



## Review

## Cities and biodiversity: Perspectives and governance challenges for implementing the convention on biological diversity (CBD) at the city level

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## ABSTRACT

City governments are fundamental to implement international environmental agreements, such as the convention on biological diversity (CBD). Even though many of them are not directly involved in the negotiation of international agreements, which are signed by national governments, most of those agreements are in fact implemented at the city level. The importance of city governance to tackle the challenges of biodiversity loss has increased as urban population has grown enormously in the last decades, particularly in developing countries. The way cities are designed, planned and governed influences the magnitude of their direct and indirect impacts on biodiversity.

This paper analyzes the relationship between cities, local governance and biodiversity. Initially, we examine the relationships between cities and biodiversity by looking at the major influences cities have on biodiversity loss or conservation within and outside the city boundaries, as well as the benefits of biodiversity conservation to cities, such as the provision of ecosystem services. The paper then moves to understand what are the main urban processes and governance mechanisms that can be improved to make cities effective to implement the directives of the CBD.

Urbanization creates new challenges for biodiversity conservation. As a large part of the world's population moves from rural to urban areas, there are changes in the link between human activities and biodiversity, and consequently to the way we should think biodiversity conservation policies. However, scarce attention has been given to understand how to make cities more biodiversity friendly, both within the urban fabric, but particularly in faraway places.

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## 1. Introduction: How are cities related to biodiversity, particularly with regards to implementation of the CBD?

The convention on biological diversity, or CBD, has three broad (and ambitious) objectives: to conserve and sustainably use biological diversity while fairly and equitably sharing the benefits from the use of its genetic resources. The progressive degradation of ecosystems is the main threat to biodiversity – or biological diversity, defined as the “variety of life on Earth and the natural patterns it forms” as per the CBD. The 2010 target to reduce the rate of biodiversity loss set by governments during the World Summit on Sustainable Development in 2002 will not be achieved (SCBD, 2010).

The way cities<sup>1</sup> develop definitively influences biodiversity conservation and the distribution of its benefits among different groups in society. The CBD has formally recognized the importance of involving cities and local governments in its implementation since the Ninth Conference of the Parties (COP-09) of the CBD in Bonn, in 2008. This was further strengthened at CBD COP-10 in Nagoya, in October 2010 by the official endorsement of ‘The Plan of Action on Sub-national Governments, Cities and Other Local Authorities for Biodiversity’ by the CBD’s 193 Parties (CBD COP, 2010).

However, the processes of interaction between cities and biodiversity are little understood, both in theory and in practice. This

conceptual gap needs to be filled if we are to make progress on the implementation of the CBD given that (a) cities are consumption centers of the world’s resources; (b) more than half of the global population live in cities and; (c) this proportion will grow in the future. Moreover, key decision-makers, whose decisions affect biodiversity, live in cities. Many decisions made by city inhabitants directly affect biodiversity in the city and beyond. To start this discussion, we pose several fundamental questions to be addressed in this paper.

Firstly: How do cities influence biodiversity? There are three levels of interaction between cities and biodiversity. Cities and biodiversity interact within the urban fabric. There is a variety of species living within city boundaries, the so called *urban biodiversity*, including those species well-adapted to the urban life, such as rats or pigeons. Urban biodiversity can influence the form of the city as well as its inhabitants. The development of a city also impacts directly urban biodiversity and how it is distributed among the different groups of the population. Urban biodiversity seems to be the most researched area so far.

Cities can also have a huge impact on the biodiversity in their nearby surroundings, what we call here *regional biodiversity influence*. City activities generate sewage, solid waste and air pollution, which generally impact the biodiversity in the nearby areas, such as rivers and marine or terrestrial hinterlands. The expansion of cities, both spatially and economically, also has tremendous impacts on the surrounding areas. Moreover, many resources needed in a city come from its surroundings (materials, water, food, etc.).

Additionally, cities consume large amounts of resources coming from faraway places, influencing the biodiversity of those places,

<sup>1</sup> There are many definitions for cities. In this paper, we will use a broad definition of a city as a geographically limited area dominated by a mostly urban landscape, which can include a part of, one or various administrative units. In certain contexts in the paper, the word city is also used to represent its inhabitants or governments. We will assume in most of the cases that cities are sub-national governments, as there are few city states.

what we call here *global biodiversity influence*. For example, some of the timber consumed in cities around the world comes from unregulated forestry activity in distant locations such as the Amazon or Borneo. This level of influence enabled by globalization in many markets means it can be hard to precisely identify the impact of a given city in different regions across the world.

Secondly, we consider the inverse question to the first. Namely, how does biodiversity influence cities and urban residents? Biodiversity provides a series of benefits (commonly termed ecosystem services) to cities ranging from the more directly perceived, such as water supplies and recreation facilities (parks) to less tangible effects of large biodiverse areas, such as hosting species which may help cure diseases or contribute to long term climate stability. The services that biodiversity provide are important to city planning both in terms of design as well as convincing citizens and policy-makers of the importance of implementing the CBD. However, those services and their maintenance costs are not distributed evenly among cities, countries and different groups of urban and rural citizens in the same locality. Understanding conceptually the main benefits brought by biodiversity to cities can help to direct policies.

Thirdly: Which biodiversity ought we to preserve? Cities are found in all natural environments and as such, they are subject to and exert different levels of influence on biodiversity. Urban biodiversity may not accommodate the native biodiversity of the surroundings as this may not be compatible with the urban environment or the connivance of urban residents. For example, Manaus in Brazil is surrounded by the Amazon jungle, but its citizens do not expect to share their daily life environment with local fauna including boas or piranhas. Some native trees may not be suitable for urban environment due to the natural limitations (e.g., the need for space, clean air, water or certain species to survive) or management constraints (e.g., the frequent need for trimming or cleaning beyond local capacity). Indeed, removal of some species from cities, like mosquitoes, can add to the quality of life in those cities. As for desert cities, citizens may want to have trees and other non-native species. Therefore, the role of cities to foster biodiversity will vary according to its individual context. For one city, the urban biodiversity may comport with the surrounding biodiversity and the city can leave a corridor for this biodiversity thus intertwining the urban fabric with local habitats. For another city (like Manaus), this may not be possible, or at least for some species.

Cities also affect other aspects of biodiversity mentioned in the CBD. Cities can be a threat to biosafety, as many genetic experiments or exotic species exist in cities. The uncontrolled spill of some of those can cause problems to the urban biodiversity or biodiversity as a whole.

Thus, urban governance – the way cities are designed, planned and managed – is important to determine the outcomes of their influences on the biodiversity at these different levels. Understanding how cities can create better governance mechanisms to effectively help in the preservation of biodiversity is the key to implement the directives of CBD. The actors, instruments, and processes that should be in place are still not completely understood to move the city-biodiversity agenda forward. This paper will shed light on the conceptual and practical underpinnings of the relationship between the city, governance and biodiversity.

## 2. Processes of urbanization and biodiversity

As a large amount of the world's population is concentrating in urban areas, there are changes to the relationship between human activities and biodiversity, and consequently to the way we should think biodiversity conservation policies. For example, human activi-

ties in rural areas tend to pose more direct threats to ecosystems by imposing land use changes to permit the expansion of agricultural land. Urbanization poses a relatively low scale impact per capita in terms of direct land use change for urban infrastructure, but cities depend a lot on outside resources for its needs and activities, which pose indirect threats on the world's ecosystems. This is exacerbated by the easy flow of goods and services, often without taking proper account of the environmental externalities. Thus, in an urbanized and globalized world, understanding and controlling the indirect impacts of cities will be the biggest challenge to biodiversity conservation and sustainability in general.

### 2.1. A very brief history of cities in the environment

#### 2.1.1. Past

From the very outset, the history of human settlements may be characterized as one of managing ecosystems to provide a surplus. Their existence is based on appropriating ecological goods and services from outside of its boundaries.

The industrial revolution facilitated rapid urbanization bringing with it changes in the manner, speed and scale of cities' affect on biodiversity. However, given the large number of people and economic activities they accommodate, cities are arguably the most efficient means of spatial organization yet devised. As such, cities find themselves in the paradoxical position of consumers of vast amounts of ecological resources but also playing a key role in their sustainable management given their central reliance on these resources.

#### 2.1.2. Present

As with biodiversity, the distribution of people across the Earth's surface is not an equal one. Many biodiversity hotspots occur in developing countries which are currently experiencing high levels of urbanization. Distances between protected areas and cities tend to decrease and most of protected areas affected by urbanization are located in medium and low income countries (McDonald et al., 2008).

Asia and Africa have the greatest potential for growth in urban population and by 2050, 63% of the world's urban population is estimated to be in Asia and one-quarter in Africa. However, growth rates differ markedly not just by region but also by city size. The UN-HABITAT reports that the urban population of the developing world grows at a rate of five million people per month (UN-HABITAT, 2008), which is 10 times the rate of the developed world. Much of the urban growth in developing countries happens informally (UN, 2007). On the other hand, the population of 46 countries including many major economies (Japan, Germany, and Italy) is expected to shrink by 2050. Thus, whilst urban growth attracts most attention in the urban literature due to the enormous pressures in the developing world that urbanization will bring, there is also the counter phenomenon of shrinking cities, mainly in the developed world, which also has a bearing on biodiversity.

#### 2.1.3. Future

The regional levels of urbanization referred above will lead to increasing city-regions and megacities (cities >10 million people) emerging throughout Asia and also Brazil (Florida et al., 2008). The largest of these is the Hong Kong–Shenzhen–Guangzhou mega-region in China and is already home to about 120 million people (UN-HABITAT, 2010). The fact that more than 50% of people live in cities means humanity is now sharing an urban experience. Whilst this poses a challenge in terms of consumption, the dense concentration of people nonetheless facilitates the production and dissemination of ideas and social interaction, which is crucial to moving forward on tackling issues related to governance of the commons.

Because land use change is a major cause of biodiversity loss, massive land consuming (sprawling) urbanization requires the concomitant designation of preservation areas. McDonald et al. (2008) state that currently 29 out of 825 eco-regions (home to 213 endemic terrestrial vertebrates) are more than 1/3 urbanized. Seen purely from the perspective of spatial expansion; of the 779 rare species with only one known population, 24 are expected to be affected by the growth in urban areas by 2030.

In the future, changing environmental conditions may affect millions of people worldwide and lead to massive forced migration (e.g., McGranahan et al., 2007). With rapid urban development, global changes like climate change and biodiversity loss have not received the necessary attention by many governments, even though biodiversity is seen as a precondition for the resilience of ecosystems (Elmqvist et al., 2003), including urban agglomerations.

## 2.2. Converging views in the movements for biological conservation and urban planning

Historically, the movements of urban planning and biological conservation came from very diverse intellectual traditions and have had very different practical applications over time. This duality has prevented consideration of these two themes together. However, as new ideas emerge and concepts change over time, both movements may now be converging to have some common grounds and principles. In particular, the growing number of urban ecologists could help to synthesize both disciplines in the near future, both in theory and practice.

Modern policies for biological conservation are based on promoting a separation between humans and nature. Even though some initiatives for biological conservation have been carried out for centuries, such as the creation of protected areas, the modern idea of a conservation area, is recent and can be expressed by the words of an American conservationist John Muir: “Our wild mountains should be saved from all sorts of commercialism and marks of man’s work” (Nash, 1978).

The establishment of protected areas is still necessary to preserve most of our biodiversity. However, as many developing countries have expanded their protected areas in the last four decades, such moves have provoked local conflicts (Tisdell, 1995). Hence, policy-makers, conservation advocates, and academics realized that local people are fundamental to their design and implementation of conservation actions. Furthermore, any strategy should take into account local people’s cultural and social values as well as their economic interests (McNeely, 1993). Given the dramatic growth of urban populations, there is an increasing need to understand how to integrate urban residents with conservation strategies, as they should be a part of; rather than apart from nature.

Meanwhile, urban planning approaches, moved from separating different functions in different spaces to a more diverse land use in the same space, including more biodiverse landscapes. The initial development of urban planning in the 20th century promoted the idea of functional division within cities and was epitomized by planners like Le Corbusier in cities such as Brasilia. Biological conservation was addressed only by the introduction of green areas, mostly urban parks or green belts ostensibly to provide recreation to urban residents. However, this planning tradition was challenged both from those that criticize the functional division of the city and those that advocate for more process oriented bottom-up input in the planning process (Davidoff, 1965).

As urban planning moved into the 21st century, plans and planners have indeed become more process oriented and have increasingly been aware of sustainability challenges. The idea of having cities divided by functions created problems, like urban sprawl and car dependent, climate unfriendly cities. This has lost ground

to more multi-function urban areas, with mixed-use developments. Compact cities, such as those in the *new urbanism* movement are argued to be more environmentally and people friendly. Non-traditional activities such as urban agriculture, has gained attention recently as a way to provide green spaces, food security and jobs and avoid greenhouse gas (GHG) emissions from the transportation of agricultural products. The explicit inclusion of biodiversity concerns in urban planning is still in the early stages of conceptualization, as green areas and biodiversity conservation have, for a long time, been seen as interchangeable concepts. Moreover, the inclusion of consumption and its faraway impacts is still incipient, but there is today an intellectual space to include biodiversity issues when we think about cities.

## 3. Linking cities and biodiversity

### 3.1. Biodiversity and urban wellbeing: provision of ecosystem services

Biodiversity is considered a key component of ecosystems and as such a key determinant of ecosystem functioning. Several of the services provided by ecosystems<sup>2</sup> which contribute significantly to human wellbeing are the direct products of biodiversity. On the other hand, biodiversity loss can, in one way or another, affect almost all services provided by ecosystems (MA, 2005). Urban residents benefit directly or indirectly from a multitude of ecosystem services that range from provisioning services (e.g. food, fuel, water) to regulating (e.g. climate/air pollution regulation, waste assimilation, flood/fire regulation) and cultural services (MA, 2005).

Urban residents are usually more aware of ecosystem services that are located within cities such as recreation/cultural services from parks or potable water from rivers and lakes. Stockholm’s residents benefit tremendously from ecosystem services provided by the parks and water bodies situated within the city. Such services include air pollution regulation, micro-climate regulation, noise reduction, rainwater drainage, sewage treatment and numerous recreational/cultural services (Bolund and Hunhammar, 1999). In the same manner, food and other ecosystem services (e.g. sanitation, nutrient recycling) can be provided through urban agricultural activities particularly in cities situated in developing nations (Pearson et al., 2010).

However, the fact remains that the contribution of ecosystems to the wellbeing of urban residents is much higher if the services provided by ecosystems adjacent to cities or very distant to the city itself are fully considered. For example, ecosystem services such as food, fuel (from biomass) and other non-timber forest products can be provided by ecosystems that are adjacent to cities (e.g. FAO, 2008; Tacoli, 2006). Additionally, most major cities are located within the catchments of major rivers and lakes that can provide ecosystem services such as potable water, water purification, food and energy (from upstream or downstream hydro-electric facilities). It is no wonder that coastal and inland water ecosystems are on average more urbanized than the other systems assessed in the MA (MA, 2005).

The appropriation of ecosystem services from distant ecosystems is mainly associated with urban production/consumption processes and trade (MA, 2005). Generally speaking, the richer a city is the higher its appropriation of ecosystem services and particularly the appropriation natural capital from distant ecosystems (e.g. Folke et al., 1997). It should also be noted that urban residents are benefiting tremendously from climate regulation services offered by distant ecosystems.

<sup>2</sup> Ecosystem services are defined as those “... benefits people obtain from ecosystems” (MA, 2005, p. 27).



### 3.2. Major drivers of biodiversity loss and its links to urban activity

According to the Secretariat of the CBD, many of the fundamental threats to biodiversity loss are related to public services and infrastructure, of which city governments are directly responsible (SCBD, 2007). The major human drivers of biodiversity loss are habitat destruction, introduction of alien species, overexploitation, pollution and climate change (MA, 2005). All these drivers can in one way or another be linked to urban activity, as we discuss below.

#### 3.2.1. Habitat destruction

There is a wide literature analyzing the impact of habitat destruction and land use change on biodiversity inside urban centers and along urban–rural gradients (Alberti, 2005; McKinney, 2002). At the same time consumption activities within cities have been blamed for habitat destruction in peri-urban areas and distant ecosystems, particularly land clearing for food production purposes.

#### 3.2.2. Pollution

Pollution can affect biodiversity in and around cities. There is significant evidence linking air pollution to the loss of biodiversity. It has been estimated that more than 1300 species were threatened in Europe alone due to acid deposition in 1990s (Tickle et al., 1995). Water pollution can also significantly affect biodiversity in coastal and inland water ecosystems through toxicity and eutrophication among other processes (MA, 2005; SCBD, 2010). The main water pollutants can be either directly emitted by urban areas or indirectly (e.g. runoff from agricultural activities, ship discharges) and can affect extensively aquatic ecosystems.

#### 3.2.3. Introduction of alien species

McKinney (2002) reports that there seems to be a greater prevalence of introduced species across a rural–urban gradient towards the city center. This implies the existence of “disturbed” habitats that provide opportunities for non-native species to find niches and compete with native species potentially turning into invasive species. For example ornamental plants can use different characteristics of the urban system to disperse within it and beyond the city (Säumel and Kowarik, 2010). In certain cases these non-native species have become invasive after their willing or unwilling introduction in cities. For example, European starlings were introduced America in the 1890s. From an initial population of 40 pairs in New York’s Central Park it currently numbers around 200 million individuals across the US and is competing with native bird species (MA, 2005).

#### 3.2.4. Overexploitation

An example of biodiversity overexploitation is the case of bushmeat overconsumption. Bushmeat is a significant component of the traditional human diet around the Congo Basin and its demand has grown significantly due to increasing urban consumers and even exports to diaspora populations in Europe (Chaber et al., 2010). This demand is resulting in a defaunation ring around population centers (in peri-urban areas), and may be driving unsustainable levels of hunting in more distant areas (Wilkie and Carpenter, 1999). A second example of the overexploitation of biodiversity is the trade, in most cases illegal, of wild animals and plants for pet, ornamental, medicinal and other purposes. In several cases the illegally traded animals and plants can be endemic (Flores-Palacios and Valencia-Díaz, 2007) or threatened (CITES, 2010). Demand associated with the generally higher incomes of urban residents (and not local demand) seems to be driving this wildlife trade in several parts of Asia (World Bank, 2008) and possibly around the world.

#### 3.2.5. Climate change

Climate change has emerged as a threat to biodiversity (Thomas et al., 2004). Urban activity is driving changes in the global and local climate through the emission of GHGs, the direct/indirect land use change and other processes (IPCC, 2007). The urban heat island (UHI) effect is one phenomenon that shows how urban activity can affect the local climate.

### 3.3. Linking biodiversity loss to urban processes

The previous section introduced the major human drivers of biodiversity loss. In the following sections, we provide a more detailed discussion of how different urban processes affect these drivers across scale. It should be noted that this discussion is not exhaustive given the complexity of these processes and their impact.

#### 3.3.1. Urban development

Urban development brings with it significant conservation challenges (McKinney, 2002, p. 883) and directly affects three of the main drivers of biodiversity loss, namely habitat destruction; over-exploitation and; the introduction of invasive species. The continuous expansion of urban areas results in land use and land cover change. For example, Pauchard et al. (2006, p. 247) have found that of the total area urbanized in Concepcion (Chile), “. . .55% corresponded to wetlands and 45% to agriculture, forest and shrub land cover types”.

Urban development can also induce the extinction of native species and the replacement of native species with alien (non-native) species (McKinney, 2002, p. 883). Urban–rural gradient studies in different cities reveal that the level of native species decreases in central parts of cities, where the ratio of built spaces to green spaces and the proportion of impervious surfaces are high (Zerbe et al., 2003, p. 144; McKinney, 2002, pp. 884–885). Pauchard et al. (2006) on the other hand find a correlation between road density and number of alien species, and emphasize the concentration of non-native species along roadsides and disturbed grounds.

Most of the aforementioned underlying effects of urban development on the drivers of biodiversity loss can be linked to urban planning (or lack of it) in various ways. Residential developments in cities mostly put stress on the surrounding ecology but have a further reach in certain instances. Housing needs in most developing nations are largely satisfied through informal and uncontrolled ways. These settlements are sometimes located in, or adjacent to, highly biodiverse ecosystems such as forests and mangroves. For instance, Rio de Janeiro lost a large part of its forests and mangroves due to the expansion of favelas (slums). It is estimated that 9% of the sandbank mangroves were lost in the last 3 years alone (Rocha et al., 2010). The lack of urban planning as a mechanism to control urban development contributes to environmental deterioration, especially in developing countries.

However, it should also be clarified that urban planning does not necessarily mitigate the causes of environmental deterioration and biodiversity loss. As McKinney (2002, p. 883) mentions half of the US population lives in suburban housing within sprawl developments, which is accepted as a major threat to peri-urban ecosystems (Pauchard et al., 2006, p. 273). These suburban residential developments are both planned and authorized. Thus, what prevents urban planning to make a positive change is the lack of an ecological understanding in our current planning approaches.

#### 3.3.2. Production and consumption in cities

Urbanization has brought significant changes in human lifestyle such as the rise of consumerism. Cities are centers of production of consumer goods, with massive processing of natural resources to produce commodities in or around urban areas. In fact, while cities

occupy only 2% of the earth surface, they consume 75% of its resources (UNEP and UN-HABITAT, 2005).

The huge growth in consumption during the 20th century is a sign of growing living standards and several parts of the world now benefits from the comfort of hot water, air conditioning, electricity, larger houses, abundance of food and access to air transportation. However, (UNDP, 1998) also highlights the skewed distribution of these benefits and the consequences of uncontrolled consumption, particularly by the rich urban centers, on the environment.

Urban residents' appetite for different kinds of products affects the habitat destruction and overexploitation of biodiversity in peri-urban areas and distant ecosystems while it can be a potent driver of environmental change. For example, the rising standards of living, particularly in some urban centers have been associated with shifts in diets and particularly with increases in meat consumption (e.g. FAO, 2006; Gadda and Marcotullio, 2007). Livestock production has been blamed as perhaps the single largest threat to biodiversity given that it currently appropriates almost a third of the planet's ice-free land and is the major driver of deforestation and a significant emitter of GHGs among other relevant environmental impacts. It is estimated that of the 35 identified biodiversity hotspots worldwide, 23 are affected significantly from livestock production (FAO, 2006).

Although a direct connection between increasing affluence and the number of endangered species (overexploitation) can be difficult to demonstrate, in regions like East and South East Asia, rapid economic development has expanded the use of traditional medicines and other cultural consumption. The Asian tiger, shark fins, and rhino horn have become desirable urban commodities, which can find an expression in the urban markets.

Production activities, on the other hand, have shifted geographically in the last two decades. Industrial production is now a major function in many cities in the developing world and is generally located within or just outside the cities and in close proximity to surrounding natural resources and labor. Industrial production processes generate sewage and solid waste, which can impact biodiversity in adjacent areas. Air pollution, water pollution and GHG emissions by industrial activities are also major threats to biodiversity in different spatial scales. The need exists for a reformulation of urban development objectives, particularly for a move away from purely economic growth targets and towards the inclusion of environmental quality, social inclusion and other long term concerns.

### 3.3.3. Trade and transportation

The expansion and growth of urban areas is also considered to be an important factor for the increase of trade and the circulation of commodities. As a result trade and transport is directly linked to biodiversity loss drivers such as GHG induced climate change and the introduction of invasive species, besides direct air pollution.

The global transport systems currently account for almost 25% of the world's CO<sub>2</sub> emissions, and are increasing at a faster rate than any other energy using sector (IPCC, 2007). Levels of emissions from transportation are higher than the world's average in many developed nations. Cities' shares of transportation-related emissions can also be significant. In Sao Paulo 48.6% of GHG emissions are due to land transportation-related emissions (Puppim de Oliveira, 2009).

Increasing transport from trade as a result of the urban appetite for global commodities might also have direct impacts on biodiversity. For instance, ship discharges along trade routes can facilitate the introduction of invasive species. Such an example is the case of the European zebra mussel which was introduced in the Great Lakes (US) through ballast water and had a significant impact on the biodiversity of the ecosystems it invaded (MA, 2005).

### 3.3.4. Heat stress related to urban heat island effect

The Urban Heat Island Effect (UHI), which is represented by the temperature difference between cities and their cooler surrounding areas, is increasingly recognized as creating biophysical hazards most typical to cities (Landsberg, 1981). There are many causes for UHI effects, including reduced vegetation cover, large areas of impervious surfaces, and the morphology of buildings in cityscapes that lower evaporative cooling, store heat and warm the surface air (Bonan, 2002).

Heightened air and surface temperature in urban areas relative to surrounding areas creates habitat modification in urban ecosystems. When the habitat modification is intensified, different trophic biophysical elements may appear in the urban areas, becoming the threats to the indigenous ecosystem in the cities and beyond. It even changes patterns of transmission of infectious diseases (Foley, 2005), as several vector-borne diseases may respond to temperature changes related to urbanization (Shochat et al., 2006; Bradley and Altizer, 2007).

## 4. Rethinking urban processes for promoting biodiversity conservation

There are quite a few urban processes that need to be changed to improve the urban impact on biodiversity. Their use is specific to each city, but we classify them here into six basic types.

### 4.1. Development and implementation of proper housing and infrastructure policies

Developed and developing countries face different challenges to have more environmentally or biodiversity friendly housing policies. Proper housing policies involve several aspects of the promotion, control and provision of residential spaces. While habitat and biodiversity is threatened by formal expansion in developed countries, developing countries lack the capacity to provide proper housing for its urbanizing population leading to the occupation of sensitive areas by informal settlements. Moreover, more sustainable use of materials, particularly concerning those located in biodiversity hotspots, is still incipient, though tools like green procurement can help mainstream this as cities have large purchasing power through their municipal budgets.

Addressing residential issues is vital for controlling cities' ecological footprint in developed nations. Urban sprawl and suburbanization are in large part caused by the demand for suburban lifestyles by middle- and high-income groups in developed and developing countries. McKinney (2002, p. 883) mentions that due to the spread of suburban housing in the US the growth rate of urban land use has surpassed that of lands preserved as parks or conservation areas. Policies favoring and facilitating the development of compact urban forms by better utilization of inner-city lands could reduce the ecological footprints of cities.

However, many urban poor in developing countries end up in informal settlements in biodiversity sensitive areas. There is a need of a strong housing policy that could provide low-cost, environmentally sustainable and adequate housing for the low income population, but at the same time controlling illegal settlements in areas not proper for housing to avoid disaster and biodiversity losses.

One initiative in this area is Eco-housing a program developed jointly by UNEP and UN-HABITAT, a concept that applies sustainability principles to the entire lifecycle of a housing project. Implementing eco-housing principles in cities of developing countries on a global scale will certainly have positive outcomes for biodiversity conservation, both in reducing footprints and in creating less polluting urban environments.

#### 4.2. Provision of a good network of urban green spaces and functional aquatic habitats

Urban green areas, such as parks, lawns and urban forests, are the major sources of biodiversity in and around cities. Therefore, provision of a network of green spaces is among the most effective instruments to preserve and enhance urban biodiversity (Niemela, 1999, p. 128).

Yet, allocation and designation of some open spaces as green areas alone are not enough to bring more nature in cities. Green spaces should be designated and designed in relevant ways to ensure biodiversity preservation. In this respect, provision of a variety of green spaces is essential. Zerbe et al. (2003, p. 146) emphasizes that uniformity has to be avoided when creating new open spaces as part of urban nature conservation strategies. Urban planning must guarantee the allocation and development of different kinds of green spaces in and around cities. Enhancing conservation in peri-urban areas also improves biodiversity in parts of the inner-city (Sneep et al., 2006).

The qualities of plant and animal species in green spaces are influential on the services that these spaces provide. The preference for native over exotic species, where possible, is argued to be a major guideline for design of green spaces (Zerbe et al., 2003, p. 146). Revegetation with a diversity of native plant species especially in areas, where land development is intensive, is recommended as a way to increase animal biodiversity (McKinney, 2002, p. 889). However, the biodiversity to be brought to the city can be questioned as many native animal and plants may not be compatible with city life.

Moreover, sizes of green spaces have to be considered while designing these spaces. As small parks are observed to be disturbed patches of habitat they are argued to have slight contributions to preserving biodiversity in cities. Bierwagen (2007) suggests, based on her study on the morphology of 66 urban areas in the US, that small urban areas spreading in fragmented habitats have limited impact on connectivity but that connectivity is threatened where larger urban areas spread through previously highly connected habitat. In this sense, priority needs to be given to the provision of large parks to preserve and improve urban biodiversity.

Critically important habitats and ecosystems need to be designated as 'protection or conservation zones' for an exclusive protection of species. Urban development has to be avoided and controlled within these areas. A continuous network of these protected zones together with other urban greenery should be established. To this end, 'green belts' surrounding cities and 'green corridors' running through cities are the effective strategies (Niemela, 1999, p. 123). These belts and corridors not only prevent urban sprawl but also ensure the connection between green and natural patches. It should also be noted that increased vegetation cover and more greenery within cities are also effective strategies for urban heat management. To reduce UHI effects, these strategies can be pursued with urban spatial strategies.

There are several diverse mechanisms currently being implemented in cities across the globe in order to bring cities and nature more closely. The city of Curitiba (Brazil) has launched US\$ 175 million "BioCity" program, which includes the use of native species for ornamental purposes, establishment of conservation areas, revitalization of the nearby water river basin, planning for tree lined streets and linear parks.

In addition to green spaces, aquatic urban habitats are also a key source of urban biodiversity. Therefore the sustainable design, planning and management of urban streams, canals, rivers, ponds, reservoirs, lakes and other water bodies, constitutes a key instrument for improving the contribution of cities to aquatic biodiver-

sity. In this regard, proper management of morphology, riparian vegetation, effluents, including temperature, pollutants and waste, as well as water catchments should be taken into account (Lafont et al., 2007). One example of an integrative policy instrument targeting the sustainable management of urban aquatic habitats is the Urban Biosphere Reserve (UBR) approach in Istanbul (Tezer, 2005).

#### 4.3. Support of sustainable productive uses of biodiversity in urban areas

The more 'local' planning and design practices are, the better the results in terms of biodiversity preservation that can be expected, as local planners are usually better informed and potentially more flexible to react to particular challenges. Hawken (1993) argues for the principle of creating, transforming, and consuming local products, appropriate to place and localities, so as to make cities economically and ecologically resilient over time – and to be resilient, cities must increase self-sufficiency. Moreover, as the rule of interdependent adjacencies in urban ecology states: the more diversity, and the more collaboration 'between unlikely partners', the better the chances for biodiversity, sustainability, and resilience (Hester, 2006).

Although the CBD does not address agricultural diversity directly *per se*, species and varieties of agricultural interest (including germplasm) and thus the agroecosystem in general, constitute an important component of the declaration. Policy instruments focusing on urban agroecological management can potentially contribute to:

- Reduce cities ecological footprints by providing local access to foods, fuels, fibers, ornamental species etc.
- Create spaces for in situ conservation by using traditional varieties and improving ecological corridors
- Contribute to social inclusion and traditional knowledge preservation by involving civil society.

A successful example of urban agroecological management leading to biodiversity conservation is Oakland (US). The city's urban agriculture program in public lands "Cultivating the commons", aims at using city spaces for organic food production to improve communities' access to fresh foods while contributing to environmental education of local residents (McClintock and Cooper, 2009).

The shrinking cities phenomenon also presents an intriguing policy space of economic crisis and ecological opportunity directly linked to urban agriculture. Whilst commonly thought to be a developed world artifact of socio-economic decline, they also occur in developing countries where outmigration from smaller cities to larger ones leaves behind an aged population (Haase and Schetke, 2010). Whilst socio-economic decline is not a desirable scenario, it nonetheless presents opportunities for the renewal of biodiversity. Around one third of Detroit's 376,000 vacant lots are being used as a resource to regenerate the city by investing in the scale up of urban agriculture (Huffstutter, 2009). By providing local sources of nutritious foods, cities cannot only improve local food security and create jobs and spaces for technological innovation, but they can also significantly reduce their ecological footprints (Costa-Pierce et al., 2005).

In addition to large scale, sustainable aquaculture, historical sustainable productive uses of aquatic biodiversity can also be integrated into successful policy instruments for biodiversity-friendly city governance. For instance, the case of sato-umi (traditional fisheries management) in Japan, illustrates the importance of taking into account traditional knowledge when planning coastal urban areas (Yanagi, 2005).

#### 4.4. Improvements in public transportation and more compact cities

Urbanization processes have serious implications regarding biodiversity and GHG emission levels. In order to successfully delink high income levels from high GHG emissions, climate-related policies should encourage energy-efficient building and urban forms, which do not depend on the use of automobiles. Moreover, urban expansion threatens surrounding habitats. However, the applicability of 'smart growth' principles has been questioned in the past due to striking differences between countries – e.g., in population density and land use. Recent growth patterns in urbanizing China follow rather unsustainable development paths, characterized by falling urban densities, large-scale consumption of farmland and open spaces, decreasing mix in land use, prioritizing of automobile transportation, and finally, loss of sense of place (Knaap and Zhao, 2009). This development stands in stark contrast to some of the main expected results of smart growth and sustainable development, including the preservation of natural resources, reduced car-reliance in urban transportation, increased density in residential development, and mixed-use zoning in planning (Ye et al., 2005). In the developing world, where urban spaces are expanding more rapidly, efforts should be concentrated on urban design and planning which leads to energy-efficient and compact cities.

#### 4.5. Increase in the awareness raising among urban residents and decision-makers

Attempts by planners and scientists to protect nature in urban environments generally encounter non-acceptance by urban residents (Breuste, 2004, pp. 442–443). Moreover, lack of environmental awareness generally brings the development and implementation of erratic and contradictory policies such as the draining of wetlands or their usage for waste disposal purposes (Pauchard et al., 2006, p. 274). Therefore, special attention has to be paid to educate and inform citizens and decision-makers about the merits of biodiversity preservation and nature protection. McKinney (2002, p. 884) states that a well-informed public can act as the most important means of promoting effective conservation of native species. In this respect, urban residents need to be made aware of the ecosystem services provided by preserved natural resources and of the contributions they make to the quality of life in cities (Bolund and Hunhammar, 1999, p. 300).

Education programs for general public and school-age children together with awareness-raising campaigns could contribute to informing people about the necessity and benefits of biodiversity preservation. Besides, increased community participation and active involvement of citizens in decision-making and decision-implementing for biodiversity preservation in urban areas can help to raise awareness (Breuste, 2004, p. 449). City governments should create new mechanisms through which urban residents and their associations are included in nature conservation, urban planning and management processes.

It should also be noted that a lack of, or inadequacy of awareness also applies to decision-makers and professionals in cities. In many cases, decision-makers and professionals are not well aware of the merits of biodiversity preservation. So, awareness-raising programs should also target these groups along with urban residents.

#### 4.6. Stronger links with national and international networks

The establishment of a variety of networks in which city governments and international organizations get together to design policy mechanisms for improving the contribution of urban spaces to biodiversity preservation can be an effective instrument for cooperation, knowledge sharing, critical debate, monitoring and

evaluation (indicators) and incentives (awards). Examples of current partnerships include the World Conservation Union Countdown 2010 working towards the 2010 biodiversity target; the Metropolis Association, which includes more than 90 cities across the globe; the urban Biosphere Group constituted under the UNESCO Man and Biosphere program (MAB), and Global Partnerships for Cities and Biodiversity established in Curitiba with the aim of acting as an implementation mechanism of the CBD.

Crucial for the effectiveness of partnerships is the development of monitoring and evaluation mechanisms. Performance indices are also key in fostering city governance efforts towards sustainable development. For instance, the global Good Urban Governance Index assesses the state of urban governance in the world. The results of the index are published in the UN-HABITAT State of the World's Cities report and the Global GEO Cities published by UNDP. International awards can also be a successful mechanism for fostering changes in urban governance leading to improving the impacts of cities of biodiversity. One example is Kigali (Rwanda), awarded the 2008 Habitat Scroll of Honour Award for innovations in building a modern city with zero tolerance for plastics, improved garbage collection and a substantial reduction in crime.

### 5. Cities, the CBD and the governance challenges

As the world becomes more urbanized, cities have a strong influence and a large responsibility regarding the outcome of the international treaties because city governments in many countries are in charge of some key policies such as land use, energy and transportation. However, in order to put in practice the changes analyzed in the section above, there are considerable governance challenges to be overcome.

City governments are not the only actors that influence policy implementation at the urban level. Companies, individuals and civil society groups are also fundamental to shape urban policies as their actions determine the outcomes of policies. Thus, policies should go beyond government and public administration in order to deliver effective results. Governance at the city level, which indeed delivers effective implementation of international treaties, is composed of governmental and non-governmental actors. The key attribute of the governance structure is not only the capacity of individual organizations but also the strength of coordination among them.

For governance structures to be effective, they should also connect the different levels of governance (multi-level governance). Cities and local governments have limitations of their authority over certain issues, which vary from country to country or within countries. For example, some countries, like Japan, have different kinds of local governments with different autonomy and authority. Good interactions with higher levels of government, or even at the international level, determine the capacity of local governments to act (Puppim de Oliveira, 2009). The same applies to the local non-governmental groups. The connections among themselves and with groups at the different levels of governance strengthen their capacity to influence policy-making and act. Finally, governance is crucial for the coordination at the same level in different jurisdictions. Local governments benefit greatly from common learning and sharing of solutions from their neighbors and many cities are an agglomeration of local authorities.

Many cities are already engaged in the CBD process either directly or indirectly. In the policy-making process, cities can influence their national governments to adopt certain positions in the CBD discussions. They are key stakeholders nationally as they represent important constituencies at the national level. This is especially true for large cities. Cities have also been involved in the international policy-making process through their own



international organizations. Local Governments for Sustainability (ICLEI) hosts the Biodiversity Initiative and participates in the CBD COPs. During the COP-09 in Bonn in 2008, the City of Bonn organized the Mayors Conference on Biodiversity that released the Bonn Declaration, which was also discussed at the IUCN Congress in October, 2008. In January 2010, ICLEI and other partners led the Second Curitiba Meeting on Cities and Biodiversity, following up the first meeting in 2007 when 34 mayors around the world signed the Curitiba Declaration on Cities and Biodiversity. During the period of the CBD COP-10 in Nagoya in October 2010, the first City Biodiversity Summit took a further step in affirming local action on biodiversity. Finally, the 'Plan of Action on Sub-national Governments, Cities and Other Local Authorities for Biodiversity' (CBD COP, 2010) was subsequently endorsed by the parties of the CBD.

Cities are also key in the implementation of the CBD through their national policies. The CBD includes the development of a National Biodiversity Strategy and Action Plan (NBSAP) by each Party in the treaty, and provides a framework for its implementation. The CBD COP-2 in 1995 gave the guidelines for the NBSAPs and their implementation. Those plans should be updated and assessed periodically by the parties. In tune with the governance concept, the NBSAPs should be developed and implemented with the participation of different stakeholders in society.

Besides the reference to local governments being included in the decisions under CBD, sub-national governments (cities included) and civil society are important actors in the NBSAPs as they are responsible for many factors that influence the outcome of the implementation process (UN-HABITAT and SCBD, 2010). Sub-national governments in many countries, such as Ecuador and India, have already introduced aspects of the CBD in their own policies (Pisupati, 2007). Sometimes cities are ahead of the national governments in the adoption of biodiversity policies. Even in countries that are not party to the CBD, such as the United States, there are cities engaged in the CBD process through ICLEI or their own initiatives.

However, even though cities are important institutional actors to achieve the objectives of the CBD, there are still many conceptual, institutional and political obstacles to improve the governance of the CBD process in order to incorporate cities in the main debates and actions to achieve the CBD goals.

### 5.1. Obstacles to improve the governance of the CBD

#### 5.1.1. Cities are not in the core discussions of CBD

The discussions in the CBD have been divided and focused on the different kind of ecosystems and access to them. This may be important to understand the state of biodiversity in the different ecosystems as well as the main problems they face. However, some of the main underlying indirect drivers as well as the solutions for the problems come from far away, particularly from cities, as most of the world's inhabitants and demands come from them. Cities need to be mainstreamed in the discussions of the CBD to push for biodiversity policies in the cities. This could be done by a larger involvement of cities in biodiversity discussions given that cities just started (in the mid 2000s) to get effectively engaged in the CBD process.

#### 5.1.2. CBD implementation by national governments is limited

Many national governments have implemented policies to fulfill their commitments to the CBD (NBSAPs). However, besides lack of enforcement, most of the policies focus on the source of biodiversity, resulting in actions like the creation of protected areas, biosafety programs or biodiversity inventories, which are fundamental, but do not tackle many of the underlying causes originating from cities. For example, the deforestation of the Amazon is

largely due to the demand for products (e.g., timber, agricultural products) that come from the major cities in Brazil and abroad. The lack of focus on city policy may be the result of how CBD is discussed, but also by the lack of engagement of the cities in the process.

#### 5.1.3. The CBD is still not mainstreamed in the cities' agenda

CBD related issues are not yet incorporated into the policy agenda of cities. The role of cities in the implementation of CBD will depend on the importance policy-makers put on biodiversity protection within and beyond the city boundaries and how this is reflected in terms of political, human and financial resources. Moreover, biodiversity is an inter-sectoral issue. For effective policy implementation, biodiversity preservation should not be the concern of a single department but rather mainstreamed into the agenda of various components of the local governance including civil society. In this way, concerns over biodiversity can be reflected in different sectoral decisions such as transportation, housing and land use.

#### 5.1.4. Conceptual clarifications are needed to move the agenda of biodiversity forward

The relationship between cities and biodiversity is still little understood in several aspects. Many policy-makers limit the relationship between their city and biodiversity to the promotion of green areas, which may help to protect biodiversity but falls short of addressing the impacts of cities on biodiversity beyond their boundaries. This issue is particularly important as cities develop economically because their impacts become more widespread and reach further afield. Another aspect is how to promote urban biodiversity in terms of whether cities should use local species or exotic species.

#### 5.1.5. Citizens lack awareness of the importance of biodiversity and ecosystem services

Citizens can be a driving force to push the biodiversity agenda in cities, both in terms of policy-making and implementation. They can induce governments to introduce coherent policies and also participate actively in policy implementation either voluntarily as individuals or through organized civil society. However, citizens have limited awareness of the biodiversity challenges and particularly their role in fulfilling the CBD objectives. Even though many citizens may be informed of the threats to faraway ecosystems, they do not relate those issues with the way of life in cities and how they may be indirectly responsible for them.

#### 5.1.6. There is a lack of proper instruments to deal with biodiversity at the city level

There are very few comprehensive instruments to deal with biodiversity challenges in cities. Without adequate instruments, cities find it hard to move on the implementation of CBD even when they have the political motivation and resources. Incorporation of biodiversity concerns in the existing practices, such as urban design projects or redevelopment plans, is still almost unheard of. The Singaporean government's initiative to develop proper biodiversity indicators for cities is vital in this regard. ICLEI has started to develop a comprehensive set of instruments (ICLEI, 2010). However, instruments for controlling the impacts of cities in ecosystems far from the city are still in the very early stages of development. Many of those instruments will involve the coordinated action of more than one locality. Economic instruments to deal with the protection of the biodiversity, which can be applied at the city level, are still being tested and are not widely applied. These include the payment for ecosystem services and its use for forest preservation in Costa Rica and Curitiba's tax incentive to landowners who protect natural forest in their properties.

### 5.1.7. Coordination among different levels of government and among local governments for joint action is missing

Individually, cities have limited influence on biodiversity beyond their borders, as the final result of conservation attempts depend on how other localities act. If one city acts to protect biodiversity and the others do not, the final result would most likely be ineffective. Thus, more effective coordination among cities is necessary (although not sufficient) to implement the CBD. However, cities and local government may lack the autonomy or the capacity to effectively implement policies addressing the CBD by themselves. Therefore, national governments should support cooperation among local governments and work with them to effectively implement policies, as in most cases international treaties are *de facto* implemented by local governments.

There is a diversity of governance arrangements between national and local governments and the relations between them are often complex. Within the 193 Parties in the CBD, sub-national governments have differing roles relating to important issues on biodiversity (sometimes directly implicated, sometimes only as conduits for federal guidelines and policies), and local governments also play different roles depending on the degree of decentralization of mandates, budget, population size, tax allocations and capacity. Political alliances and compatibilities further add to the complexity of relations across the levels of government from national and local. Additionally, there are distinct governance arrangements for overseas entities, relatively autonomous regions and/or territories under indigenous or tribal stewardship. Thus, due to this large institutional diversity, it is hard to find the best coordination mechanisms.

### 5.1.8. Differences in the challenges among cities

Cities are diverse and differ on the kind of challenges they face towards the implementation of the CBD, and this difference has to be taken into consideration when formulating solutions, instruments and governance mechanisms. Some cities have rich biodiversity within and around their jurisdictions and need to protect it; whereas others have little biodiversity and would need to enhance it. As cities develop economically they tend to shift most of their impacts from nearby ecosystems to affect life supporting ecosystem services in faraway places (MA, 2005). As the relationship between cities and biodiversity is in itself diverse, it may be difficult to find consensus among cities on how to act jointly to move the CBD agenda to implementation.

### 5.1.9. Political resistance at the various levels to change

The implementation of the CBD at the city level will affect the interests of certain local actors and create resistance to change. For example, many actions to protect urban and regional biodiversity will receive the resistance of some developers and property owners who would have to sacrifice their individual interests for the greater good. The imposition of any taxes or economic restrictions on trade or commerce will also face opposition. Many will argue that cities will have limited influence on overall biodiversity, particularly if the others do not act in the same way. On the other hand, cities consume large amounts of ecosystem services from other regions and pay very little for that. Even though there are already some voluntary initiatives already in progress, legislating for full compensation of ecosystem services will likely meet with great resistance from citizens.

## 5.2. Opportunities to move the agenda forward

Even though there are several obstacles for improving governance towards the implementation of the CBD, many opportunities also exist to make progress in this area though a city-oriented agenda.

### 5.2.1. Cities can be an efficient form to protect biodiversity

Cities may put a lot of pressure on ecosystems, but they can be an efficient way to settle large number of people. The impact on biodiversity and ecosystem services might be larger if the city inhabitants would spread in less dense forms of settlements. However, efficiencies in cities are offset by high consumption patterns, as cities tend to have larger income than rural areas and consequently larger consumption power. With rampant urbanization in developing countries, if urban consumption patterns could be more sustainable, there would be an opportunity to have more sustainable settlements, which would benefit from both the efficiencies of the city life and lower consumption patterns.

### 5.2.2. Cities are becoming more involved in the policies to tackle global problems and new instruments are being developed

Even though cities still do not have a relevant role in the CBD process, they are increasingly getting involved in the discussions on biodiversity in the COPs and other fora. In other international processes such as the UNFCCC, cities are more engaged and becoming influential in the decisions and implementation, and this can help to build a momentum in the CBD/biodiversity agenda for the cities, particularly now with the Plan of Action endorsed at CBD COP-10. Moreover, as cities become more involved, new ideas and tools emerge through their own experience in trying to tackle the biodiversity issues, facilitating the adoption of the CBD agenda by a larger number of cities. The efforts of Singapore and other cities to develop the City Biodiversity Index (CBI) is a good example of this.

### 5.2.3. Urban residents tend to be more educated and environmentally sensitive

Urban residents are not still sufficiently aware of the biodiversity challenges and their role as citizens to protect biodiversity. However, urban residents tend to be more educated and inclined to support biodiversity conservation, which can facilitate the process of awareness raising on biodiversity, as they also tend to be more politically active. For example, residents in cities are more positive in relation to elephant conservation than rural counterparts in Sri Lanka (Bandara and Tisdell, 2003). As many key decision-makers live in cities, education can be key to change their attitudes and behaviors both through their own increase in awareness as urban residents or by political pressure.

### 5.2.4. Policies can be more effective at the city level scale

Cities can scale up initiatives, such as awareness campaigns or law enforcement mechanisms, making them more efficient. Awareness initiatives can be more effective as cities are denser and better connected to communication means. The enforcement of legislation tends also to be more effective in cities. Thus, if CBD implementation initiatives have a larger focus on cities, their efficiency and impact can be much larger.

### 5.2.5. There are a lot of opportunities for win–win situations between biodiversity conservation and other benefits

Opportunities for win–win situations between biodiversity/ecosystem preservation and other benefits for the citizens are immense. For example, preserved mangroves or forests in cities can be an effective buffer for floods during heavy rains, reducing risks and losses. A better understanding of, and a more widespread access to, information about such synergies can help a larger number of cities to implement their biodiversity agenda and become more interested in the issue.

### 5.2.6. Convergence of the movements on biological diversity and urban planning

As biological conservation has moved to become more “people friendly”, urban planning has turned to be more “biodiversity friendly”. These two fields that were distant in the past have started to include certain aspects and ideas, which brings them closer. Even though these fields still have to evolve to have a complete incorporation of each other’s critical aspects, current convergence can allow us to discuss both fields together and combine them to move the city and biodiversity agenda forward on both sides. This is a helpful development in implementing the CBD.

## 6. Conclusions

Cities are fundamental players to achieve the objectives of the CBD, as most of the world population lives in cities today and many of the important decisions that affect biodiversity are made in cities. Cities are also among the biggest beneficiaries of biodiversity and ecosystem services, as most of their citizens and economic activities depend on those services. However, their involvement in the CBD process is still limited when compared to their potential contribution and amount of benefits they get from biodiversity. There are many conceptual underpinnings and governance obstacles to be overcome, requiring the creation of new, and adaptation of existing city planning and management instruments to deal with biodiversity properly.

From an ecological perspective, there are two different, yet interrelated kinds of instruments through which cities can make positive contributions to the CBD: 1. those aiming at reducing cities’ ecological footprints and 2. those aiming at restoring urban ecosystems. Although deeply interconnected, 1 does not necessarily include 2, and vice versa. For example, the reduction of consumption or increase in recycling reduces ecological footprints, but can be achieved without making any significant local environmental improvements. Likewise, cities can increase local biodiversity by creating new urban parks for leisure activities using local species while at the same time increase their per capita consumption of meat, thus not reducing their ecological footprints at a regional or global scale. Yet in certain cases, both kinds of instruments are necessarily binding: for instance, in transportation-related impacts, improving urban mobility systems contributes both to improved local ecosystems and to reduced global atmospheric impacts. Given the complexity intrinsic to tackling the ecological causes of biodiversity loss by urban governance mechanisms, efforts should be directed towards designing and implementing synergic instruments, that is, developing mechanisms which contribute to both reducing the ecological footprints of cities while improving the ecology of the urban fabric.

In addition to the ecological dimensions, integrating equity, transparency, accountability, security, civic engagement and citizenship is key to improve governance. In this respect, the inclusion of civil society and stakeholder group in local governmental policy initiatives is vital for effective biodiversity management (Elander et al., 2005). Furthermore, since interest groups and local stakeholders have a direct influence in biodiversity management through their own land use and management practices in green spaces (Barthel et al., 2005), policy mechanisms should be designed and implemented in conjunction with social initiatives, in order to create adaptive, polycentric networks.

Urban planning can serve as an effective instrument to reduce the adverse impacts of urbanization on natural environment. Nevertheless, it is not possible to rely on the current approaches and practices of urban planning as they generally lack ecological knowledge and understanding of its consequences. Baseline information in terms of the physical properties and biotic characteris-

tics of biotope patches in and around cities (Niemela, 1999, p. 127), as outlined in the CBI, would provide the sound scientific knowledge base for urban planning decisions. City governments can benefit from an urban planning approach mainstreamed with an ecological understanding in addressing biodiversity-related problems.

There is a growing participation of local governments and city representatives in the CBD process and an increasing concern about the importance of cities for the effective implementation of the CBD. However, results can still be improved, as cities have lagged in their policies towards biodiversity. The engagement of cities to biodiversity-related policies is still low compared to other global issues, such as climate change. Moreover, if we consider the three levels of interaction between cities and biodiversity (urban biodiversity, regional biodiversity and global biodiversity) much of the effort have limited to urban biodiversity. The influence on regional biodiversity has been of concern to some cities in their policies to avoid sprawl, but mostly for different reasons, such as the need to revitalize the city centers. Finally, the global influence on biodiversity is still in its early stages of conceptualization at the local level. Nevertheless, the interest of cities in the biodiversity agenda is moving fast, and there are a lot of opportunities engage cities as effective actors in the implementation of the CBD. This will require a large effort for collective action, beyond the cooperation of cities and support across various levels of governance, there is also a critical role for the scientific community, who can contribute much to addressing the conceptual component of this agenda.

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