



“BIOPOLIS”

Biopolicy for Greener and More Livable Cities

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Abstract

Urban centers are the engines which must bear the brunt of required changes to meet climate change mitigation goals, whilst continuing to provide social and economic opportunities. Restoring nature to the city is not a luxury; it is vitally important to our health and well-being. Biopolicy can help international decision-makers find new ways for understanding the relationships between cities and their environments and how environmental burdens may be mitigated or resolved. A “biopolis” model, as proposed and supported by the principles of biopolicy, can evolve into a coordinated program of action in sustainable urban management that limits emissions, preserves and expands green spaces, protects waterways, encourages urban farming, enhances cultural development, creates green jobs and promotes educational opportunities for all.

1. Building a “Biopolis” – The Road to Climate Resilient Cities

The biggest challenge for the 21st century will be the development of climate-efficient urban growth. With rates of urbanization increasing and per capita energy consumption on the rise, cities around the world are an important part of the climate change problem, but they can be an important part of the solution as well. For twenty eight years, the Biopolitics International Organisation (B.I.O.) has been sensitizing experts, decision-makers and the local authorities to promote new and innovative ways of achieving greener and more livable cities. Progress in this area has been extensive, and today, urban management policy is largely being developed with due concern for the environment. Moreover, green construction materials are increasingly sought after, while energy savings in buildings are promoted through renewable energy options and applications. Clean vehicles, public transportation based on alternative energy, optimum recycling, heating and cooling technology with the use of low-emissions/low polluting systems, are a few examples of technologies which are vital to the development of green cities. Partnerships between governments, community groups and the private sector have proven very useful in shaping the urban landscape of tomorrow in an environmentally responsible manner.

Cities are home to about half of the world’s population, and this proportion increases with each passing year. However, living in a modern city need not exclude experiencing the joys of nature. Cities in many countries have taken steps to restore the ambiance of natural

systems within their boundaries. They strive to become a “biopolis,” an environmentally sustainable city, in which human and natural populations can live in harmonious balance.

Restoring nature to the city is not a luxury; it is vitally important to our health and well-being. Cities must become more livable places for their human populations and more inviting for wildlife. They should capitalize on their green assets and expand the presence of natural systems found within their boundaries. They can achieve this through a coordinated program in sustainable urban management that preserves and expands green spaces, protects waterways, encourages urban farming, and develops educational opportunities for all. In addition to providing vital environmental functions, such initiatives can greatly benefit the physical and mental health of the inhabitants, not to mention the local economy and the job market. The participation and empowerment of all citizens are vital to the success of any such program.

1.1 Reducing Urban Sprawl and Increasing Green Spaces

Land development affects the demand for transportation, and the provision of transportation facilities changes how land is used. Real progress toward sustainable urban management cannot be made without addressing this interconnection. Designing communities so that the demand for transport is less, discouraging urban sprawl, and supporting more compact communities where people can move more easily from home to work, shopping, etc., are essential for achieving livable cities with enhanced quality of life for all their citizens.

All green spaces help urban areas adapt to the impact of climate change and are vital in climate change mitigation efforts. Cities developing open space plans that provide for interconnected systems of green spaces, including parks, gardens, walkways and stream corridors, can reap multiple benefits. Increasing urban green spaces can be achieved by a variety of techniques, including outright purchase of undeveloped tracts, gifts and bequests of land, laws and regulations requiring that a certain percentage of new development be retained as open space, conservation easements restricting the use of land in the future to green space, and the creation of urban farms and gardens. In addition, cities should adopt programs for continuous tree planting along boulevards, in parks and along streams. Tree species should be carefully selected for their suitability to the individual area, and consideration should be given to native species, water needs, susceptibility to disease, and other factors. Trees with minimal maintenance requirements should be preferred.

1.2 Taking Advantage of Urban Waterways

Rivers and streams are natural corridors that transect many urban areas. They provide a great opportunity for recreation, education and contact with nature. Fishing, boating, and even swimming, depending on the water quality, are common activities along urban riverbanks. Urban waterways are vital urban environmental assets that should be protected and made an integral part of the open space system of a city. Pathways should be provided along stream corridors that connect to other paths in the city’s pedestrian and open space network. Where appropriate, measures should be taken to protect wildlife, such as the enhancement of waterfowl nesting areas, while at the same time providing sites for passive, non-intrusive observation.

1.3 Clean Transport

To respond to the climate change challenge, urban transport policy must contribute both to solving traffic congestion and to reducing the demand for fossil fuels. Clean vehicles and public transportation based on alternative energy and greener transport practices and policies can reduce CO₂ emissions and improve efficiency. In addition, an ongoing evaluation of technologies is crucial in order to make sure that policies are well fitted to growing trends and that investment is not being made on unproductive schemes.

1.4 Employment and Education

Cities are areas of enhanced economic growth and opportunity. Urban areas have always created jobs, and attracted and trained talented and energetic individuals. From their origins as trading facilities to their emergence as centers of resource development and manufacturing, cities are the loci of economic activity for the majority of the world's population. Many people migrate to urban areas in search of employment and a better life, some successfully, others unsuccessfully. Some bring skills with them, but many do not. Because of this, cities have always struggled with balancing the needs of residents with the needs of the economy, especially during periods of economic downturn.

By training/re-training unemployed persons, urban communities can enhance their available human capital and promote positive economic improvement within their areas. Practical experience in the field, while making a direct difference to the community served, comes with extra benefit to the individual, as people experienced in sustainable development practices are highly employable in many economic sectors.

Furthermore, making cities adapt to climate change will require a well-trained cadre of professionals who understand the implications of climate change for urban development. City-specific educational programs about climate change in urban environments are also instrumental in achieving the mitigation of the impact of urban activities and climate development.

1.5 Agriculture in the City

Urban agriculture is often viewed as a holdover from the past and a use that will eventually give way to development. This view should be re-considered however. Farming and vegetable gardens in cities are valuable assets that can be encouraged and protected through appropriate city policy that supports the existence of urban agriculture and provides for its continuance. Organic farming, which eliminates the need for pesticides, is a preferable approach for urban areas in order to protect public health.

New concepts in urban design should incorporate natural elements and better integrate humans with the environment, wildlife and greenery. As proposed by B.I.O. since 1985, an extension of the existing roof that allows plants, trees and shrubs to grow in a light-weight growing medium, can be an effective strategy to address several environmental conditions facing urban environments, including management of storm water runoff and pollution miti-

gation. In this context, algae beds can be used to reduce greenhouse gas emissions, while creating an additional feedstock for renewable fuel production.

1.6 New Technologies – “Smart Cities”

Optimum recycling regimes, water management systems, heating and cooling technology with the use of low-emissions/low polluting systems, are a few examples of new technologies which are vital to the development of climate resilient cities. Furthermore, technology can radically change the way people interact with the urban environment and allow them to get more engaged in decisions about where they live, a key part of shaping zero-emission cities in the future. The challenge of fast urbanization is opening the way for the development of highly “smarter” cities, as more and more urban functions rely on emerging technologies. The differentiating factor that can make cities “smart” is the integrated use of information and communication technologies (ICT) in optimizing the flow of information among infrastructure and services such as administration, education, healthcare, public safety, real estate, transportation, and utilities.

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1.7 Bio-culture for Sustainable Urban Management

Culture is an essential element of a climate-friendly city. The environment is affected by our culture, which is, in turn, shaped by the environment. Bio-culture represents a conscious effort to reach this interdependence. Aesthetic values, music, science, the arts, politics, and economics can all come together in the struggle for a better quality of life. Bio-culture in the city can provide the needed momentum and life-supporting policies to contribute to a more efficient implementation of urban policies with a vision capable of reinventing cities adapted to the challenges of the 21st century.

Partnerships between governments, community groups and the private sector have proven very useful in shaping the urban landscape of tomorrow in an environmentally responsible manner. A climate resilient city also encourages its citizens to commit to sustainable actions in the areas of transportation, energy use, recycling, water, food, health, and community education. Cities that adopt a program of sustainable management with the ultimate goal of zero emissions will reap many benefits, both now and in the future. They will become more attractive, healthful and livable places, and the cleansing of pollutants from the air and the absorption of carbon by trees will provide long-term benefits for both humans and wildlife. Restoring nature and culture to the city would be a great step toward the creation of a true biopolis.

2. Climate Change Mitigation Through Urban Adaptation

Cities accommodate more than half the world’s population and account for two-thirds of energy consumption and over 60% of greenhouse-gas emissions. Productivity levels are also generally higher in metropolitan areas and the increasing trade and capital flows give rise to

increasing flows of people, goods, services and ideas. In this context, urbanization is viewed as the primary cause of many problems, including climate change, but also as the primary stage for a more sustainable development in the 21st century.

In addition to being one of the biggest development challenges of this century, climate change also offers opportunities to improve the way we plan and participate in cities, and decide on how best to manage the role of urban centers with respect to local, regional and global environmental changes. Achieving inclusive and sustainable growth in cities can help to build vital social networks, and help individual citizens and the community as a whole to be involved and productive. It is also a means for improving employment options and creating green jobs with staying power.

Urban centers are the engines which must bear the brunt of required changes to meet climate change mitigation goals, whilst continuing to provide social and economic opportunities. Moreover, in an era of globalization in which cities are inter-connected through flows of trade, technology, investment, finance, and people, new environmental burdens and scales of applicable governance are constantly evolving that require fresh perspectives from management. Together, these pressures are rendering cities all over the world more vulnerable to both natural and human-induced threats. Therefore, planning policies to help alleviate complex environmental stresses requires new ways of understanding the relationships between cities and their environment and how environmental burdens might be mitigated or resolved.

At its most basic level, the core principle of sustainable urban planning is that we should plan for a better future. Establishing a better understanding of the urban decision-making process and how the principles of sustainable development can be incorporated at each level of decision-making can maximize the opportunities afforded by urbanization. Remedies for curbing urban growth and its negative effects often lead to other problems. As a result, city leadership in partnership with civil society and the private sector is crucial in guaranteeing growth which can meet the challenge of urban sustainability.

With urban activities being the main source for CO₂ emissions, the choices made by urban centers over the next few decades will play a crucial role in determining worldwide greenhouse gas emissions and natural resource depletion. Cities consume 60% to 80% of the world's energy production, and with the urban population of the developing world projected to reach more than 5 billion by 2050, ideas about how to combine urbanization and sustainability are of a critical and urgent nature.

Although climate change has become increasingly prominent on the international development agenda, historically the focus has been on the effects it has on the rural environment and agricultural production. This is slowly changing, as urban populations are likely to be among those most severely affected by future climate change, being especially vulnerable to changes associated with warming temperatures. Many of the world's growing urban areas, especially in developing countries, will likely suffer disproportionately from the impacts of a changing climate. Major cities are at risk of flooding from rising sea levels. Heat-trapping

urban landscapes – buildings and paved surfaces – can raise the temperatures and lower the air quality dangerously through the urban heat island effect. In cities of the developing world, one out of every three people lives in slums, making them particularly vulnerable to the health and environmental risks posed by climate change. Also, climate change may worsen access to basic urban services and compromise urban livelihoods.

Low-carbon emissions and low pollution levels are essential components of quality of life in cities. Better urban planning and policies can reduce energy use and greenhouse gas emissions and improve the resilience of urban infrastructure to climate change, thus shaping future trends. Competitive cities that are eager to attract human and financial capital in order to enhance jobs and prosperity need to curb air pollution and ensure a healthy environment. Energy-efficient housing, measures to reduce traffic and vehicle emissions and to promote non-motorized transport, contribute directly to the reduction of CO₂. Cutting emissions will also reduce local pollution from industries and transport, thus improving urban air quality and the health of city dwellers.

Significant action by cities on climate change will have positive economic returns in the future. Making cities adapt to the effects of climate change requires a commitment from city governments to allocate and invest resources in infrastructure and technology. Such a commitment may be hard to conceive in situations where resources are scarce at the local level, and other needs require urgent attention. However, action on renewable energy and energy efficiency in cities can significantly reduce municipal service operating costs and has enormous long-term benefits, as much of what needs to be done to reduce risks from climate change also reduces other risks. For instance, better drainage systems protect health and reduce risks of flooding, and good healthcare systems can support disaster preparedness and rapid post-disaster response.

The concentration of people and production in cities facilitates the creation of increased employment opportunities through actions to keep down energy requirements and support waste reduction and recycling. Modest adjustments to investment by choosing low-carbon technologies can, over time, bring much lower greenhouse gas emissions, even in cities with booming economies. Such adaptation does not require additional government spending, but is achieved by changing regulatory frameworks that influence individual, household, community, corporate and public investments (adjustments to building regulations, land use plans, pollution control, waste management, etc.). Some indicative actions, which are also sources of green jobs, may include:

- increasing the energy efficiency of urban infrastructure such as buildings and transportation systems
- using resources more effectively, i.e., through advanced waste and water management regimes
- producing clean energy at the district-level, as well as sourcing clean energy from large-scale suppliers
- encouraging and engaging all citizens in climate change efforts and making them aware of the consequences of climate change

It is up to high-income nations to show how a transformation to sustainable urbanization can be combined with high living standards. However, urgent action is also needed in the urban areas of low-income and middle-income countries, both through mitigation to curb greenhouse gas emissions, and adaptation to the serious risks that climate change brings. Each city shares challenges and has unique needs. Finding smart and efficient ways to provide for more people with fewer resources will make cities more resilient to climate change and reduce drastic environmental changes.

3. Zero-carbon Urban Networks

Climate protection essentially means addressing local problems in a way that significantly improves efficiency and prudence in the use of energy and natural resources. Many campaigns and initiatives are enhancing international efforts to curb greenhouse gas emissions by implementing measures at the local level in the transportation, energy, building and waste sectors. These measures call for integrated and collaborative planning and management regimes to transform conventional urban areas into environmentally sustainable districts based on a cyclical urban metabolism. Furthermore, these actions are instrumental in protecting urban environments and slowing global warming, and can ultimately lead to zero-carbon urban networks with virtually no carbon footprint.

Zero-carbon urban networks served by renewable energy are emerging increasingly in France for heating homes and commercial units. In the U.S.A., the city of Dallas, Texas, derives 40% of its urban electricity supply from renewable energy sources, and approximately 76,750 employees are involved in energy efficiency services, including lighting, heating and cooling, transport regulation systems, personnel and site protection. In Salt Lake City, Utah, municipal operations have reduced greenhouse gas emissions by 31% since 2001, well below the targets of the Kyoto Protocol. Over 20% of the electricity used at the City-County Building is from renewable wind energy that does not contribute to global warming. The city also encourages its citizens to commit to sustainable actions in the areas of transportation, energy use, recycling, water, food, health, and community education.

Barcelona, Spain, has installed a district heating and cooling network which engages 65,900 employees in the water management and waste sectors, who offer services in consultancy, water treatment plants and infrastructure, water cycle management, waste services, recovery, recycling and remediation. Amman, Jordan, recently constructed a wastewater treatment plant for 2.2 million inhabitants that is 95% self-sufficient in energy.

District heating is also widely implemented in Sweden, where strict environmental legislation guides public authorities to cooperate with the private sector in the creation of green cities. In this context, an initiative themed SymbioCity was launched by the Swedish Government in 2008 to promote collaboration between the Swedish government and the Swedish industrial sector in the creation of circular, carbon neutral systems. By 2009, the initiative had created business opportunities worth the equivalent of SEK 2.6 billion. It was assessed that employment for Swedish environmental technology companies could increase by 8% annually.

An ambitious plan is under way to make Perth the world's first geothermally cooled city with the goal of achieving zero emissions under a new \$20 million Australian Government-funded project which involves CSIRO, Australia's national science agency, and The University of Western Australia. To achieve this goal the project is aiming to develop a geothermal solution to meet the cooling needs of the new Pawsey Centre supercomputer, one of the world's most powerful computers. The project will significantly reduce water use through direct cooling with groundwater and thereby save over 38 million liters of water each year compared to the standard cooling tower solution.

In China, Hong Kong boasts large modern landfill facilities with biogas recovery and on-site use, while a circular economy is generated from recycling sludge in Shanghai. Energy recovery is achieved using drying technology and the dry sludge is subsequently used as a combustible at a local power plant. The whole procedure, which serves 610,000 inhabitants, is carbon-neutral.

In Tehran, the capital of Iran, the preservation of non-renewable energy resources and efforts to use clean energy are among the most important issues the local administration has paid attention to. "Energy garden parks" have been established and solar cells have been placed on over 100 buses, 1000 traffic lights, 100 flyovers and other urban infrastructure. Large garden parks offer extensive green recreational spaces, while most highways are flanked by hillsides of green. A 70-hectare military base was turned into a park with recreational and sports facilities. Furthermore, 250 km of cycling track has been set up.

Climate change is an important issue to the citizens of Sønderborg in Denmark. The city is dedicated to creating and demonstrating new solutions, robust measurable CO₂ reductions, new green jobs and a talented generation of young people before 2029. A public-private partnership – Project Zero – was created to inspire and drive Sønderborg's conversion into a zero-carbon community, based on improved energy efficiency, conversion of energy sources into renewables and by uniting all of the area's stakeholders to reach a clear goal: carbon-neutral growth and sustainable urban development. Residents are collaborating on new green investments, while farmers are erecting their own wind turbines, demonstrating broad support for the Project Zero vision.

Energy-efficient technology is scattered throughout the German city of Freiburg, from the Strandbad swimming pool, which is heated with solar energy, to the university's clinic, which uses solar technology for cooling. Solar energy cells appear on many building facades and solar thermal tanks line the rooftops. The clustering of solar manufacturing firms, research institutes and policies for deployment in commercial, industrial and residential buildings earned Freiburg the nickname, the "Solar Region of Germany." In Vauban, a neighborhood on the outskirts of the town, 2,000 newly built environmentally friendly homes are located, including a 50-home solar village project that feeds more power into the grid than it uses. A nearby development incorporates a biomass heat and power plant that uses only 15% of the energy required by other homes in the city. In fact, Germany's low carbon framework explains why several other cities are leaders in energy efficiency. For example, Hamburg has also adopted its own strict climate action plans that support development of more efficient and technologically sophisticated buildings and transport networks.

4. Clean Energy Transforms the Transport Sector

The contribution of transportation to global emissions is 13%, and spurs climate change, releasing pollution and greenhouse gases into the atmosphere.¹ It is also a main source of noise and vibration. The air quality in most cities worldwide is poor as a result of vehicular traffic and represents a threat to human health. The construction and operation of highways and transit systems disrupt biotic habitats, pollute the water and permanently alter the landscape.² If our transportation patterns continue in the “business-as-usual” path, the global vehicle fleet will have reached 2 to 3 billion by 2050.^{3, 4}

The possibilities of the use of clean and renewable energy in the transport sector are endless. The broad range of prototype fuel cell and hydrogen developments currently taking place is creating a new concept of car technology that has led to better functioning electric automobiles with no noise pollution and no exhaust gases. In the effort to reduce CO₂ emissions and improve efficiency, more innovative technologies have allowed a wider use of fuels and power sources and also the combination of more than one propulsion technique for a vehicle. Soon, conventional modes of transportation will be almost fully replaced by electric vehicles. These developments will lead to a greater and wider use of hydrogen cells, which are quickly becoming the wave of the future and resulting in new areas of research and development.

The efficient provision of transport services is crucial for this effort to succeed. To effectively respond to the climate change challenge, transport policy must contribute both to solving traffic congestion and to reducing the demand for fossil fuels. In addition, an ongoing evaluation of technologies is crucial in order to make sure that policies are well fitted to growing trends and that investment is not being made on unproductive schemes. This kind of analysis should be performed along with broader cost benefit analyses, taking into account environmental, social and economic benefits. The side effects of policies should also be carefully assessed, so that policies do not result in harmful outcomes.

Governments may have a role to play in supporting commercialization of innovative car technologies and fuels. New business models and ideas are important for the diffusion of green cars, so encouraging venture capital investments may be a fruitful possibility. Programs in support of the commercialization of eco-innovations have had mostly positive outcomes in terms of private fund mobilization and employment creation, although some concerns about management and effectiveness have been raised.

5. Urban Agriculture – Resilient Urban Food Systems

Across the globe, urban farms that provide fresh, local produce to city dwellers and create jobs for their communities are steadily thriving. An urban agriculture movement has been quietly gaining momentum for several decades, in the developed and developing worlds alike, evolving out of the need to address such pressing issues as food sustainability and security, urban population growth, year-round crop production, a safe and varied food supply, farmland and forest land loss due to development, creative use of wastelands in urban areas, and recycling of food wastes in cities. With city growth pushing cultivation land further and

further from city centers, urban agriculture also becomes more and more sensible because it can avoid the increasing costs of transport, packing and refrigeration and the losses of produce.

As a result of this spreading movement, poor urban populations have been encouraged to grow their own food in their own neighborhoods with impressive outcomes: urban farms have turned empty sites and abandoned lots of inner city neighborhoods into productive oases that contribute to sustainable urban development, and help to bring in income and improve local diets. For example, in Peru, small urban farms located in the poorest slums in Lima provide food security and food safety for some of the most vulnerable urban communities. There are currently over 100 urban farmers in Lima, 83 of whom grow vegetables, 52 raise small animals, 45 grow fruit trees, 31 grow aromatic herbs and 18 produce ornamental plants.

Employment potential also increases as several work opportunities arise in helping urban farmers to improve soil qualities and water sequestration and conservation techniques, which require specific skills. Value-added products and approaches for tapping new markets can be created in the process and become a source for new employment. Educational curricula can also be developed and implemented, especially in cases where urban farms are located near schools or educational and/or training centers.

Horticulture, the branch of agriculture concerned with intensively cultivated plants, supplements urban agriculture and has been shown to empower the urban poor, contributing to their food security and nutrition. It also helps to make the city greener and to enhance social and environmental resilience, from slum improvement and waste management, to an increase in employment and community development. To support horticulture and urban agriculture, especially in developing countries, the FAO has helped direct multidisciplinary projects in cities to improve policies and institutional frameworks. These projects include the promotion of irrigated commercial gardening at urban peripheries, hydroponic micro-gardens in slum areas and green rooftops in city centers.

But even in the developed world, urban farmers have been receiving land, training, financial support, supplies, and even compost from municipalities and NGOs to establish urban farms. In many cities in the U.S.A., for instance, sites designated for urban agriculture are able to receive protective status from the onslaught of developers anxious to turn them into high-priced developments, making them evolve into lucrative businesses. The Red Hook Farm, in the city of Brooklyn in New York, started by a local youth group in 2003 on an abandoned asphalt ball field, sold more than US\$ 25,000 of produce by 2007. Another urban farm in Philadelphia took in some US\$ 67,000 from its production of carrots, lettuce and radishes, while the Growing Power NGO in Milwaukee sold over US\$ 220,000 worth of lettuces, winter greens, sprouts and fish to commercial enterprises and consumers. These successful organizations are helped not only by land and financial support; training has proven equally important to get these projects going, making the idea of urban farming particularly suitable for the unemployed. This training includes many aspects, from how to run an urban farm to organic farming methods. There is even a formal sixth-month training program available at the Center for Agroecology and Sustainable Food Systems in the state of California which urban farmers throughout the U.S.A. can attend.

Similarly in Europe, urban agriculture has been making promising inroads. In the metropolitan area of Delft in the Netherlands, effective and integrated land use policies have led to the creation of a unique organic farm on the outskirts of the town that has been providing not only healthy produce but also a recreational outpost and educational resource for a decade, while over 800 hectares of public land in London were already being used for gardening by the turn of the century both within the urban area and on its outskirts.

Asian countries have also seen a rise in urban agriculture. In and around the capital city of Vietnam, Hanoi, more than 150,000 tons of fruits and vegetables are produced each year. China has been including food production into its city plans since the 1960s and today receives more than half of its vegetable supply from its own market gardens, which are cheaper than trucking them in from distant sources. In Beijing, a growing number of urban farms have helped double the income of local farmers and improve the nutrition of the local populace. In Shanghai, 60% of vegetables, 100% of milk, 90% of eggs and 50% of pork and poultry come from urban and peri-urban areas.

In many regions of Africa, urban agriculture is extensively applied for the reduction of poverty and food insecurity, and the enhancement of urban environmental management. In the 1990s, urban agriculture in Nairobi offered the greatest self-empowerment earnings for small-scale enterprises and the third highest profits for urban Kenya. Correspondingly, Dakar, the capital and largest city of Senegal, is responsible for 60% of vegetable and 65% of poultry production nationally, while in Accra, Ghana, 90% of the city's fresh vegetable consumption is from production within the city. In the Democratic Republic of Congo, the FAO has helped devise measures regulating 1,600 ha of garden space to be operated by 20,000 full-time growers in five cities, introducing improved vegetable varieties and upgraded irrigation structures which extend water availability year round. To ensure safety and quality of production, 450 growers' associations were trained in good practices with organic fertilizers and bio-pesticides. In Kinshasa, 75,000 to 85,000 tons of vegetables, or 65% of the city's supply, come from market gardens.

Next to food security, local economic development and poverty alleviation, the environmental implications of urban agriculture and horticulture are also vital, as many environmental problems that accompany urbanization may be tackled with urban farming. Bogotá, Colombia, and Sao Paulo, Brazil, have benefited immensely from the improved soil structure and porosity caused by urban gardens, avoiding landslides and flooding. Urban agriculture can also help the "greening" of a city, by turning unattractive, abandoned open spaces, which are often used as garbage dumps, into green zones with positive micro-climate effects, including cooling and carbon sequestration. Many municipalities on Peru's arid coast were made "green" with the help of urban agriculture.

An exploration of the possible role of urban agriculture in future megacities is carried out in Casablanca, Morocco. Given the highly varied landscape of the urban area and the complex nature of the project, a multi-strategic approach is followed with the use of several specific goals pursued in a variety of ways. The key directives are to raise awareness about urban agriculture, begin implementing it and evaluating how it works and how it can be

improved in various contexts while observing what benefits it has for issues of sustainability and poverty alleviation in the city.

Urban agriculture is a powerful means for social integration as well. Disadvantaged groups, such as orphans, the elderly and the unemployed, have been involved in urban agriculture programs set up by NGOs or municipalities which are aimed at helping them integrate into the urban fabric and improve their livelihoods. Participants may feel enriched and empowered by these community projects in addition to the benefits reaped nutritionally and economically. In developed countries, the aesthetic and recreational aspects (recreational routes, fresh food educational functions, animal contact) of urban and peri-urban farms may play a bigger role in the promotion of urban agriculture. Indeed, with cities throughout the world already producing one-third of the food for local consumption, this trend is likely to continue as urban residents realize the dietary, economic, environmental and social benefits of growing their own food.

6. Zero-emission Cities Generate Employment

In view of climate change mitigation, cities around the world are re-examining their urban assets in terms of competitiveness, vibrancy and quality of life. Cities need to plan for the longer term to manage waste and conserve resources in order to be environmentally sustainable, socially progressive and economically competitive. Good governance and institutional frameworks are fundamental to sustainable urban management.

The goal of zero-emission cities has the potential to drive the development of new technologies and business opportunities. Development policies that fully harness the benefits of natural systems and protect and nurture these assets for future generations can enable local governments to lead an urban renewal process that delivers significant benefits, both economically and socially, and caters to the needs and priorities of key stakeholders.

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Cities everywhere are seeing the changes ahead, as well as the opportunities and commercial benefits associated with early action for climate change mitigation, such as the transition to a low-emissions economy. This recognition is already driving a range of employment opportunities across industries and services, such as the creation and implementation of alternative technologies and products, more efficient logistics and production processes, and associated services for better urban development.

Solutions addressing climate change strengthen community development, increase the livability of cities, improve the well-being of citizens and create green jobs. Green jobs can be found across traditional and new sectors, as many urban services make climate-smart improvements in their operations. Environmentally sound urban practices save money from reduced waste disposal and energy costs, create shared value and improve productivity through better environmental performance. Green jobs can result from the creation of new

employment opportunities or from the transformation of existing jobs through the upgradation of skills, and through organizations that green their existing practices to meet the growing demands of creative urban development.

Increasing transportation alternatives, reducing infrastructure costs, creating more affordable housing, improving air quality, preserving natural and cultural resources, and restoring local economic and social vitality are just some of the approaches for creative urban development. The building sector can make a substantial contribution to a sustainable world, but sustainability can become established only when the mentality throughout the entire developmental process changes. Cities that are not livable places are not likely to perform important economic functions in the future.

Green job programs are rapidly becoming high-profile centerpieces of many cities' environmental and economic development agendas. An example is set by the city of Vancouver in Canada, which has approximately 14,900 green jobs in eight sectors, based on numbers and surveys from March 2010 and April 2011. These jobs make up for more than 3% of the total jobs in the city. Indicative green jobs include, but are not limited to, green development officers, energy advisors, green funds managers, carbon offset aggregators, ICT networking specialists, smart grid engineers and technicians, smart meter manufacturers, industry association directors, green purchasing managers, policy analysts and researchers, and sustainability educators.

New York City has also launched several long-term sustainability initiatives to expand green jobs citywide. PlaNYC 2030 is a program created in 2007 which comprises 127 initiatives with 10 major goals, ranging from a 10-minute walk to a park to achieving the cleanest air quality of any big city in the U.S.A., in order to meet the goal of reducing citywide greenhouse gas emissions by 30% by 2030. Attempts to meet these goals create opportunities in many green employment fields, including building retrofits, urban forestry, renewable energy and storm water management, resulting in a 10-year planned investment of almost US\$1 billion in municipal retrofits and new technologies.

Addressing the diverse aspects of urban environmental challenges will continue to be an aspiration and vision for many urban planners worldwide. Economically viable zero-emission communities can evolve from critical collaborations between developers and their city government counterparts, and foster urban development that improves the local environment and quality of life, and creates jobs. Such communities are underway in Melbourne and Sydney, Australia, in Palhoça and São Paulo, Brazil, in Toronto and Victoria, Canada, in Ahmedabad and Jaipur, India, outside Panama City, Panama, in Pretoria, South Africa, in Seoul, South Korea, in Stockholm, Sweden, in Sonderborg, Denmark, in London, U.K., and in San Francisco and Oberlin, in the U.S.A.

Information and educational resources should also become available to all citizens as tools for understanding and appreciating what it means to live sustainably and to become motivated to act as stewards of a sustainable city. Integrating environmental dynamics with urban systems must be viewed as a challenge and opportunity in helping cities contribute to sustainability. All these actions can serve as an inspiration and guide to communities around

the world that want to participate in the effort to reverse global warming and environmental degradation, while creating new sources of employment.

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Notes

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