically alters the form of the landscape. This, in turn, affects the functions and uses of the landscape.

Wherever humans settle, they need supplies of food and clean water, as well as ways of disposing of their waste. In urban areas, these services, which are provided by the effective functioning of ecosystems, are usually sourced from the surrounding region, or in the case of food, from further afield.[16] Conversely, waste from these inputs needs to be managed. Local government is usually responsible for drinking water and waste management. Supporting biodiversity and healthy ecosystems helps secure a sustainable service. In an ideal situation, the waste from city consumption should go directly back into providing nutrients to healthy ecosystems and habitats.

2.1 The importance of biodiversity

Of all land uses, the city and town, with their buildings, transport systems and parks and need for food and other services, has the greatest and most profound impact on ecological processes [17] and on biological diversity. Because urbanization, and the food production required to support it, is a continuing trend, this impact is likely to continue. The definition of biodiversity produced by the 2005 Millennium Ecosystem Assessment, based on the 1992 Convention on Biological Diversity, is the diversity of life on Earth, made up of many components, including genes, species, populations and ecosystems, across a number of geographical scales, from local to global.[18] While urbanization can be a threat to biodiversity, cities and regions also provide a variety of opportunities for different species, in different habitats, across a range of land uses. Cities are often located in biodiversity hotspots, for example estuaries, coastlines, ecotones and fertile plains. If they are well

managed, cities can support biodiversity in the following ways:

- Cities act as refuges for species whose habitats have been destroyed by intensive agriculture and forestry;
- Cities are socio-ecological systems where new habitats and species communities can develop; and
- Urban green areas provide cities with ecosystem services that cannot be imported, for example noise reduction, absorption of air and water pollutants.

This list highlights the fact that cities are important for global biodiversity and that urban green areas and the biodiversity in them are important for urban sustainability and the wellbeing of city residents. The relationship between humans and nature is constantly evolving, and as cities grow and the boundary between the urban and rural areas blur, plants and animals adapt to the changing urban environment. The number of habitats grows with increasing city size and cities include both intentionally and unintentionally introduced species.[19]

The urban pattern has an effect on species richness and biodiversity. Landscape ecologists view the city as a complex mosaic, with the built-up areas acting as the matrix and green areas as patches. Within this mosaic there is a variety of habitats and species. Key to biodiversity is whether species can move across the urban fabric and/or colonize and inhabit it.[20] Among species there is a degree of matrix sensitivity, with some species more able to exploit the urban area as a habitat and others sometimes prevented from doing so because of fragmentation of the landscape.

The landscape mosaic pattern, which incorporates patches connected by corridors, facilitates movement of species and the functioning of ecosystems within the urban fabric, and thus protects biodiversity.

2.1.1 Biodiversity and the economy

Biodiversity conservation is the crucial factor in maintaining a sustainable local economy because society and the economy are dependent on the ecosystem goods and services provided by the environment.[21] Biodiversity supports ecosystem services, which include both natural resources (products) and processes that provide a service, such as water purification, fuel, medicinal supplies and clean air. The cost of replacing an ecosystem service, for example by building and operating a water treatment facility, is higher than conserving the ecosystem and enjoying the clean water that flows from it. Loss of biodiversity has an even greater cost when it involves the extinction and irreplaceable loss of a species that could provide medicinal services[22] and / or other services.

2.1.2 Biodiversity and ecosystem services

The goods and services provided by nature are called ecosystem services. Besides providing the essential food and water supplies needed for survival, they also include services such as water purification, cultural and medicinal benefits. In 1997, the annual value of global ecosystem services was conservatively estimated to be USD 32 trillion, almost double the global GDP.[23]

The Millennium Ecosystem Assessment[24] defined the following categories of ecosystem services:

- Provisioning services provide food, water, raw materials, biofuels, and medicinal resources.

- Regulating services regulate the quality of air, soil and water, provide flood and disease control, provide pollination services and regulate pests and prevent disease.

- Habitat or supporting services provide living spaces for plants or animals; they also maintain a diversity of different breeds of plants and animals.

- Cultural services include the non-material benefits people obtain from contact with ecosystems, including aesthetic, spiritual, educational and psychological benefits; public health; and recreational opportunities.

The Economics of Ecosystems and Biodiversity (TEEB) is an initiative to highlight the global economic benefits of biodiversity. The study resulted from a decision made by the environment ministers of the G8+5 countries at a meeting in Germany in 2007 to "initiate the process of analysing the global economic benefit of biological diversity, the costs of the loss of biodiversity and the failure to take protective measures versus the costs of effective conservation".[25] The TEEB approach is to use an economic approach to environmental issues, which helps decision makers to make an informed use of scarce ecological resources.

TEEB's approach:

- Provides information about the benefits and costs of ecosystem services;
- Creates a common language for decision makers, thereby allowing the value of natural capital to be visible and mainstreamed in decision making;
- Emphasizes the urgency of action by showing that prevention of biodiversity loss is cheaper than restoration or replacement; and
- Generates information about value to guide designing policy incentives.

Humans are dependent on these ecosystem services for survival, but natural habitats continue to be lost and biodiversity continues to be threatened. The TEEB approach aims to change this by assessing the costs and benefits of conserving and sustainably using biodiversity and ecosystems, and then using this assessment as a tool to guide biodiversity management. The TEEB study advocates a tiered approach in valuing biodiversity.

The first tier is recognizing value in ecosystems and natural features, which may include features with cultural or spiritual significance.

The second tier is to demonstrate the value in economic terms so that decision makers can weigh up the costs and benefits of a particular ecosystem service, for example using a natural system to control floods vs. building concrete flood defences.

The third and final tier is to incorporate the values of ecosystems into decision making through incentives, as well as through liability for environmental damage.

Further reading: For more information about TEEB see www.teebweb.org.

2.1.3 Climate change results in conditions of uncertainty

Climate change is giving rise to temperature increases; extreme weather patterns; changes in rainfall supply and intensity; increased risks of flooding and fire; and sea level change. This means cities operate in an increasingly unpredictable world. Urban resilience refers to a city's ability to cope with external shocks, as well as its ability to adapt to change.

Using the broader definition of the term, a resilient city has economic resilience (is able to adapt to economic challenges), social resilience (is inclusive), environmental resilience (is able to adapt to environmental challenges) and governance resilience (is able to adapt to changing governance structures).[26] The health of the natural environment impacts on the economy and society as a whole, and is of equal or greater importance than short-term economic growth.[27]

A resilient city is one that strives to be accountable for its resource use and monitors the following:[28]

- Water, electricity and energy consumption;
- Efficiency interventions to improve the productivity of resource use;
- "Unaccounted" water (water that is "lost" before reaching its intended customer because of leaks, theft, or other reasons);
- Renewable energy generated per energy source;
- Amount of waste generated and recycled per type;
- Greenhouse gas emissions per sector;
- Urban food flows and food security;
- Identification, conservation and management of ecosystem services.

2.1.4 Biodiversity and climate change

Climate change is affecting biodiversity and ecosystem services and, according to the Millennium Ecosystem Assessment of 2005, it will probably be the major cause of biodiversity loss by the end of this century.[29] The Secretariat of the Convention on Biological Diversity's (SCBD) summary of the key findings on biodiversity and climate change includes the following points:[30]

- For every 1˚C rise in global mean surface temperature there is an increasingly high risk of extinction of 10 per cent of species assessed so far.
- Ecosystems such as wetlands, mangroves, coral reefs, Arctic ecosystems and cloud forests are vulnerable to climate change.
- Climate change will have predominantly negative impacts on the ecosystems and services that are essential for human survival.
- Ecosystem-based approaches that incorporate biodiversity and the provision of ecosystem services into adaptation strategies have many benefits and help maintain resilient ecosystems.

Biodiversity is affected by climate change in a number of ways. Temperature change, rainfall frequency change, sea-level rise and unpredictable weather are all examples of first-order impacts, while second-order impacts include increased invasion by alien species and increased risk of fire.[31]

In order to develop mitigation and adaptation strategies, local governments need to assess the vulnerability of biodiversity to climate change, and integrate

climate change risk into local biodiversity strategies and action plans.[32]

2.1.5 Biodiversity and climate change mitigation and adaptation

Biodiversity can help people adapt to climate change, as well as mitigate climate change. Adaptation is "managing the unavoidable" while mitigation is "avoiding the unmanageable". Coastlines planted with mangrove forests have been found to survive the effects of tsunamis better than those that did not have forests, which means that the restoration of mangrove forests could be an effective climate change adaptation mechanism.[33] Similarly, because plants absorb carbon dioxide, store carbon and give off oxygen, the conservation of natural forests is an important carbon sequestration strategy that can assist biodiversity and mitigate climate change.[34] Biodiversity and urban green areas are important for urban climate change adaptation strategies by, for example, cooling and hence decreasing the urban heat island effect and absorbing water in times of intensive rainfalls.

2.1.6. Biodiversity, water and waste

Life is dependent on water and the quality and supply of water is in turn dependent on healthy ecosystems.[35] The supply and purification of water are two extremely important ecosystems services performed by water catchments and the natural vegetation that lines watercourses and wetlands. Waterways create a network across the landscape and promote biodiversity by providing connected habitats for both plants and animals.

The dumping of waste into the environment threatens biodiversity as natural carrying capacities are increasingly overwhelmed by excessive development. New thinking on resource flows and waste disposal will result in more circular metabolisms in cities. Because cities contain most of the world's population, and are therefore most responsible for the waste that is generated annually, local governments have a key role to play in changing the way urban residents use resources and dispose of waste.[36]

2.2 Urban sprawl gives rise to unsustainable patterns of development

The growth of cities has given rise to patterns of development that have different impacts on the efficient functioning of the city. Forman[37] studied 38 urban regions from 32 countries and identified spatial patterns that are more, and less, successful in maintaining biodiversity and ecosystem functioning. Common, but less successful, patterns include urban sprawl and uncontrolled development along transportation corridors. The urban sprawl pattern is typically low-density development that accommodates people who want a large plot of land, but it also increases the distances that they need to commute to work. This pattern favours car owners and discriminates against the urban poor who have high transport costs and diminished access to employment opportunities. Increased traffic congestion and travelling distances lead to greater levels of pollution and emissions that cause climate change; they also result in lowered local air quality, which has a severe effect on public health, for example in Beijing, China. Urban sprawl is a spatial pattern common in developed countries with wealthy market economies, but it also occurs in fast-growing cities in developing countries.[38] A second common spatial pattern is uncontrolled development along transportation corridors,[39] which fragments the landscape, often disrupting natural systems that act as corridors for wildlife[40] (and along which regional transport corridors frequently run).

Forman concluded that two patterns of growth, "satellite cities" and "compact concentric zones" are beneficial for both humans and natural systems, largely because they preserve a greater number of large patches and green spaces for ecosystems while, at the same time, they provide for human development.[41] Efficient public transport is key to supporting efficient, compact, urban forms and reducing emissions. Research shows that the "compact city" (see Leveraging Density guide) model has lower per capita carbon emissions as long as efficient public transport is provided at both the metropolitan and regional levels.[42]

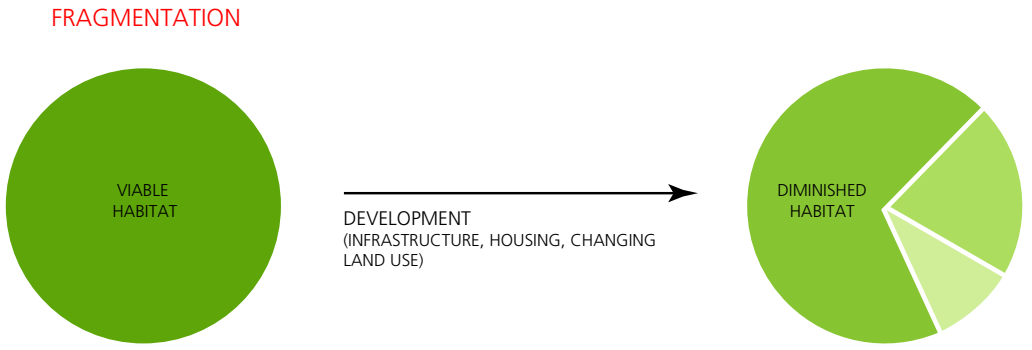
2.3 Fragmentation

When roads, infrastructure, housing and agricultural activities cut through the landscape on the outskirts of a city, areas that previously provided viable habitats for different species are fragmented into smaller and smaller parcels of land. This fragmentation of an area disrupts ecosystems and natural processes, such as the movement and interaction of animals, plants and water; genetic exchange; resource access; and water flow. Avoiding fragmentation of a landscape can protect valuable ecosystems services and biodiversity hotspots while increasing resilience to some natural disasters. It can also ensure that the benefits of these accrue to the city and its people.

Urban development in rapidly urbanizing situations puts pressure on land and its associated ecosystems. Sometimes these pieces of land are seen as marginal (for example, wetlands) but can be key components of productive ecosystems and thus the landscape mosaic, which - properly integrated into urban systems - can bring substantial benefits. This means that development can end up fragmenting the landscape and disrupting natural systems. As cities grow and put pressure on ecosystems, it is essential that an approach to city development that focuses on the region as a whole (and not just the urban area) should be adopted. The landscape mosaic spatial pattern, which works at the regional scale, can benefit the functioning of cities and ultimately positively enhance the life of the city dweller, while maintaining ecological processes and protecting valuable resources.

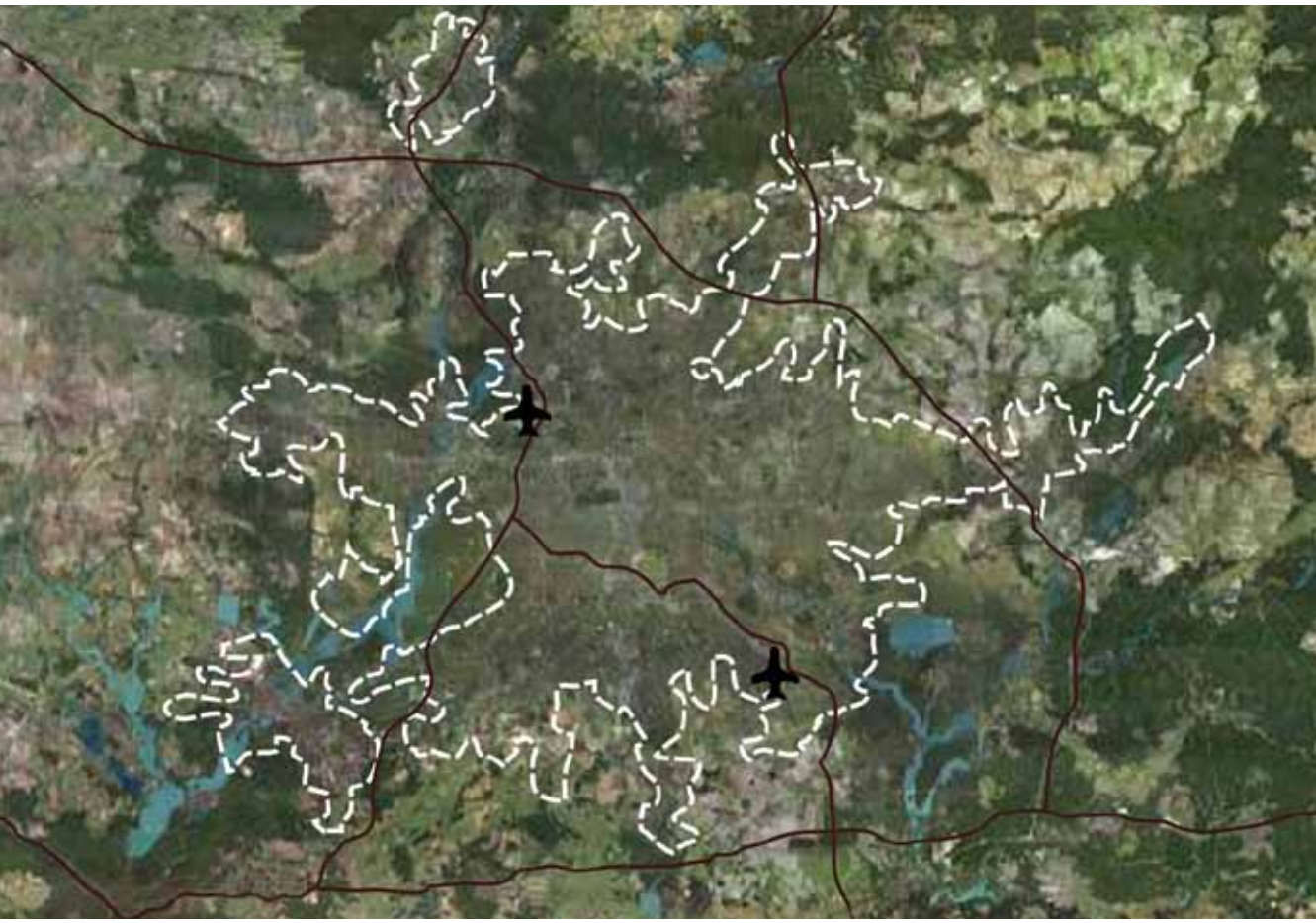
In summary, safeguarding ecosystems involves understanding how those systems work. Ecosystems provide valuable services for humans, including provisioning services (e.g. providing food, water, raw materials, fuel and medicinal supplies); regulating services

Figure 2.1: **Fragmentation leads to diminished habitats.**



Source: Forman, R.T.T. (2008). Urban Regions: Ecology and Planning Beyond the City. Cambridge University Press, Cambridge/New York

(e.g. regulating the quality of water and air); supporting services (e.g. habitat areas); and cultural services (e.g. recreational benefits of access to nature). Making the benefits explicit helps decision-makers understand why they should be preserved. At the same time, biodiversity hotspots should be protected for purely ecological reasons.



Berlin is composed of high to medium dense settlements which are well serviced by local and regional public rail and roads. This development pattern accommodates 3.5 million residents along with peri-urban agriculture and a mosaic of natural areas, many of which are protected © Google

Landscape Mosaic Patterns

3

The city is an urban system that grows within a set of interlinked natural systems.[43] Human survival is dependent on this network of processes. The city should be seen as part of a living and productive landscape from which humans draw benefits and to which we should feed waste in a manner that maintains the integrity of the system as a whole. Urban expansion should be prepared for and managed by mapping and protecting systems that are the result of socio-ecological processes and allowing these systems to inform urban expansion, instead of trying to impose a standard model of spatial development onto a landscape. Waldheim[44] argues for a new approach to city planning:

"Landscape urbanism describes a disciplinary realignment currently underway in which landscape replaces architecture as the basic building block of contemporary urbanism. For many, across a range of disciplines, landscape has become both the lens through which the contemporary city is represented and the medium through which it is constructed."

This new lens approach means starting with a map of the natural systems and appreciating the services that these systems provide us within a city and a region. Along the lines of Waldheim's landscape urbanism, Kongjian Yu argues that "ecological urbanism" is a necessary strategy for survival, entailing the recognition of the land as a living system and identifying an ecological infrastructure that will guide urban development. Landscape ecologists define a "landscape mosaic" pattern as a grouping of large areas of land connected by corridors that allow built and natural networks to exchange with one another in ways optimal to the functioning of both.[45] This spatial pattern allows for both humans and nature to thrive, because some areas are designated for development but others are preserved as habitat, and natural systems are accommodated and encouraged to function within the pattern.

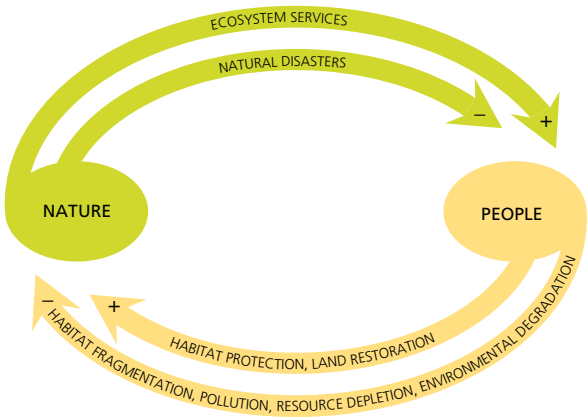
3.1 What is a landscape mosaic pattern?

Richard Forman's research examines the spatial patterns and relationships that best equip us, and nature, to survive and thrive. He defines urban ecology as "the study of the

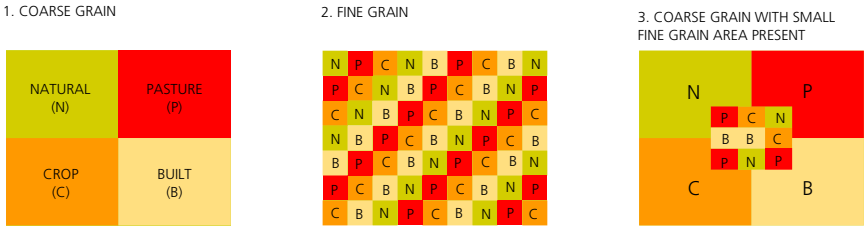
interactions of organisms, built structures and the natural environment, where people are aggregated around a city or town".[46] Most cities have a built-up core area surrounded by less-dense suburban and peri-urban land uses, often contributing to sprawl. In most cases, the line between the urban area and the rural area is hard to pinpoint.

Figure 3.1: **Principles to plan for nature in urban regions**

A) CLASSIFICATION OF NATURAL AREAS



B) EFFECT OF PEOPLE ON NATURE AND VICE VERSA



C) GRAIN SIZE AND LANDSCAPE

Source: After Forman (Forman, R.T.T. (2008). Urban Regions: Ecology and Planning Beyond the City. Cambridge University Press)

Forman raises the question of whether it is better for humans to live in a coarse- or fine-grained landscape. The coarse-grain landscape is one that has large patches that support specialization, while the fine-grained landscape has many small land uses that appeal generally. Forman argues that the landscape with the benefits of both would be a mosaic landscape with large patches and some finer-grained areas within it. The benefits of this design include a wide range of land uses; transportation time and cost is limited; and diversity and specialization are accommodated. He categorizes nature into four sections:

- A "natural" area, for example a wilderness area or forest;
- A "semi-natural" area looks like a natural ecosystem but is often degraded, for example a city park;
- An "intensive-use green space" is a heavily adapted landscape, for example a golf course or a farm/rural agriculture; and
- A "built" area is a typical cityscape with residential and office buildings and roads.

These categories can be used to classify the environment during the planning process. Forman states that the relationship between people and these areas determines the level of degradation of the environment. While nature has a positive effect on people (and sometimes negative, for example natural disasters) and people sometimes have a positive effect on nature (when an area is restored), the most significant impact is the negative effective that humans have on nature. From this, Forman concludes that a fine-grained intermixing of people and nature would lead to the transformation of the environment into intensive-use green spaces and built areas and the complete destruction of natural areas.

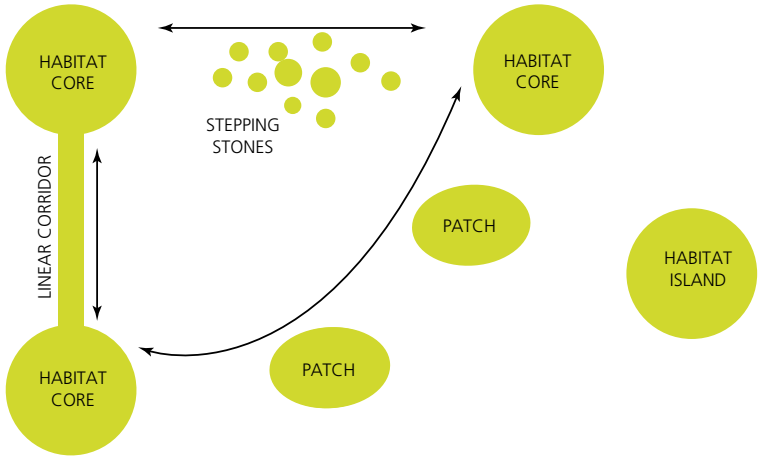
The function of an area is informed by the landscape infrastructure or pattern. Human and ecological conditions are affected by the patterns and processes at three scales: regional, patches, and site. The patterns differ across the scales, and the movement of species across the landscape is affected by the size of the habitats and the species population. A coarse-grained landscape incorporating fine-grained areas provides a better range of habitats than a single type of grain. A range of elements makes up the mosaic, including natural systems, biodiversity hotspots, agricultural land, hazardous areas and developed area (housing, transport routes etc). Forman argues that a "patches and corridors" approach is one way to connect these systems, allowing for continuous links that enable a city to grow around the natural systems.

In terms of biodiversity, green corridors (as opposed to transport or infrastructure corridors) in the land mosaic provide a connectivity, which allows species to move between areas. While some species can tolerate moving between small patches, others need linear corridors, the widths of which depend on the species and the surrounding developments. Modified habitats can function as corridors, for example Barcelona uses parks and tree-lined streets as part of its corridor network, and Johannesburg uses protected wetlands and rivers as part of its corridor network.[47]

Putting an economic value to these system services highlights the role that they play in the region as a whole. The "patches and corridors" approach protects elements of the natural landscape, such as aquifers, stream headwaters, large-home-range species and viable populations of species. Forman states that in this approach, important goals

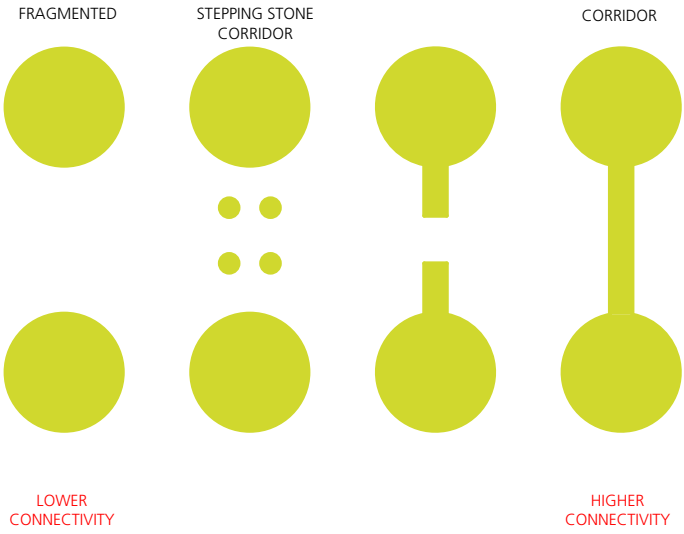
include a grouping of large natural patches or "emerald islands" as well as vegetated corridors between the patches to provide connectivity.[48] Having these patches and corridors reduces local extinction and increases decolonization, which improves a species' chances of survival.

Figure 3.2: **Patches and Corridors.**



Source: After Forman (Forman, R.T.T. (2008). Urban Regions: Ecology and Planning Beyond the City. Cambridge University Press)

Figure 3.3: **Connectivity.**



Source: After Forman (Forman, R.T.T. (2008). Urban Regions: Ecology and Planning Beyond the City. Cambridge University Press)

Forman puts forward the Multiple Species Conservation Plan (MSCP) for San Diego as a good example of an ecologically focused regional plan. It had a clear environmental goal, which was to protect biodiversity. The plan included an agreed map and a strategy to protect a network of green patches and corridors. It identified the areas that needed to be protected in order to ensure biodiversity, and it removed ecological constraints on development elsewhere in the region. This meant that developers were able to invest in areas outside the network and administrative delays were reduced. Crucially, the government provided funding for land acquisition and management, and it managed the process so that both parties were protected if new information meant that the map needed to be changed. Ten years after the plan was developed, two-thirds of the areas identified as needing protection, remained protected.

3.2 Key concepts of the patches and corridors model

Patches and corridors are the key spatial concepts and interventions for increasing connectivity and preventing fragmentation.[49]

For more information see Forman, R.T.T. (2008). Urban Regions: Ecology and Planning Beyond the City. Cambridge University Press, as well as Jaeger, J.A.G. and Madriñán L.F. (2011). Landscape Fragmentation in Europe. Joint EEA-FOEN report.

3.2.1 Patches

The key factors regarding patches are:

- The size and shape of a patch affect how well a patch can function on its own or in relation to other nearby patches. Large patches provide larger habitats and are more effective in protecting water systems. The shape of a patch is important; rounder patches with a smoother edge provide a greater core area than long, thin patches or those with jagged edges.

- Patches help to conserve natural habitats and should be defined in biodiversity hotspots. Patches help to conserve species by protecting a representative area of a species and allowing for reproduction of the species.

- Natural systems such as wetlands can be protected by the definition of a patch around the system.

3.2.2 Corridors (natural or green)

- The key factors regarding corridors, natural processes and networks are:

- The shape, size and relationship of the areas between patches affect the opportunities for movement of species, genetic exchange and the viability of species.

- Patches and the corridors between them affect the flow of water. Natural vegetation alongside river systems protects against erosion, minimizes downstream flooding, keeps aquifer groundwater clean and facilitates wildlife movement.

- The width and connectivity of a corridor between patches affects the ability of a corridor to act as a conduit, filter (or barrier), source, sink and/or habitat. Species use small patches as places to rest along a corridor and as stepping-stones between larger patches. Where there are habitat differences between a patch and a corridor there is a reduction in species movement across the landscape; where there is

heterogeneity of microhabitat there is an increase in the species pool.

- An area that has a network of large natural patches and connecting corridors has a high degree of connectivity. Areas that have this connectivity tend to have a greater diversity of species. There is a greater diversity of species in an area that has a high degree of connectivity.

3.2.3 Movement

- When roads are built they fragment a landscape, they can destroy habitats and can act as barriers to the movement of animals and natural systems such as water systems. Providing highway underpasses and overpasses helps to reduce fragmentation by allowing the movement of water and animals. Roadsides can be excellent migration routes for species.

- The bundling of roads close together allows for patches to remain large, which is preferable to a number of different roads crisscrossing and fragmenting an area into small patches. A road should be placed parallel to an existing railway line so that the transport routes are bundled.[50] The barrier effect of a bundle of road and rail routes is greater than that of a single route, but a bundle reduces the fragmentation of the surrounding area. Underpasses or overpasses can help mitigate this effect.

- The upgrading of existing roads should be prioritized over the building of new roads. Widening an existing road increases the barrier effect, but this is preferable to building new roads that contribute to further fragmentation of the landscape.

- Bypasses should be located close to human settlements to reduce the fragmentation of the surrounding landscape and keep patch sizes as large as possible.

- Roads that are under-used or unnecessary should be closed and the infrastructure removed to facilitate the movement of species and water across larger patches.

- Corridors linking parks creates a pedestrian network of parks that facilitates the movement of people and species between the parks.

3.2.4 Communities and development

- Development needs to be located in areas of low ecological value to protect ecological processes that provide ecosystem services.

- Protecting natural areas of high hazard risk reduces the risk of community disasters.

- Compact development increases access to the opportunities available to a community, such as employment, education and access to markets.

- Public transport is supported by higher densities.

- Infill development on green spaces should be carefully considered as it may reduce the opportunity for species movement across a park and patch network.

- Implementing measures to manage urban environmental resources that prioritize long-term benefits is cost effective and supports sustainable development. For example, reducing impermeable surfaces limits runoff and the pollution of water

sources, recharges groundwater and sustains streams. The need for piped connections is reduced when storm water is channelled into natural vegetation and drainage systems. Wetlands have a number of benefits such as recreation, biodiversity, flood control and pollutant absorption.

3.2.5 Landscape changes

- The landscape is affected and changed by human activity. Urban sprawl surrounding a city fragments the landscape and degrades natural resources. Compact cities aim to increase built area and residential population densities; to intensify urban economic, social and cultural activities and to manipulate urban size, form and structure and settlement systems in search of the environmental, social and global sustainability benefits, which can be derived from concentration of urban functions. Compact cities and directed urban growth cause the least resource degradation because they have a smaller footprint and the growth is directed to areas of low ecological significance.

- The effects of change on ecological systems are not always apparent immediately as they may take time to emerge.

- A land-use plan should be flexible and accommodate potential changes as well as regional and local needs across scales.

The Municipality of Uberlândia in Brazil grants authorization for construction to private developers only within the perimeter of the city's ring road. The urban planning idea is to develop the city so that all vacant lots are filled before authorizing either verticalization of new buildings or the development of rural areas. Many lots, which are used by locals for agriculture until they are sold, remain available very close to the city centre © UN-Habitat/Alessandro Scotti

Promoting a Landscape Mosaic Pattern

4

This section provides a range of broad principles designed to promote a landscape mosaic.

4.1 Identify strategic landscape patterns to safeguard the critical ecological process

The mapping of strategic landscape patterns allows planners to protect valuable ecosystem services and biodiversity hotspots, while increasing resilience to some natural disasters. Biodiversity assessment involves mapping existing biodiversity (and productive green spaces which support ecosystem functioning) within a region and the collection of data. Biodiversity planning then sets targets for biodiversity conservation,[51] including protection of the ecosystems and habitats. Both processes should be on-going within a management system informed by monitoring, evaluation and review. Once the ecosystem services and biodiversity hotspots have been identified and mapped, it is far easier to make informed decisions about where urban development should and should not occur. A good analysis of all natural systems should be kept updated and GIS should be used for storing and manipulating spatial data as well as for monitoring and evaluation purposes.

Planning of Ecological Infrastructure across scales (adapted from Kongjian Yu)	
Regional scale	Identify, prioritize and protect strategic landscape patterns to safeguard critical ecological and natural processes.
City scale	Extend regional ecosystems into the urban fabric and use parks and natural features to create a fine-grained network
Local / site scale	Identify and protect patches and corridors.

Case study: Watershed management, New York City, United States

The case study on New York's approach to ensuring supplies of clean water provides an excellent example of the importance of identifying strategic landscape patterns, and how ecosystem services can be embraced to save money on infrastructure. About 90 per cent of the water used in New York City comes from the Delaware-Catskill water system, about 193 km north of the city. Over a 12-year period, the city purchased land and subsidized best management practices for the watershed, avoiding the need for extensive filtration of its upstate water supply. (Full case study in Section 6.)

Case study: Valuation of ecosystem services in Cape Town, South Africa

The case study on Cape Town's valuation of ecosystem services documents how the city has calculated the contribution of its ecosystem services to its economy, which is helping to strengthen arguments for investments in environmental protection. Cape Town's natural areas are under pressure from land transformation, pollution and alien invasive species and are in need of increased investment and management effort. The city's Environmental Management Department assessed the possible economic returns on increased investment in, and protection of, natural assets, and this showed the huge value of ecosystem services. In an example of cooperative city management, the department engaged with all the other departments in the city's management structure and involved them in the valuation process. (Full case study in Section 6.)

4.2 Highlight the economic and cultural value of ecosystem services

This Quick Guide has already highlighted the "TEEB" approach, which uses an economic approach to environmental issues so that decision makers can determine the best use of scarce ecological resources. Kongjian Yu[52] argues that ecological infrastructure works to safeguard critical eco-services by:

- Providing food and water;
- Regulating climate, disease, flood and drought;
- Supporting habitats for indigenous plants and animals; and
- Providing spiritual and recreational benefits.

4.3 Work with ecological processes

Planners need to work with ecological processes, for example flood/storm water, instead of against them. Flood control can be managed using ecological systems instead of conventional engineering, as was done in the Yongning River Park Project in China. There, native grasses replaced the concrete flood control measures and both locals and tourists appreciated the new park-like river's edge.[53] Settlements should be kept away from hazardous areas and growth prevented from spreading onto sensitive areas of ecological importance (not only to prevent natural disasters, but also to protect sensitive natural systems). Ecosystems that have been weakened by urban fabric can be restored, albeit with some artificial help, as was done in Seoul's Cheonggyecheon River Restoration Project.

4.4 Adopt an integrated planning and management approach

The urban environment is the site of complex economic, political, social and cultural relations, that are constantly shifting and changing, and as such, needs a range of

viewpoints and approaches.[54] In order to imagine an alternative vision of the city to the one that is most generally accepted now, a new approach needs to be adopted, one that is able to accommodate the conflicting needs of these relationships. This approach means working across a range of scales, and incorporating the views of people who might disagree with each other. As pointed out by Charles Waldheim,[55] the challenges of the city do not respect disciplinary boundaries. There is a need for a new, interdisciplinary language, and with this new language would come the imperative to consider city management and planning as a multidisciplinary task with a shared vision and as an opportunity to improve the quality of life for all citizens. Planners need to prepare a long-term, adaptable, planning framework in collaboration with other experts and stakeholders, and they need to seek consensus on common goals. It is necessary to work together to proactively guide urban development and use spatial strategies, such as compact cities, satellite cities and the urban edge (rather than allowing unguided sprawl). This approach needs to be discussed and refined by local urban practitioners and a champion(s) needs to be identified to drive the process.

Planning policies, standards and legislation will also often need to be reviewed to accommodate the desired urban growth. A catalytic project designed to support the desired urban growth should be selected to test and demonstrate the approach.

Case study: Commitment to biodiversity and ecosystem habitats: Zagreb, Croatia

The city of Zagreb has experienced rapid and dynamic urban development over the last few decades, but has managed to safeguard its biodiversity and ecosystem habitats. The physical location of the city, its history and cultures are intricately linked to its biophysical setting and associated ecosystems. The city made a concerted effort to involve a wide range of stakeholders in the protection of the city's biodiversity. (Full case study in Section 6.)

Case study: Magat Watershed - A co-management approach in Nueva Vizcaya, Philippines

The case study on the Magat Watershed in Nueva Vizcaya documents the move from a traditional watershed management approach to the country's first watershed co-management model, piloted in the Lower Magat Forest Reserve in 1998. The Memorandum of Agreement (for 25 years and renewable for another 25 years) was between the local government units of Nueva Vizcaya, the Department of Environment and Natural Resources, individuals, associations, cooperatives and corporations. Using this innovative, holistic approach, the local government units were able to protect and manage the watershed in partnership with local communities. (Full case study in Section 6.)

4.5 See the city as a living system

Andreas Branzi's Seven Suggestions for a New Athens Charter[56] suggests that people should practise a "cosmic hospitality", and lose their anthropocentric view; they should rather see the city as a place to accommodate humans and animals, technology and the sacred, and biodiversities. Urban planners need to see the city as a living system[57] and identify the ecological infrastructure that is essential for protecting ecological and cultural processes.

4.6 Make open spaces productive

Urban agriculture is practised throughout the world, both on privately owned land and on public space, with or without permission. Making open spaces productive offers the urban poor a chance to supplement their diet and/or their income, but it is not only the urban poor who can benefit from urban agriculture. Kongjian Yu[58] writes that universities in China have traditionally been landscaped with ornamental lawns and flowers, but the Shenyang Architectural University Campus was designed to be productive. Storm water was directed to a pond, which acted as a reservoir to water rice paddies. Open classrooms were situated amongst the rice paddies. Frogs and fish were farmed in the paddies. The project demonstrated that agriculture could be part of the urban environment and be aesthetically pleasing at the same time.

Case study"StEPKlima" - The ecological utility of green-spaces in the context of climate change, Berlin, Germany

In Berlin, the "StEPKlima" has already demonstrated the significance of existing urban green spaces and parks for the improvement of climactic conditions, for centrally-placed leisure opportunities, for protection of water resources, and for the maintenance of habitat for animals and plants. The ecological benefits that derive from the largest park in the city, the Tiergarten, provide a model for future planning and argue for the safeguarding of green spaces. These areas play a key role in adapting to the negative effects of climate change and to the improvement of living conditions in the city. (Full case study in Section 6.)

Urban agriculture results in a reduced farm-to-table distance; accommodates small-scale farmers; and is close to markets. It also provides city dwellers with a respite from urban stresses, which has social, cultural and psychological benefits.

4.7 Recycle, reclaim and reuse urban spaces

As the needs of a city change, the spaces in that city need to be recycled. Andreas Branzi's "New Athens Charter" describes a city of the present rather than the future, one that has to accommodate the demands of globalization, diffuse work and the environmental crisis. This city is a city with faults and contradictions; it requires flexibility in its structure to allow constant reshaping and replanning to deal with its permanent state of crisis. Branzi makes a number of suggestions regarding flexible spaces and advocates fostering the reuse of existing estates; the building of reversible facilities that can be dismantled and changed to accommodate unexpected new activities; and buildings designed with crossable perimeters so that a function of a space is not predetermined.[59]

Case study: Towards mainstreaming urban agriculture into land use planning in Dar es Salaam, Tanzania

In Dar es Salaam, urban agriculture has been developed and promoted as an income earner as well as a food source at the subsistence or household level. Food security was a national concern following droughts in the 1970s and 1980s, and the government supported urban agriculture in a bid to encourage households to be self-sufficient. The challenge has been to regulate the largely informal urban agricultural activities so that natural systems such as river valleys and wetlands are not compromised. (Full case study in Section 6.)

Kongjian Yu[60] provides an example of successful recycling of an industrial area into a public park. The Zhongshan Shipyard

Case study: Cheonggyecheon River Restoration Project, Seoul, Korea

The case study on Seoul's Cheonggyecheon River Restoration Project demonstrates how a natural system can be reclaimed and revitalized. During the 1960s, the Cheonggyecheon River, which ran through the centre of Seoul, was covered in concrete and replaced with a four-lane, elevated freeway as part of a modernization process. When the city authorities changed their focus from accelerated industrialization and modernization to sustainability, health and social responsibility, the restoration of the river was seen as an opportunity for urban renewal. The freeway was dismantled and the Cheonggyecheon Restoration Project created a 5.8 km landscaped green pathway alongside the revitalized Cheonggyecheon stream. The project was completed in 2005. With over 17,000 people per square kilometre in this densely populated city of 10 million people, the green pedestrian pathway has become a major recreational area for city residents. The government supported the project by providing funding to local merchants and the project has reinvigorated a run-down section of the city. (Full case study in Section 6.)

in China was built in the 1950s and went bankrupt in 1999. The shipyard was greened and transformed into a public park, which is used by the local community and is a popular site for weddings.

4.8 Make the process transparent and inclusive

It is vital to include citizens and stakeholders in the planning process, so that there is a shared understanding of the importance of biodiversity conservation and management, and a common vision of what needs to be done. Planners need to work with non-governmental organizations, academics and stakeholders to share information and resources, and to make the process inclusive. They need to engage with the local community to highlight the economic and cultural value of natural systems so that there is a shared understanding of why natural systems need protection.

The internet can be used as a tool to make the planning process a platform for information, communication, public participation, marketing, public relations and education. Developing a communication strategy to raise public awareness, and compiling and maintaining stakeholder databases are important tools to increase public participation. The city of Bonn raises awareness of conservation issues by encouraging its residents to experience biodiversity in its open areas. It has a bi-monthly report on environmental issues, runs a hotline to answer questions on environmental issues and offers nature-based courses and excursions.[61]

The project named Parque Linear Rio Uberabinha (Linear Park of the Uberabinha River) is part of a landscape design operation launched by the Municipality of Uberlândia, Brazil, for the reclamation of the areas of the city crossed by the river Rio Uberabinha. Previously abandoned, the area covering the Parque Linear has now been redesigned and hosts a permanent track for running and/or cycling
© UN-Habitat/Alessandro Scotti

Implementing Sustainable Urban Growth

5

There are three elements to the planning and management of the regional landscape: an inventory of what natural capital exists; an assessment of which natural systems are critical for the healthy functioning of ecosystem services and therefore need protection; and mapping which areas can be developed, and under what conditions. The principles presented in the previous section should inform the use of the following planning tools.

5.1 Plan on a tier of levels

While there is a need to plan across scales, the focus here is on the regional scale because ecosystems do not operate in isolation, but impact on a number of systems across a region. A wetland, for example, is affected by water usage and pollution upstream, so the study area should be widened to the regional level.

An important element is to show the levels at which a plan can be implemented most effectively, and it is essential to view the interaction of the plans across levels or tiers.[62] In Germany, for example, landscape programmes are prepared for entire regions and include objectives and guidelines for nature conservation policy as well as spatial descriptions (see figure below). These are then coordinated alongside landscape structure plans, which define regional management objectives, requirements and measures in more detail, as well as local landscape plans that show land use planning objectives.[63]

In South Africa, there is a strong emphasis on spatial planning at various levels. The country also has a National Spatial Development Perspective with guidelines for investment in social and economic infrastructure. At the municipal level, an Integrated Development Plan incorporates a Spatial Development Framework. This range of levels presents an opportunity to incorporate spatial information on biodiversity priorities across the spatial planning scales.[64]

5.2 Plan on an efficient modular basis that can be updated

Landscape planning should be viewed as a dynamic process that has to contend with continuously changing information. A modular approach allows for information to be updated easily and efficiently, and

technology such as GIS is especially useful in this regard. Updating a module of information quickly and connecting it to other modules allows for a more rapid response to changing circumstances and requirements.

The first step is to document and assess what actually exists in a region. Biodiversity varies across the landscape and a spatial assessment of biodiversity should be done at different levels - from national to regional and local. A spatial biodiversity assessment maps information about species, habitats and ecosystems, protected areas, patterns of land use, and possible future patterns of land and resource use.[65]

The Local Action for Biodiversity Guidebook: Biodiversity Management for Local Governments (ICLEI 2010) includes the following elements of biodiversity mapping:

- Do a desktop study of existing data and biodiversity history, assessing biodiversity within the regional and national contexts.
- Map and compile information about the open spaces within the city and region, as well as the corridors between them.
- Count and differentiate indigenous and alien species within the area. Do vegetation and animal surveys.
- Quantify how biodiversity has changed and possible reasons for this change.
- Identify which species have become extinct in the defined area and why.
- Identify and assess the ecosystem services in the defined area, and identify the areas critical to the continued functioning of the ecosystem service.
- Create a biodiversity map, either by hand using aerial photography or by GPS (global positioning system).
- Keep the biodiversity map regularly updated.

In undertaking the above, it is valuable and important to tap into indigenous knowledge and to use other local experts who have a close relationship with all or parts of the system.

Once the spatial information is mapped, one has a clear idea of what areas are critical for the functioning of ecosystem services and so should be off limits to development. The loss or degradation of habitat and ecosystems is the biggest cause of loss of biodiversity around the world. As a habitat is degraded, its functioning decreases, leading to the collapse of the ecosystem and loss of the ecosystem services and associated species. In South Africa, the National Spatial Biodiversity Assessment (2004) based an ecosystem's status on how much of its original area remained intact relative to different thresholds. The threshold beyond which an ecosystem became critically endangered varied from 16 to 36 per cent.

In Germany, a landscape plan is used to assess the existing condition of nature and the landscape as a whole is assessed against objectives. The BFN (2008) presents an exemplary structure of a landscape plan, which includes:

- Introduction (tasks and legal basis; spatial scope; action and implementation framework);
- Current uses and expected changes in use (human settlement; traffic; agriculture; water management; leisure and recreation; fishing and hunting, etc);

- Existing and expected condition of nature and the landscape (characterization; fauna and flora; soil types, surface waters and flood areas; groundwater; climate/air; diversity, characteristic features and beauty);
- Assessment of the existing and expected condition of nature and the landscape (biodiversity function; natural yield function; water resources functions; water pollution protection function, etc);
- Objective and development concept (objectives and spatial focuses);
- Protection, management and development measures (protection management and development of parts of nature and the landscape; concepts of measures; action proposals);
- Notes on implementation (priorities, strategies, instruments and funding; public participation; development programmes).

By anticipating future land uses, the landscape plan aims to describe the effects of use on the landscape and to classify them. The interaction between future uses and the environment can then be estimated and used by decision makers when making strategic planning decisions.

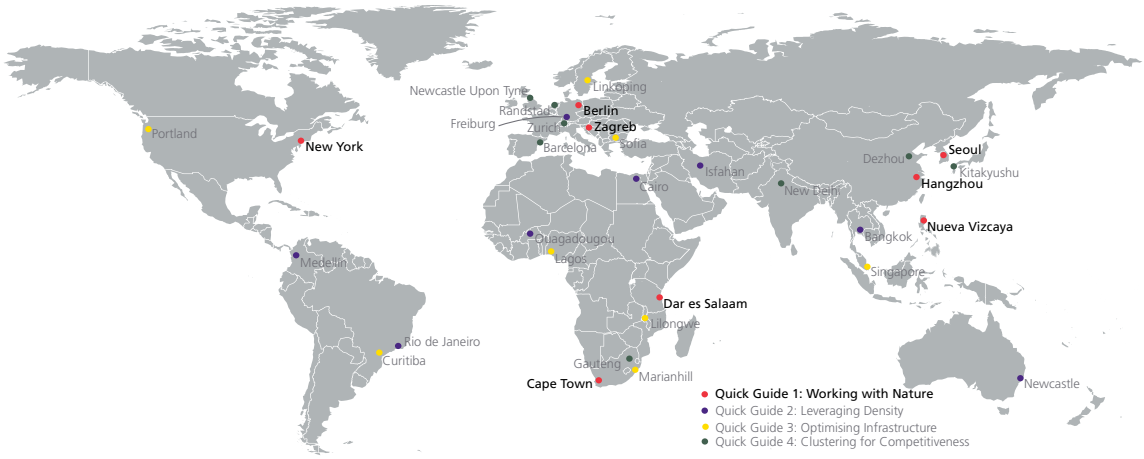
Table 5.1: The co-benefits of ecosystem-based planning

Interventions	Ecological Benefits	Economic Benefits	Equity Benefits
Protect large patches of natural areas	Conservation of habitats and biodiversity; increased connectivity between network of patches	Encourages natural storm water drainage (less run off), which can save on maintenance costs of these systems as well as costs associated with disaster management (floods)	Access to natural area, with associated cultural and recreational benefits
Manage water catchments	Natural systems and habitats protected	Saves on costs of installing alternative water purification infrastructure	Natural environment is protected to the benefit of all; and residents get access to clean water
Restore wildlife movement corridors	Increased species movement and connectivity	Short-term job creation	Broad support for life systems results in better access to nature.
Restore natural systems such as rivers/wetlands (e.g. via a brownfield development)	Restoration of habitats; improved biodiversity and ecosystem functioning	Short-term job creation; possible ecosystem services benefits (e.g. water purification)	Access to natural area, with associated cultural, economic and recreational benefits

Interventions	Ecological Benefits	Economic Benefits	Equity Benefits
Build roads close together (bundling of infrastructure)	Reduces fragmentation of natural areas and habitats; allows for animal bypasses at a single point for multiple transport routes	Saves on construction and service costs; savings on the cost of the land	Non-motorised and public transport prioritised; Improved infrastructure access.
Remove unnecessary roads separating or splitting large patches	Increased connectivity between habitats	Short-term job creation; encouraging less car dependency and more public and/or non-motorised transport (which will reduce the travelling cost for the individual). The land freed up can be sold or used for other public services with potential economic returns.	Land made available can be used for public services (recreational).
Upgrade existing roads rather than building new ones	Slows the fragmentation of the landscape and habitats	Saves on construction cost as well as on the cost of the land.	Opportunity to prioritise non-motorised rights of way and public transport

Interventions	Ecological Benefits	Economic Benefits	Equity Benefits
Prioritise dense, compact city development and directed growth	Protects the surrounding natural landscape and systems; Reduces reliance on cars and fluctuating oil prices and therefore has less of an impact on rural and agricultural land and resource consumption.	Time and cost savings relating to travelling for the individual through enhanced public transport services and decreased car dependency. Harnesses urban agglomeration advantages (i.e. grouping of firms because of access to large labour pools, social network relationships and knowledge spillovers. Encourages growth away from natural areas (i.e. steep slopes, in floodplains) thus reducing cost of disaster recovery efforts.	Increases access to social, educational and employment opportunities given that higher thresholds are achieved. Increases social inclusiveness and reduction of social segregation through designing quality mixed-used areas within walking distance.

Equity benefits require more detailed understanding but effectively these interventions will protect the global and local commons.


Newcastle Upon Tyne
Linköping
Randstad
Berlin
Freiburg
Zurich
Zagreb
Barcelona
Sofia
Portland
New York
Isfahan
Cairo
Dezhou
Seoul
Kitakyushu
Hangzhou
New Delhi
Nueva Vizcaya
Bangkok
Ouagadougou
Lagos
Singapore
Medellín
Dar es Salaam
Lilongwe
Rio de Janeiro
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Quick Guide 1: Working with Nature
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Case Studies

6

6.1. Towards mainstreaming urban agriculture into land use planning in Dar es Salaam City, Tanzania

Following droughts in the 1970s and 1980s, food security has been critical in Tanzania and has prompted the government to pursue a "cultivate or perish" approach to food supply in both rural and urban areas. At national and policy level, urban agriculture in Tanzania has been recognized as important for the availability of food in cities such as Dar es Salaam. In urban areas, government pronouncements favour urban farming that allows households to be self-sufficient in food production, and which, to a certain extent, mitigates the effects of drought in food growing rural areas. In Tanzania, urban agriculture is defined as those farming activities carried out in open spaces in built-up and peripheral urban areas, and includes the keeping of livestock such as dairy cattle, goats and chickens. Urban agriculture has significantly developed in Dar es Salaam in response to economic hardships experienced in the 1980s, when it subsidized incomes and supplemented sources of food at household level.[66]

In rapidly urbanizing cities, food security and the provision of food for a growing population is a crisis for urban dwellers and managers alike. The estimated annual population growth of Tanzania was three per cent between 2005 and 2010, while that of Dar es Salaam was 5 per cent, bringing the population to an estimated 3.3 million in 2010. The challenge with urban agriculture has been guiding and regulating the largely informal farming activities to avoid adverse health and environmental consequences to city dwellers and green spaces such as river valleys and wetlands.

Urban agriculture has been encouraged and integrated into various policies and by-laws in Tanzania, most notably in Dar es Salaam where it is now formally recognized as a land use. While urban agriculture was recognized as a potential land use in the 1979 Master Plan of Dar es Salaam, its stipulation was ineffectual. This was because the plan included urban agriculture mostly in fragile areas such as flood-prone areas, hazardous land and non-built up land especially in the urban periphery. Demand for informal housing and a lack of enforcement to prevent the encroachment of residential

developments into non-built up areas meant that the land was often subdivided for more profitable residential use instead of being used for farming.

Around 90 per cent of Dar es Salaam's vegetables are grown in open spaces and home gardens, with some sold to generate an income. City authorities, city residents and other key stakeholders recognized the important role played by urban agriculture in the economy of the city in generating employment opportunities and providing access to food.[67] As a result, it was officially included in Dar es Salaam's Strategic Urban Development Plan (SUDP) in 1992. This led to more concrete proposals and plans relating to urban agriculture in the SUDP and subsequent policies, building upon the plan's experiences.

The Strategic Urban Development Plan designates special land zones for different types of agriculture (Figure 1). The plan assigns areas to be used in the future for large- and medium-scale urban agriculture and includes development guidelines. Also, vertical expansion (as opposed to horizontal expansion, which encroaches upon valuable peri-urban land) is encouraged to free up land for urban agriculture and green spaces. This is a significant departure from earlier allocations of land for urban agriculture where vacant land meant for future uses was zoned for such activities without any guidelines. The proposed Dar es Salaam 2030 Master Plan builds on the framework of the Strategic Urban Development Plan in its proposals for urban agriculture activities. It identifies areas for different types of urban agriculture and encourages the formulation of urban agriculture strategies in each municipality, including the designation of areas (plots) of 0.8-1.6 hectares for residents' use.

The Dar es Salaam City Council is the custodian of the Strategic Urban Development Plan and has been responsible for implementing the strategies outlined in it. One strategy is the development and management of urban agriculture and, with this in mind, a working group has been formed to develop an action plan for urban agriculture. The group comprises of stakeholders from the Ministry of Lands and Human Settlements, Sustainable Dar es Salaam Project, the regional agricultural and livestock development officer; a city veterinary officer and some members of the Association of Farmers and Pastoralists who were involved in discussions to prepare the plan.

Several activities have been implemented, including:

(i) The development of Urban Vegetable Promotion Projects in designated districts of Dar es Salaam.

(ii) Training and support for vegetable and horticultural groups carrying out farming activities in open spaces and road reserves to facilitate income generation opportunities and temporarily protect such areas from invasion and dumping of waste.

Most of the sites for farming activities already existed as unused open-spaces, for example institutional land. The working group has provided support for training, group strengthening, self-organization as well as technical advice through agricultural extension officers employed by the Dar es Salaam City Council. Identified projects have been funded from external sources. For example, The Urban Vegetable Promotion Project, which ended in 2001, was funded by the German Government through the Ministry of Agriculture and Food Security.[68] The municipal councils have been responsible for providing personnel such as the agricultural extension officers. Municipal funding

limitations, particularly a shortage of funds for capacity building activities, make the continuity of projects a challenge.

Urban agriculture in Dar es Salaam city
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The zoning of urban agriculture land use, the establishment of working groups and subsequent action plans for the development of urban farming have served to highlight how critical urban agriculture is for food security and for the nation's efforts to alleviate poverty, particularly in urban areas. As a follow-up activity, the Sustainable Cities International Network - Africa Programme has facilitated the production of Municipal Strategies of Urban Agriculture in the three districts of Dar es Salaam. These have been submitted to the ministry responsible for land use for approval, and are being followed up with Municipal Councils. Once Municipal Strategies have been approved, the Dar es Salaam City Council plans to produce a city wide strategy based on the identification of suitable land. Urban agriculture is also acknowledged in several policies such as the Draft National Agricultural Policy (2010), the Draft Urban Development and Management Policy (2010) and the National Human Settlements Development Policy (2000).

This recognition of urban agriculture through the above policies and actions has:

(i) Helped to protect open spaces (such as slopes along river valleys and road reserves) for use in urban agriculture, rather than leaving it vulnerable to the encroachment of houses and city waste.

(ii) Improved the lives of both men and women in Dar es Salaam due to the additional income generated through the sale of food crops. Dar es Salaam's urban producers supply an estimated 95,000 litres of milk, 6,000 trays of eggs, and 11,000 kilograms of poultry to city residents every day. This ready market is a source for increases in income.[69]

(iii) Urban farming was the second largest employer engaging about 7 per cent of the 3 million people in Dar es Salaam in 2000.[70]

(iv) The use of open spaces and unbuildable land for urban agriculture (plants and forests) has a positive impact on air quality as well as on the aesthetics of the city. Well-maintained roadside horticulture is pleasing to the eye.

While special land zones were designated for urban agriculture in the Strategic Urban Development Plan, these were in green spaces and areas unsuitable for built-up development. When open spaces are used for urban agriculture, it is temporary and the farmer does not have any form of security or permit, and can be evicted at short notice. The Sustainable Cities International Network - Africa Programme is assisting the municipalities in Dar es Salaam to lobby for secure land tenure by requesting the government to allocate land for urban agriculture in the same way that land is allocated to residential developers.

Furthermore, since the activity is seen as temporary by local authorities it is not strictly regulated and, farmers, for example, have been known to use polluted sources for irrigation, raising public health concerns about the safety of the food products.

Figure 6.1: **Catskill/Delaware Watershed Map**

6.2. Watershed management, New York City, United States[71,72]

New York City's approach to ensuring supplies of clean water provides an excellent example of how ecosystem services can be embraced to save money on infrastructure. About 90 per cent of the water used in New York City comes from the 1,800 square mile Delaware-Catskill watershed, a non-filtrated water supply system consisting of 19 reservoirs and three controlled lakes that are about 190 kilometres north of the city.

The key pressure that necessitated the initiative was the rising cost of filtration requirements for New York City's drinking water supply, which serves nine million people daily from the Catskill-Delaware watershed. The federal Safe Drinking Water Act requires filtration of drinking water coming from all surface water sources in order to protect against waterborne disease. This Act, a key driver for change, can be waived if a water system provides safe water and is sustainably managed.[73]

The facilities required to filter the city's consumable water would have cost about USD 8,000 million to build, and between USD 300 million and USD 400 million each year to operate. To reach a more cost-effective solution, the city purchased land and subsidized best management practices for the watershed over a 12-year period. This avoided the need for extensive filtration of its upstate water supply and led to a reduction in project costs.

The city now invests USD 200 million a year on a non-filtrated integrated water resources programme that manages land use in ways that help keep the water supply clean and protect the watershed, ensuring sustainable growth. It is now the largest unfiltered water supply in the United States.

The timeline of the initiative spanned 15 years, in which the Department of Environmental Protection (DEP) and its partner agencies developed and implemented the monitoring and protection programme. The Environmental Protection Agency (EPA) concluded the New York City Watershed Memorandum of Agreement in 1993, but it was only signed in 1997 by multiple stakeholders, including city and state bodies and environmental and public interest groups.

The signing finally came to fruition when the Environmental Protection Agency issued a five-year Filtration Avoidance Determination and the city committed to channelling USD 1,000 million over a decade into remediating pollution sources and promoting sustainable economic growth in the watershed.[74] In 2007, the Filtration Avoidance Determination was extended until 2017, cementing the success of the programme's advances.

Central to the issue of protection of the water supply system is the question of sustainable land management and its impact on a healthy watershed. Throughout the eastern half of the United States, forest land is frequently subdivided and converted to other uses by owners with differing land-use objectives. This phenomenon, known as parcelization, has a negative impact on land stewardship capabilities and is also a significant driver of landscape fragmentation.

Parcelization and fragmentation are both major obstacles to sustainable forest management, because forestry requires relatively large tracts of open space to remain economically viable.[75] Parcelization poses a further threat to water quality, particularly in the case where a forest is replaced by new housing developments. In this case, nutrient loading occurs as a consequence of run-off from septic tanks, fertilizers, animal waste

and road salts. This is exacerbated by hard landscaping of surfaces that are unable to absorb liquid wastes.[76]

A key actor in rectifying the deteriorating forest landscape scenario was the New York State Department of Health, which, in 2007, took over the authority for the Catskill-Delaware water supply system. The state department drew on financial resources and a broad knowledge base through stakeholder involvement to launch programmes tasked with protecting the watershed, and which in practical terms qualified for a Filtration Avoidance Determination (FAD).

The MOA's goal to protect water quality and its economy was thus implemented via an institutional framework of protection programmes such as PlaNYC 2030.[77] Included in the policy adjustments was the requirement that the state-owned watershed area be enlarged. This was enabled by the use of brownfield sites and land-use conversions through the acquisition of environmentally-sensitive land in the watershed by the voluntary sale of land in exchange for fair market value. The programme focuses on six aspects of management, namely property management, natural resources, recreational use, land use permits, land acquisition assistance and conservation easements.

The initiative's success in contributing to sustainable resource flows in the city is indicated by the city's peer-reviewed source water monitoring programme, which was independently evaluated for water quality and approved in 1997 by the National Research Council. Although the original motivation for seeking an alternative water supply was driven by economic constraints rather than ecological drivers, the project was ultimately effective in contributing to urban sustainability.

This is evident from large water-saving measures made possible through a demand management programme offering free leak detection and the installation of water-saving plumbing devices such as showerheads, taps, aerators, toilet tank displacement bags, and low-flow toilets.[78] Water demand has reduced by almost one and half a billion gallons per day with a corresponding decrease in per capita demand from 187 to 125 gallons per day over the same time period.[79]

Indirect successes of the programme's urban sustainability measures include the uplift in food production of community and school gardens and composting programmes. Although not directly relevant to the water catchment initiative, the initiative has provided community impetus to source underused properties used for urban agriculture conversions. This resulted in 129 new community gardens planted on New York City Housing Authority land[80] and the promotion of school gardens through a scheme called Grow to Learn New York City. Fertilizer use has been actively discouraged.

The Watershed Protection Strategy measures the provision of clean, safe drinking water; manages a disease surveillance programme; encourages partnering with upstate farm communities to reduce pollutants on farmland (including the repair of septic tank systems); and increases compliance at sewage treatment plants. A formal evaluation of the strategy indicates positive results. Based upon the information collected through its monitoring and research efforts, the Department of Environmental Protection has designed a comprehensive watershed protection strategy that focuses on implementing both protective and remedial initiatives.

For a drinking water system to qualify for filtration avoidance under the Surface Water Treatment Rule (SWTR), the system cannot

be the source of a waterborne disease outbreak and must meet source water quality limits for faecal coliform, turbidity and total trihalomethane MCLs.[81] The city demonstrated that the Catskill/Delaware supply complied with these quantitative criteria. The New York State Department of Health now monitors the programme to assess both water quality and public health.

The New York City watershed protection initiative demonstrates that it is possible to meet both downstream water quality goals as well as upstream economic objectives through voluntary partnerships of upstream and downstream users, and through implementation of community based watershed protection.[82] The programme also shows that by protecting reservoirs and areas surrounding source waters it is possible to supply water for a massive urban population without expensive filtration or chemical treatment.

Although the city was initially hesitant to relinquish control of the watershed's management, on which the economic success of the area depends, responsibilities were delegated as a result of feedback received in participatory processes. Key to the success of this initiative was thus extensive stakeholder involvement and ensuing stakeholder confidence through the recognition of sustainable economic development and community management, a result ultimately made possible by adherence to the core principles of the implemented policy reforms.

6.3. Replacing highways with rivers: Seoul's Cheonggyecheon River Restoration Project

Between 2003 and 2005, an elevated highway covering Seoul's Cheonggyecheon River was demolished to improve the area's environmental and aesthetic condition. Now a city highlight visited by 90,000 pedestrians daily, the restored river is a model for urban renewal projects worldwide.

Throughout much of Seoul's history, the Cheonggyecheon was a polluted river prone to frequent flooding, particularly after the deforestation of the surrounding area to fuel economic development (Park 2004). The response to the problem was to cover the river and, in 1961, to turn it into an arterial road.[83] The rapid urbanization that followed prompted the building of an elevated highway above the covered river. This was completed in 1971.[84]

In 2000, the Korean Society of Civil Engineering found that the road and elevated highway had severe structural problems that would cost approximately USD 95 million to fix.[85] In addition, downtown Seoul was experiencing serious traffic congestion and poor air quality from the mass use of private vehicles, while public transport was in need of a thorough upgrade.[86] Urban ecosystems had suffered considerable degradation during fast-paced industrialization and urbanization, and the city lacked green spaces for public recreation.[87] There was also concern about socio-economic inequality: while development had taken place on the south side of the Cheonggyecheon, the north side had become uncompetitive and dilapidated.[88]

Rather than repair the highway, the Seoul Metropolitan Government decided to restore the river, using it as an opportunity to address several of these problems at the same time.[89] The restoration project was thus intended to recover the flow of the river, to reintroduce biodiversity to the area, and create a space where people and nature could interact.[90] The project would also rehabilitate significant historical and cultural sites, create a centre for business and finance and uplift the area. It would also restore the balance of development between north and south Seoul.[91] Designers intended it to be a symbol of the city's

"21st Century Advanced Era" identity.[92] The project entailed demolishing the highway, restoring the river and creating a 5.84 km park on either side totalling about 1,000 acres.[93,94]

The project began in July 2003 and was completed in October 2005. It cost Seoul USD 367 million, and social costs were valued at USD 1,900 million, but the project is expected to deliver USD 3,500 million worth of social benefits.[95,96]

A long park runs on both sides of the restored Cheonggyecheon stream
© Wikipedia/2007 madmarv00

The river was restored in three sections differentiated by urban, urban-natural, and natural landscaping areas.[97] Curves and irregularities in the river provide suitable conditions for fish, and swamp areas offer a habitat for wildlife. An ecological park and continuous green belt encourages human interaction with nature.[98] Two of the old historical bridges, the Gwanggyo and the Supyogyo, have been restored,[99] and traditional cultural activities such as the lantern festival and bridge stepping on Supyogyo Bridge are being revived.[100]

The project design promotes walking and cycling, while traffic flow to the city centre has been improved through one-way roads and designated bus-only lanes.[101] The bus service was upgraded through a switch to travel cards for payment, a centralized logistics control system and an effective transfer system between main routes and feeder routes. Hours of operation were extended and service frequency increased to make the service more useful. The subway system was also improved through similar measures. The city has discouraged parking in the central area by raising parking fees and clamping down on illegal parking, and campaigns encourage commuters to leave their cars at home for one day a week.

The project was led by Seoul Metropolitan Government, championed by Lee Myung-Bak, Seoul's mayor at the time and now the country's president.[102] The planning and execution of the project was the collective effort of the Implementation Centre (part of the Seoul Metropolitan Government), the Citizens' Committee, and the Research Support Group from the Seoul Development Institute (sponsored by the Seoul Metropolitan Government).[103]

Social sustainability has been improved through an increase in quality of life: citizens now have green public spaces where they can meet socially, exercise, participate in traditional festivals and enjoy cultural events. The project inspired the creation of an informal "knowledge community" to discuss issues relating to the Cheonggyecheon and recommend solutions.[104] The public now have access to valuable educational resources through their renewed contact with nature, restored historical sites and the Cheonggyecheon Museum.[105]

Ecological sustainability has also improved. Fossil fuel use has been reduced by removing about 170,000 cars from the artery each day, improving public transport, and creating pleasant pedestrian routes to encourage walking.[106] This has also led to reduced air and noise pollution in the city.[107] Specifically, small-particle air pollution in the area has fallen from 74 to 48 micrograms per cubic metre.[108] High city temperatures have decreased by up to 5?C due to reduced traffic, the proximity of cool water, and a 50 per cent increase in average wind speeds following the removal of the highway.[109] The restoration has re-established lost habitats and, as a result, the number of fish species has increased from 4 to 25, bird species from 6 to 36, and insect species from 15 to 192.[110] The river has also helped to improve Seoul's resilience to climate change because the open river is better able to cope with flooding than buried sewers.[111]

Economic benefits can be seen in an increase in the number of businesses and employment density within 1.2 km of the Cheonggyecheon corridor.[112] Property prices have also increased at double the rates found elsewhere in the city.[113] Single-family residential units are now more likely to convert to high-rise residential, commercial-retail, and mixed units.[114]

Though the lack of private sector and non-governmental organization involvement may be seen as an "imbalance of power" in other contexts, the Seoul Metropolitan Government's dominant role (and support from Lee Myung-Bak) was key to the project's success. As a result, restoration plans were coherent and achieved a significant level of integration. Implementation time was also relatively short due to fewer administrative challenges. Also contributing to the success were the strong ties and shared agenda of the Metropolitan Government, Cheonggyecheon Citizens Committee and the Research Support Group during planning.

Despite its overwhelming success, there are a few criticisms about the project. Those with visual impairments and mobility problems complain that they have difficulty accessing the stream.[115] Lifts and free wheelchairs have been provided at seven locations, but the minority feel indignant that their needs were not included at the design stage.[116] Some people have criticized the project's ecological authenticity and cost, especially since water must be pumped from a nearby river and groundwater reserves to keep the Cheonggyecheon flowing all year round.[117] These critics have called for a more expansive ecological and historical restoration that includes the entire Cheonggyecheon basin and ecological system.[118] Finally, rising property prices due to the urban renewal have caused concern that local inhabitants may soon be unable to afford to live and work in the area.[119]

The success of the Cheonggyecheon River Restoration Project and the pleasure it gives Seoul's citizens has inspired similar projects around the world.[120] Cities in Japan, Singapore and the United States are recovering streams from storm drains, acknowledging the significant contribution of a well-planned urban green belt to social, ecological and economic sustainability.[121]

6.4 Striving towards sustainable development through a mosaic of land use patches and corridors: Hangzhou, China [122, 123, 124]

The city of Hangzhou is the capital of Zhejiang, one of the most developed provinces in China. The history of Hangzhou dates back 2,200 years when it was one of seven capitals of ancient China and was famed for its natural and cultural charms. The city is regarded as one of the most

important economic, cultural, educational and tourist destination points in the Yangtze Delta region.

Hangzhou's urban population was estimated at 6.6 million and its total population was estimated at 7.5 million in 2005 and they were projected to reach 7.15 million and 8.15 million respectively by 2010. This was an increased level of urbanization from 62 per cent to 70 per cent over that period. The projected population by the year 2020 for the urban area was 8.2 million and the total projected population was 9.3 million. It was anticipated that the population growth will increase the level of urbanization to 84 per cent by 2020. These projections contrast with the period 1949 to 2002, which had an average annual population increase of only 0.8 per cent per annum. The rapid urban growth has put pressures on the ancient city and its rural and agricultural hinterland. The city's growth and its dynamic and evolving peri-urban areas have been accompanied by urban sprawl, which has led to the rapid conversion of natural and agricultural land to urban development, within a context of insufficient land use management. Consequently, the close interrelationship between the ecological system, historic city and cultural assets has deteriorated and social conflicts have increased. In response, the city and provincial authorities prepared the Hangzhou Master Plan, the Hangzhou Urban Forestry Plan and the Hangzhou Grand Master Plan to guide the future development of this ancient city.

The Hangzhou Master Plan (1981-2000) was initiated by the State Council in 1983 and was aimed at guiding urban development, improving urban functions and promoting economic and social development. The city's area increased from 683 km2 to 3,068 km2, the urban core increased by 7 times and the peri-urban area expanded by 4.5 times in the period from 1988 to 2004. The State Council and the Ministry of Construction therefore mandated an update of the Master Plan and the Overall Urban Plan for Hangzhou (2001-2020) was prepared. The Hangzhou Master Plan (2001-2020) was framed within

Beijing-Hangzhou Grand Canal © He Youjun, Li Zhiyong, Yang Jianjun

the goals of economic prosperity, cultural conservation and ecological sustainability with the aim of developing a sustainable city that is "prosperous, harmonious, well-equipped and ecological". The protection of the historical and cultural cityscape of the ancient city and its integration with the natural landscape was emphasized. This included the historic streets, and historic, underground cultural relics, religious, ethnic and cultural sites, ancient trees, folk arts and traditional place names. Components of the Master Plan include a central urban centre, three sub-centres, six eco-corridors, the urban forest and the central Grand Canal.

The Hangzhou Urban Forestry Master Plan was initiated in response to rapid urbanization, a decline in wetland areas and the degrading of the ecological and cultural functions of the natural landscape. The Forestry Plan was based on the principle of establishing forests in the city and allowing the city to embrace the forest. The Forestry Plan aimed to protect farmland, safeguard the interests of farmers and promote sustainable food cultivation measures that result in high quality produce.

The Beijing-Hangzhou Grand Canal originates in Beijing and ends in Hangzhou and is regarded as the most important transportation route in both ancient and contemporary China. The transportation function of the canal declined in recent times with the development of the highway system. Many factory and warehouse buildings along the canal became deserted and low quality residential buildings have developed. Cities along the canal launched a collective effort to preserve the Grand Canal and apply for World Cultural Heritage status.

The city's resultant land use pattern is a mosaic of patches and corridors and this provides a consistent and clear framework to guide urban development and safeguard the city's ecosystems and associated biodiversity hotspots.

Urban conservation interventions included protecting the basic structure of the historic city, limiting the width of roads and limiting the height, massing and colour of surrounding buildings. The city's disaster prevention system uses the green open system to prevent natural disasters, for example flood control, protection against tide and precaution against earthquakes. Actions to conserve the natural systems and promote biodiversity include protection of the cloud-capped hills and mountain areas of northwest Yuhang and hilly areas of southern Xiaoshan, as well as protecting the urban water resources of the Qiantang and Shao rivers. Other interventions include establishing suburban forest parks, water reservation areas, wetland reserves and the development of green belts along rivers, streams and roads. The city promotes the use of clean energy through mandatory energy-saving design standards. Efforts have also made to improve the city's air quality by reducing the usage of coal through the promoting the efficiency of fuel gas. Other actions include setting targets for emissions reduction from power plants and vehicles as well as the control and treatment of the waste from industrial gas. Measures were introduced to reduce noise from traffic, construction and other sources. Action also includes improving the management of solid waste and actively advocating no waste or less waste processing.

Grand Canal Preservation implementation measures included improvement of infrastructure facilities to prevent water pollution of the canal, and the preservation of the traditional historical features along the canal sides. An estimated one kilometre in width on both sides of the canal was included in the preservation area, totalling

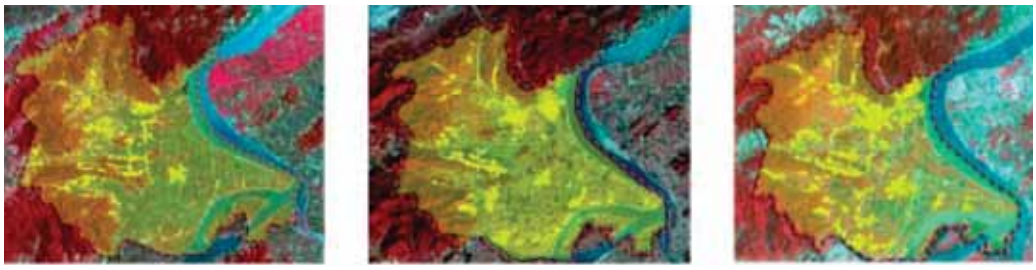
an area of 38 km2, excluding the water surface. Other interventions included redevelopment of industrial buildings, roads and residential complexes.

Implementation of the Forestry Master Plan resulted in more space for expansion of the urban forests into the city, improved management of the urban forest ecosystems and improved overall health of the forests. This initiative included international cooperation between state forestry agencies in China, Denmark, Finland and Estonia. This strengthened the capacity of Hangzhou foresters and policy decision-makers through sharing and learning from European urban forestry and greening practices. The West Lake Scenic Area was protected and this included conservation of the natural environment and the relocation of pollutant-discharging factories to less critical areas. Interventions in three areas, namely Xixi, Zhuantang and Bingjiang, show different responses to the challenges of peri-urbanization.

Hangzhou was declared a National Forest City and its Xixi wetland was listed as a Wetland of International Importance under the Ramsar Convention in 2009.The Xixi Wetland Park was under threat from market-led urban development before 2004 (the area was reduced from 60 km2 to 10 km2) and this led to the rapid decline of the wetland and degradation of the ecological, cultural and landscape functions. In 2003, the municipal committee and the municipal government established the Comprehensive Protection Project with the explicit aims of halting wetland loss and degradation. The Comprehensive Protection Project included restoration of degraded wetlands and the creation of new wetland areas with a specific emphasis on demonstrating the cultural significance of the landscape. In 2009, Hangzhou hosted the first China Wetlands Cultural Festival, which formally marked the significant progress made in protecting and restoring the wetland cultural landscape.

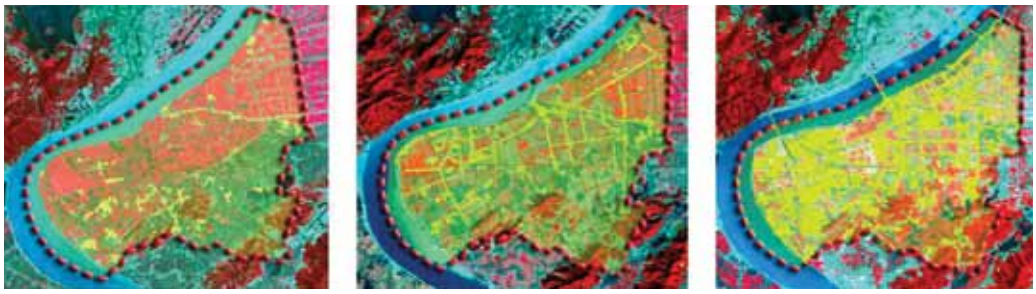
The Zhuantang area is one of six ecological belts in the city and is important for its role in tourism, as a source of drinking water, for its agricultural products and for the preservation of the natural landscape. Strategies to conserve the area include severe restrictions on development, the establishment of the Zhijiang National Tourism Resort and the development of the College of Visual Art, rural tea houses and home inns.

Figure 6.2: **Zhuantang area**



Source: Urban Forestry and Nature protection for Sustainable Urban Growth: Hangzhou PLUREL Case study region. He Youjun, Li Zhiyong, Yang Jianjun, Oct 2010, Copenhagen, Denmark

Figure 6.3: **Bingjiang area**



Source: Urban Forestry and Nature protection for Sustainable Urban Growth: Hangzhou PLUREL Case study region. He Youjun, Li Zhiyong, Yang Jianjun, Oct 2010, Copenhagen, Denmark

Challenges in the Bingjiang area included rapid urbanization, industrial development, inaccessible green spaces along roads and the interests of farmers. Actions within these areas include the development of high-tech industry, development of the White Horse Lake eco-culture-creative town and improvement of residential construction and infrastructure.

The preparation of an overall master plan, followed by the more detailed urban forestry plan and the canal preservation plan, within the context of rapid urbanization, provided consistency between the different strategies and plans used. This enabled linkage and co-ordination of planning and implementation of the various plans as well as for timing and different stages of development. The master planning approach strived to achieve a balance between the need to protect farmland, conserve ecological and culturally important areas and allow for urban development. Effective planning strategies included urban forestry to promote greening of urban areas; conservation of the Beijing Hangzhou Grand Canal; the protection and promotion of the Xixi and the Zhuantang ecological areas; and balancing urban growth between the core city and the peri-urban areas. The city recognized the important connections between ecosystems and urban services and the need to strive towards more sustainable resource use. This could be achieved through actions such as increasing renewable energy flows, recycling of waste and pollution reduction. The most effective outcomes of the master planning process were the restoration of the cultural and historic aspects of the city and the protection of the interest of farmers through the development and implementation of a broad strategy for modernizing the city. The Hangzhou case study demonstrates how sustainable development can secure ecological systems, protect cultural and historic assets and plan for rapid urban growth. It also shows how cultural assets embedded within the ancient city and the rural lifestyle of its peri-urban residents can be integrated within the planning of a modern city.

6.5 "StEP Klima" - The ecological utility of green-spaces in the context of climate change, Berlin, Germany

Berlin has already taken measures to adapt to the unavoidable demands of climate change. The city is vigorously attempting to anticipate the local impacts and help Berlin adopt modes of sustainable development whose ultimate goal is to safeguard the quality of life of its citizens.

Like all other large cities, Berlin must develop and implement adaptation strategies with respect to climbing average temperatures, the increase in extended periods of extreme heat in the summer months, and changes in the overall levels and seasonal variation in precipitation. Due to the density of building, the formation of urban "heat islands" has already had discernible negative effects on public health. In the future, additional areas of the city are likely to be effected by such conditions. An expected decrease in summer rainfall will lead to stresses on the vegetation in Berlin's urban parks and green spaces, endangering their vital contributions to recreation, biodiversity, and their role in mitigating the effects of urban heat.

The overriding goal of the "StEPKlima" (StadtentwicklungsplanKlima Berlin - City Climate Development Plan)[125] is to prepare for climate change. The Senate Department for Urban Development commissioned a scientific analysis of the consequences of climate change and the identification of areas needing urgent attention, along with recommendations for the appropriate measures to be taken, from the Technical University of Berlin. The results were made available in readily accessible language and expanded into a plan of action by the Senate Department. This plan of action pinpointed current city building projects that, in the short-term, might contribute to the city's agreed-upon climate-change adaptation measures. The "StEPKlima" was passed by the Senate in May 2011 and is binding for decision makers and planning authorities. However, the plan is not a definitive blueprint, but is a point of departure in the discussion process between various actors in the city, all of whom must ultimately harbour the goal of keeping the city liveable. This process of communication and participation within various planning departments, regions of the city and the citizenry is currently carried out by the Senate Department for Urban Planning through open meetings, informative gatherings, canvassing of public opinion, and negotiations. From the start, the intent was to disseminate knowledge so that the necessary planning decisions could be made and conflicts resolved.

Berlin-Tiergarten park © UN-Habitat/Andrew Rudd

In order to contribute cogently to Berlin's urban development, the creation of the "StEPKlima" took ecological, economic and social issues into consideration. In investigating the value of urban green spaces, reference was continually made to the comprehensive and frequently updated data of Berlin's digital Environmental Information System. Detailed information on the environmental contributions made by soil, water, air, climate, biotope, land use, transportation, noise, and energy, along with their functions and environmental value, were made available to city and landscape planners, politicians, and interested citizens.[126] The materials of the Environmental Information System were made available in English for the benefit of other cities. With the help of these data the effects of climate change can be studied, as can the contributions of green spaces

to urban cooling. Specific information can be accessed about the availability of public, near-residential green spaces and recreational areas,[127] the climatic benefits of existing zones,[128] and ground water conditions within the city.[129] With respect to social considerations, demographic studies can be referenced that show, for example, the future density of elderly people, a group particularly susceptible to the adverse effects of extreme heat.[130]

Berlin-Tempelhof park, April 2012
© Wikipedia/A.Savin

Berlin's renewed economic growth has brought with it new jobs and the building of additional housing units, which, in turn, has increased pressures on remaining open spaces. The economic interests of Berlin are tied up in construction and in the fostering of an increased population density, and these factors are taken into consideration in current planning for the large undeveloped areas remaining in the city. The largest of these are the inner-city airports Tempelhof and Tegel, which will become redundant with the upcoming opening of the international Berlin-Brandenburg Airport. The repurposing of these former airports can play a crucial role in sustainable development in the city.

Tempelhof Airport was closed to air traffic in 2008. Its 386 hectares are situated in the middle of a densely populated residential area, which has a lower-than-average store of recreational areas. Since 2010, the former airfield has been a public open space. The public's use of the landing strips and adjacent fields has been overwhelming. Diverse groups gather here for their leisure activities such as kite-flying, inline skating, jogging, cycling, or picnicking on the abundant grass. This vibrant interest shows how intense the need is for restorative urban green spaces and parks. While the margins of the airfield will be developed for housing purposes, a green space of some 220 ha will be retained as a climatological offset and recreational area. Various proposals are currently being discussed with regard to Tegel Airport. Whether the area will become an industrial site, given over to apartment buildings, dedicated to green space for leisure and the lessening of climate impacts, or a combination of uses will be strenuously debated.

The "StEPKlima" has already demonstrated the significance of existing urban green spaces and parks for the improvement of climactic conditions, for centrally placed leisure opportunities, for the protection of water resources, and for the maintenance of habitat for animals and plants. The ecological benefits that derive from the largest park in the city, the Tiergarten, provide a model for future planning and argue for the safeguarding of green spaces. These areas play a key role in adaptation to the negative effects of climate change and to the improvement of living conditions in the city. To be sure, the integrity of the Tiergarten is legally secured. But this single green space is not sufficient to satisfy the ecological needs demanded by a city of some 3.5 million inhabitants.

An aerial view of Cape Town CBD from Table Mountain, showing some of the natural assets that make it such a popular city © Blake Robinson, 2009

The overwhelming support for the "StEPKlima" among city planners, politicians and citizens demonstrates the general recognition of the ecological benefits of the city's green spaces. Acceptance of the importance of these spaces has been strengthened through the political ratification of the plan, which provides guidelines for climate-adapted housing and industrial developments, and which will have to be considered by the various interests competing for the city's green space. Future planning decisions must be oriented towards climate-based standards. That the necessity of climate adaptation has found a broad resonance across the urban community is witnessed by an initiative of the Berlin Chamber of Industry and Commerce to retrofit large urban industrial estates in accordance with the requirements of adaptation. Public interest meetings and discussion forums where the "StEPKlima" has been presented show that many citizens rate the goals of sustainable development in the context of climate change as urgent.

The significance of urban green spaces and parks for public health and the maintenance of important ecological functions were analysed in detail by the "StEPKlima". The authors investigated not only the contributions of individual green spaces to the improvement of the urban climate, but also the extent to which these areas and their vegetation would be impacted by the effects of climate change. This project could be undertaken so quickly because of the comprehensive and up-to-date data available from the Environmental Information System. These factual resources were expanded by studies of demographic developments, transportation, and future water supply. Now the city has many of the tools necessary to secure the sustainability of its future building development.

Since adaptive measures cannot be implemented by government alone (especially in light of limited public budgets), all citizens and institutions of the city must contribute. For this reason the "StEPKlima"

is not to be viewed as a rigid template for future planning, but rather as a source of technical information for a comprehensive city wide dialogue between planners, politicians, economic interests and citizens. This participatory process is meant to be an intermediate step in the dissemination of knowledge about the consequences of climate change and to foster public acceptance of the necessity to adapt to these developments. With its Environmental Information System and "StEPKlima", Berlin has solidly prepared itself in a timely fashion for the coming transformation of the city's environmental conditions.

6.6 Valuation of ecosystem services in Cape Town, South Africa

Cape Town boasts enviable natural assets including world-class mountains, beaches, green open spaces, wetlands and marine life all within the limits of a bustling metro of roughly 3.6 million people. The city has a relatively well-diversified economy and is a world-renowned tourism destination. In addition, it enjoys the status of a global biodiversity hotspot thanks to its location in the Cape Floristic Kingdom (the smallest of six floristic regions worldwide with almost 9,000 plant species, 70 per cent of which are endemic).

Cape Town's natural assets are under pressure primarily from land transformation, pollution and aggressive alien invasive plant species. They need increased investment and management effort if they are to continue contributing towards the city's economy.

The municipality has considered reinvesting more of the proceeds of its growth into maintaining the natural assets. There are good reasons for doing this. First, natural assets produce a flow of goods and services that has value for people living in and visiting Cape Town. A second related reason is that the degradation of urban natural assets impedes on the ability of the municipality to deliver services in a cost-effective way.

Municipal budget allocations are heavily contested in Cape Town, especially because of often urgent and competing development needs, such as housing, education and health care. Arguments to preserve the environment have traditionally not focused on the financial logic of investing in natural assets. The rationale for this study was specifically to develop a financially motivated business case for investing in natural assets in the city. The focus of the overall project was to influence budget allocations by developing focused economic arguments for investing, maintaining and expanding the city's natural assets.

The city's Environmental Management Department drew up terms of reference for consultants to make a case for increased spending on natural asset management. The study was done over a 4-year period – 1.5 years of preparatory work by the department, 1.5 years of data collection, analysis and reporting, and 1 year of dissemination to city managers and senior staff, external stakeholders such as universities and other research institutions as well as to some NGOs and conservation groups.

Three aspects characterize this study, namely, the continued engagement with senior city managers, the single focus on a financial argument, and the use of a consulting team experienced in business, economics and ecosystem services, who were willing to run an intensive participation process with all relevant city departments throughout the study.

A first phase of engagement between environmental and finance managers in the city defined mutually shared terms of reference focused on making a business

case for investing in natural assets. The concept that an ecological infrastructure, like any other infrastructure, supports economic activity and social wellbeing was accepted early in the process.. The success of early phase internal work ensured that consultants wasted no time and resources building critical inter-departmental linkages.

During the processes of data collection and analyses, every department in the city impacting on or responsible for the city's natural assets were invited and engaged, including managers of environmental resources, parks, tourism, heritage, sports and recreation, wastewater, storm water, solid waste and spatial planning. Selected managers and/or senior staff from these departments were interviewed to compile an inventory of the ecosystem goods and services produced by the city's natural capital, and to identify the groups of people who were benefiting from these goods and services. For the purposes of the consultation process all open-space natural or semi-natural areas (for example, floodplains, wetlands, city parks, sandy beaches or rocky beaches) were included when referring to natural and semi-natural environments.

The consultants then developed a methodology that included an economic approach to valuing ecosystem goods and services. A process was followed that valued input from city managers and staff on the relative importance of environmental goods and services (EGS) to beneficiaries, the linkage to the city's development objectives, the city's ability to influence the value of EGS through management, and the risks associated with continued provision of environmental goods and services. A short-list of environmental goods and services prioritized for further economic valuation was created in a workshop with city officials. The five services that were ranked with highest relative importance for valuation were the regulation of natural hazards, recreation and tourism, water purification and waste treatment/assimilation, space for biota and aesthetic values/sense of place.

The focus of the study was to make a business case for investing in natural assets.[131] Better resource use or less pollution are not direct measurable outcomes of such a study, but can be an indirect impact as increased budget allocations to invest in natural assets become a reality. The initiative was successful in calculating the benefits of select ecosystem services to Cape Town's inhabitants and visitors, conveying the message that the benefits associated with natural assets are not for free. The initiative was also prominently referred to in a TEEB (The Economics of Ecosystems and Biodiversity) manual on how to include ecosystem services in urban management.[132]

With the case having been made for investing in such natural assets to maintain and expand such a flow of economically valuable services, the next question was where to source the funding to do so. Many ecosystem goods and services can be enjoyed simultaneously by the city's inhabitants and visitors (think, for example, about clean air and scenic views). This does not create an immediate incentive for private investors to invest in and maintain such services because the economic gains do not flow directly back to investors. Because everyone benefits from ecosystem goods and services, the relevant authorities who are custodians of the public good have a role in investing and maintaining such services. Where such services do benefit private agents as well, it will only be fair for private agents to contribute to the maintenance of such services.

This is not very different from the investment and maintenance of other utilities - municipalities invest in infrastructure and

the provision of services and those who benefit (households, industries, tourists) pay through mechanisms such as tariffs, property rates and charges. Where social objectives need to be achieved, for example the roll-out of services to the poor, national and/or provincial government also contributes.

Internally, the study did set the stage for a more informed debate between departments on using investment in natural assets as a means to save on expensive operational costs. One specific example is an agreement between the roads and the environment departments to invest in dune stabilization rather than in expensive cleaning of sand from roads in certain areas. A broader initiative following from the study is to design a ring-fenced and publicly accountable environmental fund dedicated to investing in municipal green infrastructure. At the time of writing (November 2011) the discussion on how to generate revenue for such a fund was still ongoing.[133]

The initiative gained a lot from a focused effort early in the process to build inter-departmental linkages, especially between departments responsible for finance and environmental resources. This culminated in clear terms of reference for the consulting team and a high amount of social capital present in the steering committee of the project.

The initiative also provided a good foundation for the further development of environmental fiscal reform strategies in the city. However, one thing that should have been done differently was to have expanded the brief from the start from making a business case alone, to one that included developing a strategy for the implementation of Environmental Fiscal Reform (EFR) - taxation and pricing measures raising revenue while advancing environmental goals - in the city.[134] City staff are now developing an outline of such a programme, but realize that external support would help to raise credibility and to focus the effort.

It was also realized early in the project that one can have a well-presented argument, but this will have little impact if it is not heard, understood and acted upon. Different communication products were developed to support a communications strategy, namely, a 270-page technical report, a 7-page summary document for decision-makers, several half page core messages designed for different audiences, and PowerPoint presentations for city managers and researchers.

Despite these efforts, recent feedback suggests that continuing threats to the implementation of Environmental Fiscal Reform in the city come from some politicians, who argue that any additional tax or tariff negatively impacts on the voter base. There are also some city leaders who still perceive investing in natural assets as incompatible with the objectives of job creation and economic growth.[135] Although the study did recognize the limitations of making a business case alone, the urgency of implementing a well-designed and relevant communications strategy is becoming more and more evident.

6.7 Magat Watershed - A co-management approach in Nueva Vizcaya, Philippines

The Magat watershed was characterized by continuous degradation of forest resources, erosion and marginalization of forestlands, and land use conflicts resulting from unsustainable practices and diverse uses of watershed products and services. Traditional watershed management, which included standard tree planting programmes, contract reforestation and selective logging, was met by a "traditional people response" - i.e., weak, indifferent and, thus, unsustainable - because it lacked real incentives and tangible benefits. With the failure of the

traditional approach, the local government units (LGUs) of Nueva Vizcaya, together with the Department of Environment and Natural Resources (DENR), developed the first watershed co-management model in the country. In February 1998, this approach was piloted in the Lower Magat Forest Reserve (LMFR). The provincial government and the Department of Environment and Natural Resources forged a Memorandum of Agreement (MOA) for 25 years (renewable for another 25 years) with individuals, associations, cooperatives and corporations. This agreement, which specifies limited agricultural cultivation and harvesting rights, is based on the Department of Environment and Natural Resources - Department of Interior and Local Government (DILG) Joint Memorandum Circular No. 98-01 entitled "Manual of Procedures for DENR-DILG-LGU Partnership on Devolved and other Forest Management Functions".

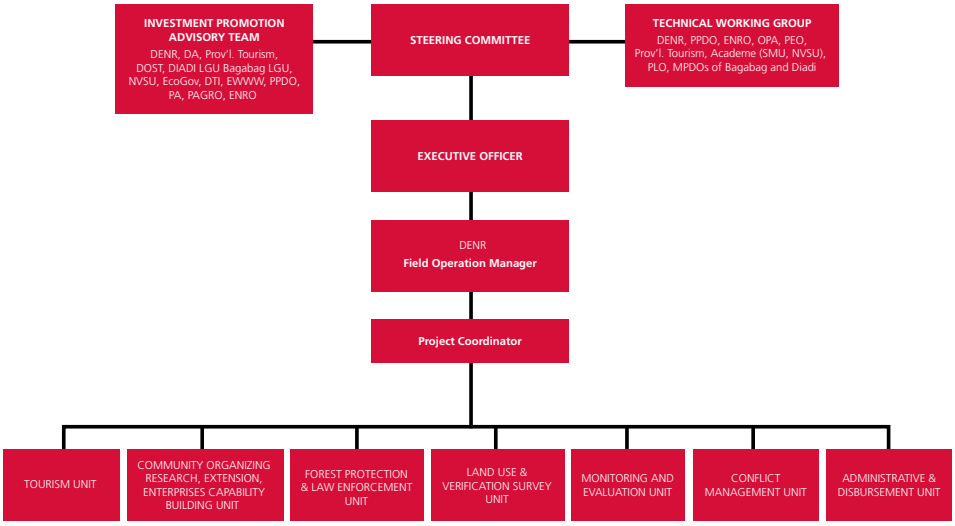
The goals of the co-management initiative in the Lower Magat Forest Reserve are to:[136] (1) develop and mobilize sustainable local government units and Department of Environment and Natural Resources-driven support services to protect, develop and manage the 24 251 hectares forestland areas. They will do this by encouraging and promoting environmentally-sound forestland and nature-based enterprises; (2) implement community-based forest management approaches with strong private sector participation in the protection, development and management of the reserve; (3) increase and sustain the supply of food, wood, water, and fibre through the proper allocation of management of forestlands; and (4) uplift the socio-economic conditions of communities in the reserve.

The active role of the provincial government in this watershed management initiative can be traced back to the passage of the Local Government Code (Republic Act 7160) in 1991, which handed over to the local government units environmental management functions of the central government. At the provincial level, the Department of Environment and Natural Resources devolved the enforcement of forestry laws in community-based projects. At the municipal level, the department devolved management and control of communal forests with an area not exceeding 5,000 ha.

The Lower Magat Forest Reserve was managed through a traditional reforestation project until 1989.[137] It covers 21 barangays1 in two municipalities (Bagabag and Diadi), home to just over 19,000 people in 2000. Before the co-management and the new LGU-DENR alliance, the reserve was fraught with illegal logging, rampant firewood gathering and charcoal making, unregulated commercial ranching, frequent forest fires, influx of landless people (illegal occupants) engaged in destructive land uses and increasing population pressure that led to land resource use conflicts.[138]

The Lower Magat Forest Reserve Memorandum of Agreement provides the legal framework to operationalize the co-management of the Magat watershed, which is legally consistent with basic national policies. The agreement takes as its context the realities and environmental imperatives in the forest reserve.[139] As a customized feature and centrepiece of the agreement, the provincial governor (as head of the Steering Committee) and the Department of Environment and Natural Resources (as co-chair) enter into sub-agreements with legitimate occupants for stewardship of any portion of the reserve. These sub-agreements provide order and stability to former "open access" areas, which constitute the largest portion of the reserve and the main sources of land and resource use conflicts.[140]

Figure 6.4: **Organizational structure of Lower Magat Forest Management Office**



Source: Tolentino 2011. Nueva Vizcaya Experience on Co-Management. Presentation Notes. Regional Environment and Natural Resources Office, Nueva Vizcaya, Philippines

This arrangement provides opportunities to the private sector, cooperatives and even government agencies for the protection, development and management of any portion of the reserve under a similar sub-agreement for a period of 25 years.[141] Other key features of the arrangement are the flexibility and autonomy shared between the Department of Environment and Natural Resources and local government units in co-managing the forest reserve in accordance with some annual work plans. Figure 2 shows the organizational structure of the Lower Magat Forest Management Office (LMFMO) created by Sangguniang Panlalawigan Resolution No. 98-138 to implement and monitor work plans.[142] The steering committee is chaired by the governor and co-chaired by the regional executive director of the Department of Environment and Natural Resources. The members include municipal mayors of Bagabag and Diadi, the provincial environment and natural resources officer (PENRO), Nueva Vizcaya Chamber of Commerce and the provincial non-government organization federation. The Department of Environment and Natural Resources and Nueva Vizcaya contributed personnel to the LMFMO and the municipalities of Diadi and Bagabag each contributed one person to the project office. The relatively simple structure avoids the rigid bureaucratic processes and promotes more effective and responsive management.[143]

The Department of Environment and Natural Resources appropriates funds for research in forest production and management and ensured the transfer of technologies to the forest reserve management office, communities and individual upland farmers, while the provincial government provides the operating budget. The LMFMO ensures the maximum participation of legitimate upland farmers, claimants, and indigenous people in the suballocation and management of forestlands. It explores workable and beneficial institutional and business arrangements with government agencies such as the National Irrigation

Administration, Department of Tourism, Department of Agriculture, Department of Trade and Industry, National Power Corporation, and other public and private organizations.[144]

While the Lower Magat watershed management experience has been labelled a success, there is a caveat. At present, evidence of the initiative's success may be anecdotal and largely based on data from the records of the LMFMO and reports by its officers, which may need to be verified and complemented by interviews with the benefiting partners.[145] As of September 2009, or halfway through the 25-year Memorandum of Agreement, a total of 174 sub-agreements were issued to individuals and associations covering about 3,375 ha and tenured forestland stands at 5,359 ha or about 22 per cent of the total.[146] An earlier report also cites 22 per cent of the reserve as tenured through 28 agro-forestry land management agreements and community-based agro-forestry land management agreements.[147] In terms of immediate observable results, reduced incidence of forest fires, timber poaching and charcoal making was reported. As envisaged, self-reliant communities act as forest guards and fire suppressors. Natural regeneration, expansion in fruit and forest tree farms and revival of mountain springs has been observed.[148]

Some socio-economic outcomes of the co-management initiative include reduced squatting and migration, and selling of rights, implying that holders may be better off and not as cash-strapped anymore. The approach also provides livelihood opportunities to the partners. One example is through the sale of seedlings, which has become a cottage industry. Another example is through supplying of materials for the furniture industry. Lastly, with increased incomes for partners, the initiative may not be far off in claiming that it has helped in reduction of poverty.[149] Official statistics show that Nueva Vizcaya's poverty incidence declined substantially in 2003 to 9.2 per cent from 2000 (16.5 per cent) but rose again although at a lower level in 2006 at 12.7 per cent. Statistics for 2003 show that Bagabag has 17.4 per cent and Diadi, 27.9 per cent[150] poverty incidence, both higher than the average for the province. It is possible that the poverty reduction impact may yet be realized since the co-management initiative started only in 1998. The lack of municipal level poverty data before 2003 makes it difficult to determine if the 2003 levels are lower than they originally were. Also, unless a systematic analysis is carried out, it is difficult to clearly establish how much of the improvements in the reserve and municipalities can be solely attributable to the co-management initiative. A systematic analysis would require collection of primary data.

The reported sustainability of Magat watershed management efforts in Nueva Vizcaya can be attributed to:[151] (1) the complementarity of the Department of Environment and Natural Resources' resource management expertise and the local government unit's ability to deliver basic services and manage people, (2) the co-management model with empowerment of stakeholders and treating human concerns as linked to land and water resources; and (3) a holistic approach. The first aspect comprises the competence of the Department of Environment and Natural Resources and high motivation of the local government unit, with political leadership playing a vital role in prioritizing watershed management and allocating funds. The local initiatives and innovations from the constituents catalyzed participatory management. In the light

of the frequent changes in political leadership, enhancement of capacity at the local government unit level has to be sustained. The second aspect adhered to the idea that "food security objectives of stakeholders can be made compatible with ecological security objectives of the state". The challenge related to this is to find viable short-term livelihoods to bridge and sustain medium- and long-term watershed-related investments. Lastly, the holistic approach with enabling policy and other institutional support, forest resources security, forest protection, biodiversity and soil and water conservation, sustainable flow of forest products and socio-economic and cultural well-being, make all stakeholders winners.[152]

6.8 Commitment to biodiversity and ecosystem habitats: Zagreb, Croatia[153]

Zagreb is the capital and the largest city in the Republic of Croatia.

It has experienced rapid and dynamic urban development over the last few decades, whilst managing to safeguard its biodiversity. This biological diversity results from the city's varied geology, hydrology, climate, biogeography and historical background. Landscape-wise, the Zagreb city-region occupies four macro units: the Medvednica Mountains, the foothills, the alluvial plain and the Vukomericke Gorice Hills.

The city itself is positioned on the southern slopes of the Medvednica Mountains, which mitigate the impact of the extreme climate from the north and promote air circulation through the city. Nearby mountain forests also provide a valuable educational, cultural, historical, tourist and recreational asset. Greenery extends from the foothills through the city's various habitats, including parks, forestland, arable land, vineyards, orchards, meadows, pastures and water bodies. The fertile alluvial floodplain associated with the Sava River has prevented urban sprawl, hosting instead a few rural settlements, while the hilly area of Vukomericke Gorice is known for its small-scale farming.

Through biophysical and anthropogenic interactions the four macro landscape units present in Zagreb are divided into smaller units of forest, cultivated rural areas and urban landscapes, resulting in a rich mosaic. In total, 196 species of flora and 120 species of fauna recorded across the city are designated as threatened or protected on national and international biodiversity lists, and six habitat types (mostly forests) are listed for protection under the European Union Habitats Directive. Important species include 14 amphibian species, 21 threatened wetland bird species, 45 fish species, more than 110 butterfly species, 67 species of mammals and 25 species of bat, with a significant amount of these categorized as threatened.

The Zagreb case study demonstrates the ability of city officials, decision-makers and communities to acknowledge and secure the city's unique biodiversity and ecosystem habitats within the context of fast urban growth and the associated pressures.

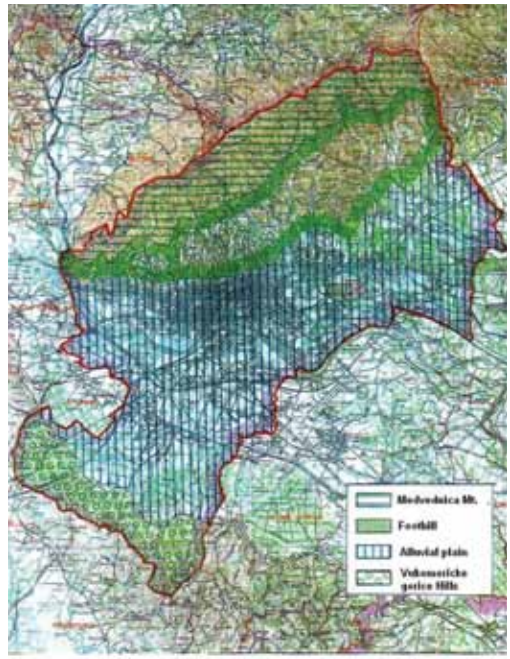
In the past, the city engaged in biodiversity management practices that yielded positive results. In 1991, the Zagreb City Assembly meritoriously designated the Savica area as an important landscape with separate special zoological reserve status. This intervention was assisted by the commercially-owned Zagreb thermal energy plant, by maintaining the water levels in the Savica wetland eco-system and thereby enabling the preservation of endangered wetland species. Another successful intervention was the placing of "bat-friendly" gates at the entrance to the Veternica Cave following

recommendations from experts from the Croatian Natural History Museum. An action that has not yet yielded positive outcomes is the city's efforts to establish a public institution dedicated to the management of natural assets and habitats important for preserving biodiversity. Management and administration of the city's biodiversity was, therefore, fragmented, with several city administration entities responsible for nature and biodiversity protection. However, co-operation on joint programmes was achieved between the city's institutions and outside partners. The city was a signatory to the Countdown 2010 Declaration, coordinated by the European Centre for Nature Conservation (ECNC) aimed at taking all necessary steps towards preventing or considerably mitigating biodiversity loss by 2010.

Zagreb prepared a biodiversity report in 2008 as part of the Local Action for Biodiversity (LAB) Project advocated by the International Council for Local Environmental Initiatives (ICLEI)[154] – Local Governments for Sustainability and partners. The Biodiversity Report (2008) identified a wide range of threats that included disjointed responsibility for managing biodiversity, insufficient funding resources, inadequate awareness, an economy in transition, urban sprawl, changes in traditional rural management, the introduction of invasive species, etc. The plan acknowledged that urbanisation can have a negative impact on biodiversity, but argued that this can be mitigated through measures such as preservation and creation of sufficient green areas within biodiversity significance within the city, establishment of green corridors and creating conditions that enable the survival of species. The City of Zagreb Physical Plan identified a number of biodiversity objectives[155], and this included the protection of highly developed biodiversity areas and ensuring protection of rare and threatened habitat types and individual species through appropriate guidance, regulation and enforcement. Yet another objective was the preservation of agricultural land. In 2004 up to 30% of the city area was classified as agricultural land and whilst not supporting many threatened or rare species, the areas still have the potential to act as corridors or refuges for many species), reversing the trend of grassland biodiversity loss and preserving the existing diversity of plant, fungi and animal species.

The city of Zagreb employed a wide range of methods in improving its biodiversity management. This included ten-year Protected Area Management Plans and a national certification procedure, based on sustainability principles for the management of Croatia's forests. The city devised incentives for the wise management and utilisation of biodiversity. Measures provided by the City's

Figure 6.5: **Landscape Macro Units**



Source: City of Zagreb Biodiversity Report (2008). City of Zagreb City Office for Strategic Planning and Development of the City

Office for Agriculture and Forestry, included financial support for plant production and assistance for cooperatives, eco-production and events in agriculture, forestry, hunting and freshwater fishery. Fines are in place for violation of the provisions of the Nature Protection Act for activities such as introducing alien taxa into natural areas, the degrading of natural assets, construction of barriers on watercourses, water draining, backfilling springs, ponds, etc. and harming wild animals or destroying their habitats.

Zagreb initiated a number of biodiversity projects aimed at enhancing species and habitat management. Countdown towards 2010 was aimed at increasing community involvement in biodiversity assessment. Maksimir, a public institution, focused on projects with the objective of protecting and preserving natural values and undertaking scientific and technical research within Maksimir Park such as preparing an inventory of plants, research on butterflies, study of birdlife, protection of the common toad and research on the influence of introduced species. On-going projects in Medvednica Nature Park include linking strategies in freshwater crayfish conservation between Austria and Croatia, nature-friendly forest management, damage assessment of forest ecosystems, monitoring of Veternica Cave fauna, preparing an inventory of vascular flora, and research on butterfly fauna, study of the Dipper and Wagtails birds, inventory of cave fauna, and research on the influence of visitors on bat cave activities.

Significant efforts were aimed at mainstreaming biodiversity within wider city policies and this included broad based community participation in the processes. This was achieved through close co-operation between the various city administrations and collaboration with city wide NGOs, such as the Croatian Ornithological Society who do monitoring and give public talks and

Figure 6.6: **Preliminary zoning prepared for opening of discussion with responsible institutions and land users**

Source: City of Zagreb Biodiversity Report (2008). City of Zagreb City Office for Strategic Planning and Development of the City

lectures, civic organizations and national and international organizations. The Community Involvement in Biodiversity Assessment Project was aimed at enhancing co-operation and awareness between the city, NGOs, the research community and civil society on issues relating to biodiversity. A combination of ecological and people-orientated participatory methods were used and this resulted in a community based monitoring scheme and inventory of urban diversity, with a particular focus on the occurrence of species of international importance. This project was funded by the Dutch Ministry of Agriculture, Nature and Food Quality and City of Zagreb and implemented by the European Centre for Nature Conservation (ECNC), ICLEI, the

University of Zagreb, the Croatian Natural History Museum, the Croatian Ornithological Society and the City of Zagreb. Further public participation was achieved through the hosting of national and international environmental events. Other avenues pursued included environmental publications, round table discussions, press coverage and conferences. The widespread location, range and variety of habitats available, and a balance between the degree of development of green spaces and the owner relationships have all made green space accessible to the local population of Zagreb. Entry to protected areas was free of charge, and the City of Zagreb provided free public transport for scholars, students, the unemployed and the aged. Special ecology education programmes were implemented in kindergartens and schools, funded by the City of Zagreb. The city's cultural, educational and open-university centres implemented a variety of programmes and actions related to the environment, nature protection and eco-education.

Within Zagreb there is wide recognition of the benefits provided to its citizens by biodiversity. These ecosystem services extend across forests, wetlands urban parks and agricultural land. Forests provide timber, food such as mushrooms and honey, regulate the local climate, help to reduce run off and thus prevent soil erosion and offer opportunities for recreation and leisure. The water bodies and wetlands provide drinking water, support recreational activities and help in removing pollutants. Urban parks not only provide recreational and leisure opportunities but they also moderate daily temperature extremes and improve the city's overall aesthetics. Agricultural land is managed primarily for the food and natural resources it provides, however it also preserves the genetic pool for local domestic breeds of animals and offers recreation through hunting, shooting and fishing.

The Zagreb case study demonstrated the commitment and dedication of the city's decision-makers, officials and communities to acknowledge and safeguard the city's unique biodiversity and ecosystem habitats. The physical location of the city, its history and culture are inextricably linked to its biophysical setting and associated ecosystems. The city made a concerted effort to involve stakeholders within and outside the city, and the efforts aimed at community and public involvement in the process of biodiversity protection are commendable. These efforts were wide ranging and included active participation programmes, which, amongst other outcomes, resulted in the recording and monitoring of biodiversity assets. Although the city's biodiversity assets were managed and administered by various public entities, integration and collaboration were achieved through clear goal setting and tackling workable projects and programmes. These could be accelerated significantly once a unified entity for biodiversity management is established. Also, it is conceivable that the educational and support efforts aimed at securing community ownership of the biodiversity initiatives and the recognition of the value of biodiversity by the citizens will yield benefits for generations to come.

Urban farm in Chicago © Wikipedia/Linda

Conclusion 7

While acknowledging the complexity of urban systems and the uncertainty of a city's future requirements, this guide offers an approach to working with nature at a regional scale. This approach involves identifying and assessing the ecological processes that operate within the region. The aim is to safeguard these processes so that the ecosystem services that they provide will be available to present and future city residents.

This approach also supports ecological resilience. With climate change (and indeed any change) comes a level of uncertainty. Biodiversity is crucial to the adaptive resilience of a city as it sustains the flow of ecosystem services to the city-region in times of change by supporting the adaptive capacity of the ecological system. Working with nature at a regional scale creates a basis for ensuring the biodiversity's and system's integrity to enable this adaptive capacity to be sustained.

The ecosystem services that biodiversity sustains are those goods and services provided by nature that are beneficial to humans. Besides providing the essential food and water supplies that are needed for survival, they also include services such as water purification, cultural and medicinal benefits.

The Millennium Ecosystem Assessment[156] defined the following categories of ecosystem services:

- Provisioning services provide us with food, water, raw materials, biofuels and medicinal resources.
- Regulating services regulate the quality of air, soil and water, provide flood and disease control, provide pollination services and regulate pests and prevent disease.
- Habitat or supporting services provide living spaces for plants or animals; they also maintain a diversity of different breeds of plants and animals.
- Cultural services include the non-material benefits people obtain from contact with ecosystems, including aesthetic, spiritual, educational and psychological benefits; public health; and recreational opportunities.

The approach to support biodiversity and ecosystem integrity outlined in this guide is to promote the landscape mosaic spatial pattern, which incorporates a network of green "patches" and interlinked "corridors". This network of patches and corridors increases the connectivity of the green spaces in a region, allowing increased opportunity for species movement throughout the network. This guide presents a number of principles aimed at promoting a landscape mosaic spatial pattern:

- Identify strategic landscape patterns to safeguard the critical ecological processes;
- Highlight the economic and cultural value of ecosystem services;
- Work with ecological processes;
- Adopt an integrated planning and management approach;
- See the city as a living system;
- Make open spaces productive;
- Recycle, reclaim and reuse urban spaces; and
- Make the process transparent and inclusive.

In order to implement and promote a landscape mosaic spatial pattern, city managers are encouraged to:

- Plan on a tier of levels; and
- Plan on an efficient, modular basis that can be updated easily.

In conclusion, there are a number of co-benefits from supporting biodiversity, promoting a landscape mosaic spatial plan and safeguarding critical ecosystem services. Ecological, economic and equity benefits can result from the following interventions:

- Protection of large green patches;
- Management of water catchments;
- Restoration of wildlife movement corridors;
- Restoration of ecosystems, such as rivers and wetlands;
- Building of roads close together (bundling);
- Removal of unnecessary roads separating large green patches;
- Upgrading of existing roads rather than the building of new ones; and
- Prioritization of dense compact city development and directed growth.

The eight case studies in this guide capture the complexity of urbanization and ecosystem provision, and illustrate that there is no single approach to maximizing the benefits of urbanization, but that innovation in pursuit of maintaining the ecological functioning of a city and its region can bring sustained benefits.

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