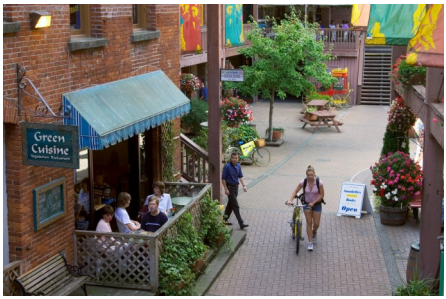
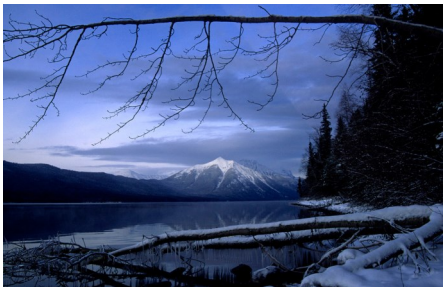
INTERNATIONAL ECOCITY STANDARDS

The International Ecocity Standards (IES) initiative seeks to provide an innovative vision for an ecologically -restorative human civilization as well as a practical methodology for assessing and guiding progress towards the goal.





ECOCITY BUILDERS

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Additional information is available at: www.bcit.ca/construction/sustainability/

What is an Ecocity?

An Ecocity is a human settlement modelled on the self-sustaining resilient structure and function of natural ecosystems.

- An ecocity seeks to provide healthy abundance to its inhabitants without consuming more renewable resources than it replaces.
- It seeks to function without producing more waste than it can assimilate or recycle for new uses or than nature can dilute and absorb harmlessly, and without being toxic to itself or neighbouring ecosystems.
- Its inhabitants' ecological impacts reflect planetary supportive lifestyles; its social order reflects fundamental principles of fairness, justice, reasonable equity and consensus at ample levels of happiness.

Ecocity Builders

Ecocity Builders reshapes cities for the long-term health of human and natural systems.

We develop and implement policy, design and educational tools and strategies to build thriving and resilient urban centres based on "access by proximity" and to reverse patterns of sprawl and excessive consumption.

Ecocity Builders and associates' definition of "ecocity" is conditional upon a healthy relationship of the city's parts and functions, similar to the relationship of organs in living complex organisms. We are concerned with city design, planning, building, and operations in an integral way and in relation to the surrounding environment and natural resources of the region, utilizing organic, ecological and whole-systems lessons to reverse the negative impacts of climate change, species extinction and the destruction of the biosphere.

We believe the form of the city matters, that it is within our ability and indeed crucial to reshape and restructure cities to address global environmental challenges.

ECOCITY BUILDERS

Why the IES?

An important role of the International Ecocity Standards (IES) is driving innovation and improvement in performance measurement and management. Cities and towns around the world are interested in the ecocity model. However, there is enormous diversity in how ecocities are built, including the level of performance these initiatives achieve. It is this concern with accountability for performance, meaning the ability to achieve ecocity objectives for reducing human impact on the earth while simultaneously advancing socially just and livable human habitats, that served as the impetus for development of the IES. Led by Ecocity Builders with worldwide input from ecocity activists and academics, the IES seeks to describe both the conditions for an ecologically healthy and restorative human presence on earth as well as a practical methodology for helping design, assess and guide the journey toward achievement of an ecocity civilization.

Academic Lead: BCIT School of Construction and the Environment

The British Columbia Institute of Technology (BCIT) School of Construction and the Environment is concerned with the natural environment, the built environment, and the relationship between them.

The School has stepped forward as the academic lead for development of the International Ecocity Standards (IES). This initiative aligns with the School's expertise and interest to advance the state of practice through education and applied research in the natural and built environments (www.bcit.ca/construction).

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BCIT SCHOOL OF CONSTRUCTION AND THE ENVIRONMENT

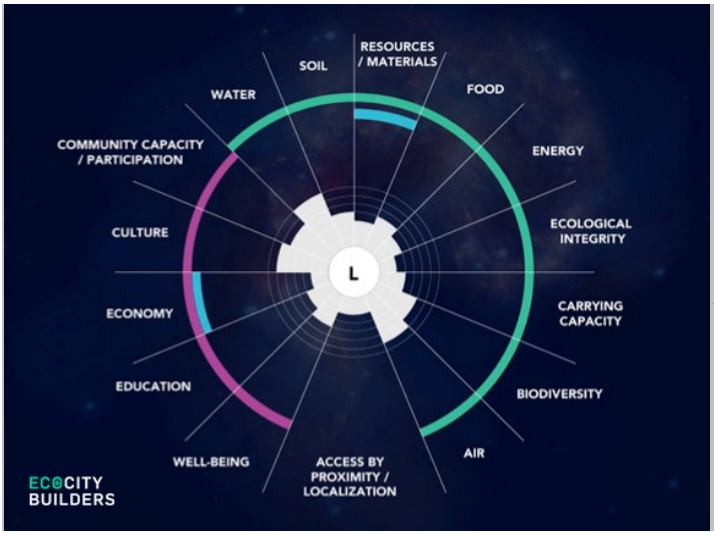
WHAT ARE THE INTERNATIONAL ECOCITY STANDARDS (IES)?

Ecocity Builders and its network of Partner Advisers is creating the first International Ecocities Standards (IES) so participating cities may assess their ecological condition in conjunction with a global network of local governments and subject matter experts committed to a *whole-systems* improvement process.

The goal of the IES is to provide support and criteria by which cities can adopt measures that would enable them to successfully move toward becoming ecocities. This approach provides a network, tools and a methodology for cities to assess their performance relative to the IES.

Through the process of deconstructing, or "unpacking" the 15 Ecocity Level 1 definitions, we have identified individual candidate indicators and assessed their readiness for use based on availability of information, efficacy, elegance and funding potential.

Prioritization of appropriate indicators is based on existing indicators that can be successfully applied statistically, practically and economically at the necessary scale (City, Metropolitan Sub Area or Bioregion).



A way to visualize an ecocity assessment along the 15 dimensions (coded for natural capital, social capital and financial capital).

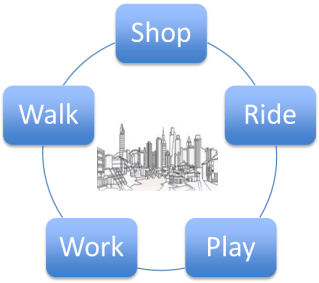
ECOCITY STANDARDS

Urban Design					
Access by Proximity	Low - Amenities Not Within Walking Distance				
Safe and Affordable Housing	Unsafe, Unaffordable				
Green Building	Resource Inefficient Wasteful, Unhealthy				
Environmentally Friendly Transportation	Environmentally Damaging				
Bio Geo Physical Features					
Air	Pollutes				
Water	Pollutes - Wastes				
Soil	Destroys				
Material Resources	Depletes				
Energy	Nonrenewable				
Food	Does Not Provide				
Socio Cultural Features					
Culture	Unsupported				
Community Capacity and Governance	Non Cooperative/Not Well Organized				
Economy	Destroys Nature's Economy				
Education	Not Provided				
Well Being	Violent, Unjust				
Ecological Imperatives					
Biodiversity	Endangered				
Carrying Capacity	Overshoot				
Ecological Integrity	Weak, Unhealthy				
Total Score					

International Ecocity Framework

Walkable, Accessible					Complete + Sustainable
Safe, Affordable					Safe, Affordable
Resource efficieny, Healthy					Regenerative
Does not Damage					Improves Environment
Clean					Purifies
Clean and Safe					Purifies
Healthy					Restores
Responsible					Sustains
Clean and Renewable					Clean and Renewable
Healthy and Accessible					Nutritious and Abundant
Healthy, Supported					Nurtured
Health, Participatory					Highly Organized/ Highly Cooperative
Healthy and Equitable					Restores Nature's Economy
Lifelong, Accessible					Provide for All
Quality of Life Satisfaction					Justice, Peace & Contentment
Healthy					Sustains
Low Impact					Within the Biosphere's Limits
Healthy					Strong, Restorative

Access by Proximity



The city provides residents with walkable access between safe and affordable housing, basic urban services, and open/green space. It demonstrates environmentally friendly transport options and provides walking and transit access to close-by employment.

A distinguishing feature of ecocities is that they enable "access by proximity" (Register 1987). This is important for quality of life and reducing automobile reliance (Newman and Kenworthy 1999).

Ecocities concentrate density coupled with a mix of uses to enable access by foot to jobs, services, natural areas, and entertainment. To reduce reliance on automobiles, the nodes of development within ecocities are connected through rapid transit. Getting where you need to go becomes fast and effective when the transit service is frequent and drop-off points are centrally located just a few minutes walk from your destination.

A challenge to transforming urban centres to pedestrian/transit-oriented development is minimum parking requirements that stipulate a number of parking stalls be made available per square foot of built area. This approach of designing for the car as the primary mode of transportation can prevent clustered development, the type needed for access by proximity. An example is the sea of parking that surrounds many shopping malls, even ones that are serviced by rapid transit. In Vancouver, for example, transportation accounts for the second largest component of the city's ecological footprint (COV 2011), and single occupant vehicle travel is responsible for half of that (Moore 2013). Of

course, goods movement is also a challenge, but one that can be overcome with a shift in investment to home delivery service.

Finally, there are people for whom walking is not an option due to physical ailments or disabilities. Making sure that people with special needs can be accommodated is a priority that can be met through greater investments in transportation services. Medical assisted travel is expensive but these costs can be offset by the savings in reduced motor-vehicle infrastructure. To achieve access by proximity, therefore, requires not just smart land-use decisions but a shift in public service investment coupled with a transportation system designed around moving people first, then goods, and lastly single-occupant vehicles.

An ecocity mapping system available through Ecocity Builders (www.ecocitybuilders.org/mapping-urban-villages) can help guide development towards zoned centres of social, cultural and economic vitality. Shifting development towards existing centres clarifies the best location for new open spaces to accommodate the restoration of natural features such as waterways. It also helps identify opportunities for expansion of urban plazas, parks, gardens, playgrounds and other open spaces.

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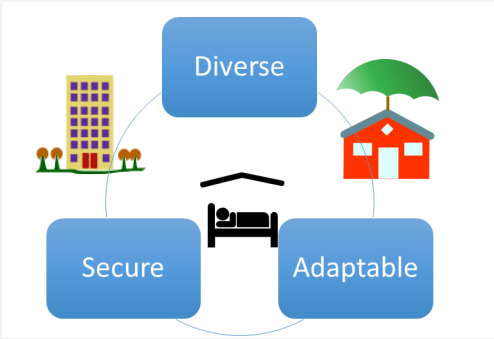
Safe and Affordable Housing



Dwellings are affordable, including to low income households, are in a reasonable state of repair with operational facilities and services, provide thermal comfort, and are protected from environmental or human caused hazards.

The United Nations has declared access to housing a human right because it is required for a standard of living conducive to health and well-being (Housing Rights Watch 2016).

Planning policies affect access to housing and its affordability which particularly impacts marginalized people struggling with poverty, disability, citizenship and security of tenure (Leisk and Moher). Access to affordable housing within central locations of the city, close to employment and services, is essential. In many cities, affordable housing is only available at the periphery, requiring long commutes to jobs and services. It also contributes to urban sprawl, contradicting ecocity principles that aim to achieve access by proximity.

Cities, such as Vienna retain ownership of land that is leased. These lands are developed as cooperative or rental housing and the leasehold on individual units can be sold for a time equivalent to the remaining lease. Vienna, has provided 60% of its population with social housing that requires a financial commitment limited to 30% of a resident's income (Bula 2016).

In other cities developers of privately owned land are required to contribute a

percentage of their project toward building affordable homes, and zoning permits existing land owners to build additional units on their propriety for the purpose of expanding the rental housing pool.

National governments, can also contribute funds towards the construction of affordable housing. An example can be found in Singapore, where public funding enables residents to purchase a home without spending more than 25% of their income. Grants coupled with a home owner protection plan enable people who have lost the ability to earn an income or who earn below the minimum capacity to afford a home (Government of Singapore 2016). Because this plan is implemented nation-wide, housing is managed across the income spectrum and attention is given to building community capacity and maintaining renewal of infrastructure and services, thereby eliminating the amassing of marginalized people in specific areas of the city (Government of Singapore 2016).

The ability to address housing affordability requires social cohesion of the community and transparent and accountable government. These qualities are reflected in the Ecocity Standards addressing Community Capacity/ Governance and Healthy and Equitable Economy.

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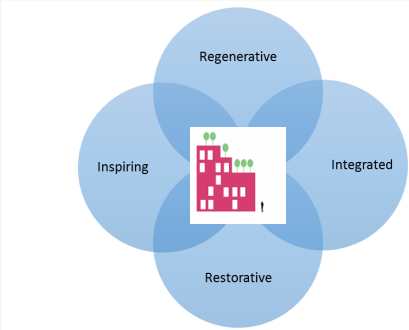
Green Building



New buildings and renovations are assessed in terms of environmental sustainability and green building standards.

Many historical construction methods used concepts that form part of the green building approach. This includes using and reusing locally available building materials, designing and orienting buildings to take advantage of sunlight and shading, co-locating buildings to allow heat generated from one building to warm another or conversely to allow shade generated from one to cool another. Green building standards such as LEED (Leadership in Energy and Environmental Design), BREEAM (Building Research Establishment Environmental Assessment Method), Passivhaus, and Minergy (to name a few) help guide development of buildings that source locally appropriate materials, are energy efficient, conserve resources or even help to regenerate them. Green building standards vary in how well they perform on a variety of considerations, but the most ambitious, e.g., the Living Building Challenge, address the broadest spectrum of concerns with an emphasis on contributing a net benefit to the people who use them and the environment in which they are located (International Living Future Institute 2016).

Thinking of buildings as extensions of urban infrastructure further maximizes opportunities for utility services to serve multiple functions that augment the

capabilities of green buildings by using green infrastructure that takes advantage of nature's services. For example, creating narrow, pedestrian streets enables buildings to form shaded breezeways that channel winds and discharge heat from the urban core. Green roofs, living walls and open spaces between buildings, such as parks or squares, expand opportunities for planted surfaces to capture and retain rainwater so that it can be harvested for human use or be allowed to percolate into soils to recharge rivers and aquifers. The amalgamated approach of addressing sustainable built environments where buildings and their related infrastructure are addressed as a holistic system integrated with the natural surroundings and their related energy and material flows is reflected in practices of permaculture, bioregionalism, and regenerative development. More recently this approach is also being captured in developing EcoDistricts.

Green building councils have been set up in many countries to advance the adoption of green building practices (World Green Building Council 2016). While the focus tends to be on new construction, increasingly attention is being given to the renovation of existing buildings. Improving energy performance supports Ecocity Standards of Clean and Renewable Energy and Clean Air. Maximizing the life of buildings reduces demand for new materials, thereby supporting the Ecocity Standard of Responsible Use of Materials.

Thinking about buildings over their entire life cycle starts with where the building is located and the impact of sourcing materials through the construction, operation and deconstruction of buildings. Green buildings that support access by proximity and responsible use of materials, clean and renewable energy, as well as clean air and clean water represent an important part of environmental and social stewardship that is essential to building cities in balance with nature.

References:

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World Green Building Council 2016. http://www.worldgbc.org/our-green-building-councils (Accessed on June 18, 2017).

Environmentally Friendly Transport

Non-motorized transportation is supported and encouraged by the city and is used by a significant proportion of people for trips under 5 km. Mode split aims towards the access-by-proximity principle with 80% of trips made by walking, bicycling or low emissions public transportation.

Environmentally friendly transport designed for the human body instead of the car body is an important aspect of ecocity development that supports the Ecocity Standards of Access by Proximity and Clean Air. It can also yield substantial socio-economic benefits. Cities such as Bogota, Curitiba, and Copenhagen have advanced a healthy and equitable economy by placing emphasis on affordable transportation systems that promote accessibility to everyone not just those who own a car (Curtis 2003; Goodman et al. 2005; Nelson 2007). These cities implemented integrated land use and transportation demand management strategies including: a) increases in density of both jobs and housing close to transit services, b) expansion of pedestrian, bicycle and transportation infrastructure and services, c) restrictions on motor vehicle use. Including a cap or even a reduction in roadway and parking available to cars, road tolls and parking fee increases.

For example, systematic investment in bicycle infrastructure in Copenhagen has resulted in a significant increase in the mode split for cyclists, now at 41% of all commuter trips in the greater Copenhagen metropolitan area (Cathcart-Keays 2016).

Cities with very high walking, cycling and transit mode share (i.e., 75% or more) typically have high density, mixed use urban centres at or above 100-200 people per hectare and are supported by a transportation strategy that prioritizes pedestrians first, then cyclists followed by transit users (Newman and Kenworthy 1999). Cities that achieve this level of mode split approach what would be needed to stay within ecological boundaries of greenhouse gas emissions associated with a one-planet lifestyle (Moore 2013, 2015). Goods movement is also an important consideration that must be addressed through attempts to support use of clean and renewable energy and an integrated transportation system that works with the design of a city to minimize the distances goods are transported.

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Clean Air

The city maintains a level of air quality that is conducive to good health within buildings, the city's air shed, and atmosphere.

The IES calls for clean air at three scales: i) in buildings, ii) the city's air shed, and iii) the atmosphere. Most people spend a portion of every day in some form of shelter. Whether it is a natural enclosure (like a cave), a one-room shelter, or a multi-story building, the air we breathe affects our health. Natural ventilation usually provides the best solution from an environmental perspective because it avoids the need for electrical and mechanical equipment that increase demand for energy and materials.

Of course, what we do inside also affects the air. Cooking, cleaning, and off-gassing of fabrics and paints can contribute to poor indoor air quality. For example, using toxic chemicals or burning charcoal or wood in a poorly ventilated area can negatively impact health. Ensuring clean air in buildings is, therefore, about what we build, how we build, and what we do in buildings - be they big or small.

If the air outside is polluted, however, then a naturally ventilated shelter cannot provide healthy indoor air. Clean air in the city is critical. Urban air pollution comes from a variety of sources, most notably the combustion of fossil fuels. Cities that are automobile-dependent tend to have poor urban air quality. Buildings can also contribute to local air pollution if they are being heated by wood, coal, oil or to a lesser extent natural gas, or if these products are used in activities such as cooking. Clean burning technologies can help reduce the

impacts substantially. But it isn't just buildings and transportation that affect a city's air quality. Where the city is located also plays a role. This larger context is the city's air shed.

An air shed is an area defined by the natural movement of air within a region. Air flow is affected by prevailing wind patterns. Topography (e.g., mountain ranges) and other geographic features such as large open bodies of water or savannah, seasonal changes in temperature, and even localized weather events such as a warm sunny day, can all affect air flow in the air shed. For example, cities located within valleys are often subject to the build-up of emissions that create a brown haze on hot sunny days. This can be caused by a thermal inversion - where a mass of cold air sits above the air shed, trapping the warmer air and all of the contaminants below. To ensure clean air in the city's air shed, ecocities support the principles of: a) Access by Proximity, b) Clean and Renewable Energy, and c) Responsible Use of Resources and Materials.

Moving beyond the city's air shed, the largest scale of concern is the atmosphere. Ozone depleting substances and an imbalance in greenhouse gases can jeopardize both human health and all life on the planet. The atmosphere is the relatively thin layer of gases that surround the Earth and enable life to thrive by shielding out harmful ultraviolet rays from the sun while simultaneously retaining a certain amount of thermal radiation to keep the planet warm. This is an essential feature of GAIA (Lovelock 1972), earth's self-regulating systems that maintain the conditions necessary for life. Global conventions, such as the Montreal Protocol and the Kyoto Protocol aim to regulate human activities that jeopardize the health of the atmosphere.

However, more action is needed. Scientists call for an 80% reduction in greenhouse gas emissions to stabilize the insulating function of our atmosphere and avoid disruptive impacts such as rising sea-levels from thermal expansion of the oceans as they warm coupled with melting glaciers. Fortunately, ecocities can help reduce greenhouse gas emissions through the very same principles that support clean air in the city's air shed. Yes, what is good for the air shed is also good for the atmosphere: a) Access by Proximity, b) Clean and Renewable Energy, and c) Responsible Use of Resources and Materials.

References:

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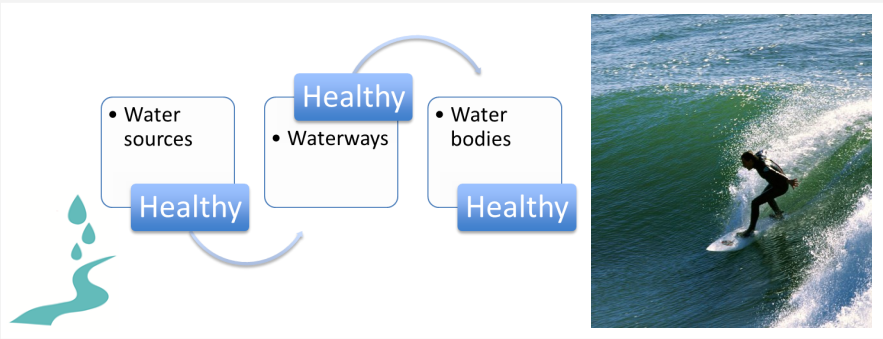
Clean and Safe Water



Residents have sufficient and continuous access to convenient and affordable clean drinking-water and domestic use water; city water sources, waterways and waterbodies are healthy and function without negative impact to ecosystems.

Water is essential for life. Cities cannot be sustained without access to potable water. The IES identifies "clean and safe water" as an essential bio-geo physical condition. Everyone should have "access to clean, safe, affordable water" (www.ecocitystandards.org).

Ecocity mapping begins with identifying the natural waterways that flow across the land. Although streams and rivers may have been channelized or put underground, a goal of the ecocity is that "water sources, waterways and water bodies, including oceans, are healthy and function without negative impact to ecosystems" (www.ecocitystandards.org). Therefore, protecting and rehabilitating the natural hydrological systems within the city and its bioregion becomes a priority for ecocity development.

Several cities have found that daylighting streams and celebrating the waterways in the city provides numerous benefits. For example, the River Walk in Austin Texas, USA serves as both a major tourist attraction and a greenway for pedestrians and cyclists (Newman and Kenworthy 1999). Indeed, the ecocity movement arguably got started in Berkeley with daylighting Strawberry Creek in

1980. This was the first opening of a buried creek in the USA, and the project still brings people together and strengthens the local community today.

Conservation of water is also important. Many cities lack efficient water infrastructure, resulting in leaks that represent losses of up to 20% of total urban water demand. In wealthy cities, water use is often metered and a premium is charged for excessive consumption, meaning above a level needed for health and sanitation purposes. Ultimately, ecocity planning requires consideration of the bioregion's natural hydrological capacity and how this impacts both the total urban population that it can sustain as well as what types of activities it can support. In contrast to the efforts of some cities to conserve water, others have chosen an unsustainable path. For example, building golf courses in the desert represents an inappropriate water use, especially if there are simultaneous challenges pertaining to maintenance of sufficient water levels in-stream to support agriculture and wildlife habitat (National Geographic 2010).

The IES identifies that "water consumed is primarily sourced from within the bioregion" (www.ecocitystandards.org). In 2005, the Metro Vancouver Region in Western Canada made an important decision to curtail plans to import water from its neighbouring watershed. Instead, it focussed on a "demand-side management strategy" that emphasizes water conservation using a combination of infrastructure improvements, pricing incentives, regulations and education. The goal is to keep the region's water demand within the capacity of what the local watershed can supply. The plan is working and the region and its citizens avoided costly infrastructure and tax increases as a result (Metro Vancouver 2005).

References:

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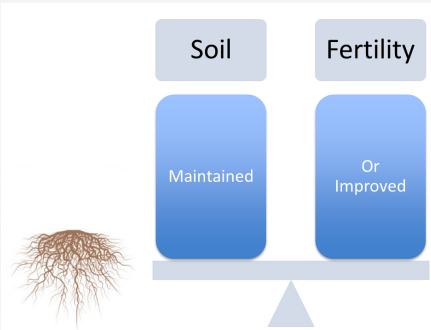
Healthy Soil



Soils functions and operations meet their ranges of healthy ecosystem functions as appropriate to their types and environments; fertility is maintained or improved.

Cities are utterly dependent on nature's services, including provisioning of food and fibres from healthy soil. Healthy soil is one of six essential bio-geophysical conditions in the IES. "Soils within the city and soils associated with the city's economy, function and operations should meet their ranges of healthy eco-system functions as appropriate to their types and environments" (www.ecocitystandards.org). This means that ecocities and their residents work to ensure that fertility of soil is maintained or improved both within cities and in the rural areas all around the world from which cities draw sustenance.

Lester Brown, founder of the Worldwatch Institute and the Earth Policy Institute, identifies soil erosion as one of the major contributors to the collapse of urban civilizations. Modern technologies, including the use of petroleum-based fertilizers, have artificially raised the productive capacity of agricultural land. However, this practice is not sustainable. Approximately one-third of global agricultural land is losing top soil faster than it is being replaced (Brown 2009). Drought and agricultural practices that include intensive tillage result in soil erosion and are anticipated to worsen due to climate change (Brown 2009). It takes approximately 500 years for one inch of top soil to regenerate in the temperate, wheat growing areas of North America (National Geographic 2010). In the future, a different approach to regenerating healthy soil is needed.

An important question for those interested in ecocities is: what can be done to support healthy soils in rural areas? Cities occupy two percent of the earth's surface, but account for 75% of global resource demand (Giradet 2004). Therefore, while a focus on urban agriculture is important, a focus on the sustainability of rural agriculture is essential. Permaculture (Mollison 1997), the practice of permanent culture, includes an emphasis on building soil fertility and is a promising start. Permaculture initiatives are springing up within cities and small rural land-holdings. But how can urban residents engage in advancing sustainable agriculture at large scales? Purchasing fair-trade and organically produced food creates a market signal that stewardship of the land is of value. But is there more that the residents of an ecocity could do?

Answers include engaging in local community planning initiatives and working with local government officials in efforts to shift development toward existing centres of social and economic vitality while strategically removing deteriorating buildings and opening landscapes for gardening and composting to build healthy soils. Tools include "willing seller" deals and transfer of development rights (Pruetz, 1997)

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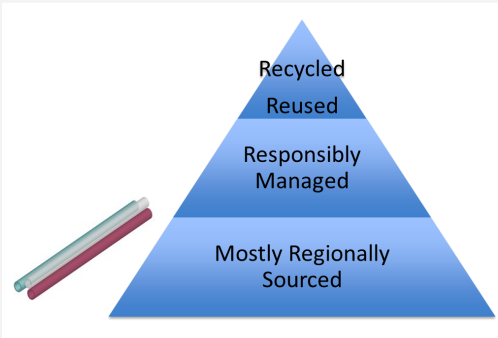
Responsible Resources / Materials



Non-food and non-energy renewable and non-renewable resources are sourced, allocated, managed and recycled responsibly and equitably, and without adversely affecting human health or the resilience of ecosystems.

By concentrating people, cities concentrate consumption of resources and materials. The IES calls for the city's renewable and non-renewable resources to be sourced, allocated, managed and recycled responsibly and equitably, and without adversely affecting human health or the resilience of ecosystems. Resources and materials should also be primarily sourced from within the bioregion (www.ecocitystandards.org).

The ecological footprint of high-income/high-consuming cities is approximately 200 times their physical area (Rees 1996). This means the amount of land required to produce the resources consumed is 200 times greater than the physical space the city occupies. If one excludes food and energy from this estimate, the resources needed to produce consumer goods along with the materials used to construct the city requires an ecosystem area approximately 43 times the city's physical area, with half the demand attributed to consumables and half to construction (Rees and Moore 2013). The latter may seem surprisingly low considering how much materials are used to build cities. However, it is important to consider the duration of the materials' life once incorporated in the built environment. Whereas most goods are consumed and discarded within the year, the buildings and infrastructure of the city typically last 50 to 75 years, if not longer.

To achieve the IES principle of responsible resources/materials use requires a focus on both the type and amount of goods we consume as well as the way we build and maintain our cities. Manufacturing processes associated with production of just four products: paper, plastics, chemicals and metals, account for 71% of USA toxic emissions (Young and Sachs, 1994). Paper and metal products enjoy high recycle rates in many industrialized economies, but the process remains energy intensive, and some products such as plastics can only be down-cycled not recycled. This means that decisions about what we consume and the durability and capacity for reuse of what we consume are important. Decisions about what materials to use in city-building are also important from both the perspective of the functioning of the city and its impact on local and global ecosystems. For example, local governments in high-income cities are typically the largest users of concrete for municipal infrastructure, including roads and sidewalks. For every tonne of concrete produced, one tonne of greenhouse gas emissions is also produced as part of the cement manufacturing process.

Sustainable cities use materials responsibly. This means building durable cities that allow for flexible use and reconfiguration of space. It also means avoiding materials with toxic substances. Cities that make use of locally available materials reduce the need for importing foreign substances and support locally appropriate building technologies that enable people to access materials to construct their own residences. Appropriate technologies that match supply of materials to demand for services is also an important strategy. For example, not all urban surfaces need to be paved. Maximizing green spaces and using alternatives such as pebbles to line heavily trodden paths can provide similar surface integrity to concrete.

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Clean and Renewable Energy

Energy is provided for, and extracted, generated and consumed without significant negative impact to ecosystems or to short or long-term human health and does not exacerbate climate change.

Fossil-based energy, i.e., coal, oil and gas, enable construction and operation of modern cities. High-rise buildings, mega-infrastructure, motor-vehicle transportation, and the importation of resources from widely dispersed hinterlands are all possible and essential in a global economy. Side effects, however, include local air pollution that can cause respiratory problems, depletion of global resources, and atmospheric accumulation of greenhouse gases.

The IES calls for clean and renewable energy that avoids negative impacts to ecosystems and the atmosphere, as well as human health in both the short and long-term. Energy consumed is also primarily generated within the local bioregion.

To achieve the Clean and Renewable Energy principle articulated in the IES requires re-thinking the way that modern cities are constructed and operated. Much can be achieved through better design of urban environments that enable dense mixing of residential and commercial land uses to create "access by proximity." Urban right-of-ways coupled with intelligent design of buildings can create passive daylight penetration and shading according to the needs of the local climate. Thinking of buildings as an extension of the infrastructure system

also reveals opportunities for waste-heat exchange, rainwater collection, and food growing opportunities (e.g., on rooftops). These approaches can help reduce the urban energy load by at least 40% (Walker and Rees 1997; Rees 2010).

The challenge of generating most of a city's energy within its bioregion depends largely on three factors: i) the natural resources of the bioregion including its geophysical characteristics, ii) the design of the built environment including a variety of land uses, and iii) the socio-cultural demands of urban residents. These elements are the starting points for determining the supply and demand of the energy balance within the bioregion.

Clean and renewable energy sources include: sun, wind, water (e.g., tides, currents and gravity to produce hydropower), and biomass (ideally from waste sources including wood, crop residues and animal dung). Natural gas can also be generated from fermenting biomass, e.g., anaerobic processes that decompose food wastes. However, not all bioregions are created equal from a resource endowment perspective. Thanks to the availability of fossil fuels, many bioregions that are not well-suited to supporting large concentrations of people are now home to millions. Examples include desert cities such as Las Vegas and Phoenix in North America and Dubai in the Middle-East.

The socio-cultural demands of urban residents also play an important role. These are influenced to a great extent by income, driven by desires for luxury and status. Technology can help cities make more efficient use of available resources, but whether residents choose to live within the existing carrying capacity of the bioregion is largely a matter of personal choice if the financial means to exceed carrying capacity are within reach. Ecological footprint analysis reveals that most of a city's energy metabolism is associated with its residents' consumption of goods and services (Rees 2010).

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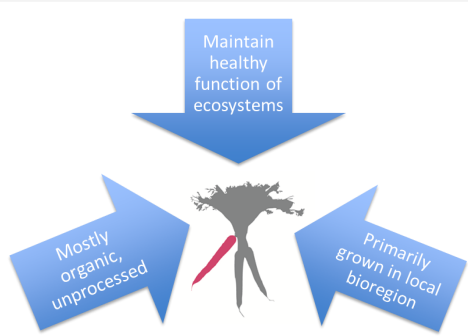
Healthy and Accessible Food



Sufficient amounts of healthy and nutritious food are accessible to all and are grown, manufactured, distributed and recycled by processes which maintain the healthy function of ecosystems and do not exacerbate climate change.

Uneven access to healthy and nutritious food is a global phenomenon – witness: many North Americans' struggle with obesity while many Africans' starve. Food often comprises the largest component of a city's ecological footprint, and agriculture contributes 10-12% of global greenhouse gas emissions (FAO 2009). Recent studies indicate that the type of food (e.g., meat) and the way it is processed have a greater environmental impact than the overall distance food travels (i.e., food miles) and the total amount consumed (Webber and Mathews 2008).

The IES calls for nutritious food that is accessible and affordable to all residents and is grown, manufactured and distributed by processes which maintain the healthy function of ecosystems and do not exacerbate climate change. Food consumed is primarily grown within the local bioregion.

Ecocities enable access to healthy and nutritious food through zoning of land dedicated to agricultural production both within the city and at its periphery. This could include greenbelts and areas adjacent to natural parks, formation of contiguous open space and green corridors, community gardens, home-based agriculture, street-side gardens, etc. Community-based programs such as fruit-tree harvest and crop-sharing initiatives further enable people to access the

bounty of urban agriculture. Food hubs and farmers' markets can provide the means for food producers to access local markets directly. More broadly based agriculture activity, including farms and orchards that surround the city, can enable access to bioregionally based food supplies as well. Rooftops and terraces can also be used for local food production, including raising small animals such as chickens and rabbits. Ground-oriented buildings and sheds, including court-yards, and even below-grade structures such as cisterns can be used for local farming including aquaculture (Todd and Todd 1994).

Although density can produce a more efficient pattern of living through, for example, access by proximity to services, it also concentrates demand. In the case of food, access to retail venues is increased, but careful design is required to ensure that access to the means of food production is not eliminated. Where demand for food by an urban population exceeds the capacity of the local bioregion, the importance of policies that shape demand for organic and fairly traded foods become increasingly important. The success of organic food retailers demonstrates that many people in Western society are willing to pay a premium for ethically and organically produced food. Still many others find these types of products too expensive to purchase on a daily basis.

Some cities are beginning to map food access and finding that parts of the city are virtual nutrition deserts. Understanding the population's nutritional needs and planning for access to healthy and nutritious food is an important strategy that can help communities move toward achieving this important IES principle.

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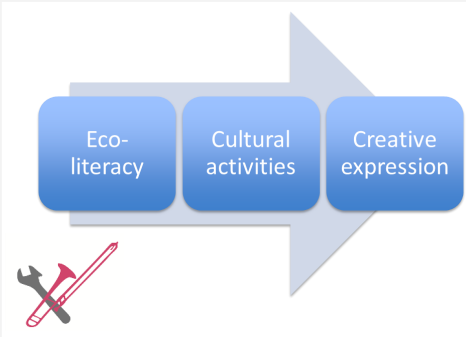
Healthy Culture



Cultural activities that strengthen eco-literacy, patterns of human knowledge and creative expression are facilitated, symbolic thought and social learning is developed.

The IES identifies "healthy culture" as one of the 15 essential conditions of an ecocity. Specifically, "an ecocity facilitates cultural activities that strengthen eco-literacy, patterns of human knowledge and creative expression, develops symbolic thought and social learning" (www.ecocitystandards.org).

There is an iterative relationship between culture and its expression in the built environment. We build what we believe, and as we build so shall we live (Register 2006). Therefore, whether a society values the ecological systems upon which it depends becomes evident through the treatment of local ecology within the city and the design of the built environment in relationship to it. Examples include i) preservation of urban streams and natural topographical features, ii) buildings that are energy efficient and orient to the sun or create shade as local climatic conditions require, iii) public spaces that provide opportunities for relaxation and "re-creation" and also function as green corridors or buffer zones to support habitat protection and food production.

Of course, a city's ecological dependence also rests with its surrounding bio-region and other areas scattered all around the world whence it draws energy and resources. The ways that an ecocity facilitates cultural activities that strengthen eco-literacy with regard to these "urban ecosystem relationships" is critically important (Rees 2010). Indeed, a healthy culture is one that can

regenerate itself and adapt according to changing circumstances (Diamond 2005). Like the city, the culture that built it is also "a living system of human relationships that expresses itself in language, arts, tool-making and social organization, including politics and economics" (Downton 2012). Downton uses the geometric notion of "fractals" to explore how healthy culture can both develop and scale-up across a city. A fractal contains within it all the essential characteristics of the larger whole of which it is a part. A small community that contains the values and governance structure essential to a healthy culture can create and re-create an ecocity over time.

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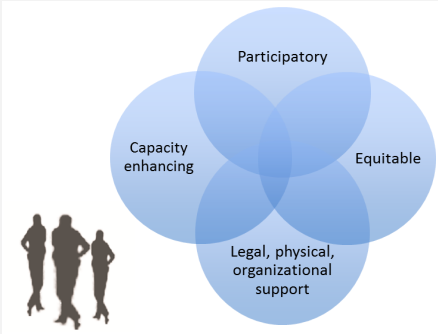
Community Capacity / Governance



Full and equitable community participation is supported in decision making processes along with legal, physical and organizational support for neighborhoods, community organizations, institutions and agencies to enhance their capacities.

The IES identifies "community capacity building" as an important socio-cultural feature. Specifically, the IES notes that a city that builds community capacity is one that "supports full and equitable community participation in decision-making processes and provides the legal, physical and organizational support for neighborhoods, community organizations, institutions and agencies to enhance their capacities" (www.ecocitystandards.org).

Capacity in this context refers to the actual or potential ability to act. Action in an ecocity is informed by ethics, not only an environmental ethic, but an ethic of care as well. A society's caring capacity is arguably the cornerstone of sustainability. Morality expressed as an ethic of care towards each other in the form of social justice and toward the planet in the form of environmental stewardship is the hallmark of a sustainable society.

In a study contrasting the effectiveness of regional governments in northern and southern Italy, Robert Putnam (1993) found that societies that care for each other also achieve fuller participation in decision-making processes. He qualifies caring societies as having a high degree of social capital. This is a fancy term for good social relations, predicated on familiarity, trust and reciprocity, integrity and accountability. Mark Roseland (2012) sees social capital as an

important feature of "community capital, and is developing tools to help cities measure it. Mike Carr (2004) sees social capital as contributing to both bioregionalism and civil society.

The socio-political dimensions of an ecocity reflect the cultural values of the people who live in it. These values shape the political process and emergence of governing regimes. Ecocities depend on democratic participatory processes that enable citizens to participate in decisions that affect the places in which they live (Register 1987, 2006). Building community capacity, therefore, can be seen as an important starting point not only for building ecocities, but also for transitioning to the Ecozoic era.

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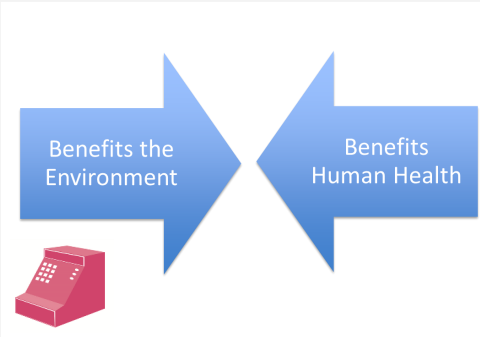
Healthy and Equitable Economy



The city's economy consistently favors economic activities that reduce harm and positively benefit the environment and human health and support a high level of local and equitable employment options.

Ecocities support economic activities that reduce harm and positively contribute to both environmental and human health (www.ecocitystandards.org). This includes efforts to reduce emissions to air and atmosphere from the combustion of fossil fuels, avoiding the use of toxic chemicals applied to soils or discharged to receiving waters where they can bio-accumulate in animals and plants, and supporting locally and organically produced foods and renewable energy sources.

Ecocities also support local and equitable employment options integrated within the design of the city. For example, the layout of land uses as well as the city's policy framework play an important role in: a) making jobs and housing accessible and b) ensuring that companies comply with environmental protection legislation. This approach sets the foundation for "green jobs" and "ecological-economic development" that contribute positively to the city and its residents without causing harm to the ecosystems upon which they depend.

Cities such as Curitiba, and Copenhagen have advanced a healthy and equitable economy by placing emphasis on dense, lively centres and a more equitable transportation system, one that promotes accessibility by everyone not just those who can afford a car (Goodman et al. 2005; Nelson 2007). For example, these

cities implemented integrated land use and transportation demand management strategies including increases in density of both jobs and housing close to transit services with expansion of pedestrian, bicycle and transportation infrastructure and restrictions on motor vehicle use.

Whereas many cities focus on economic growth to achieve prosperity, research shows that equity is more strongly correlated with health and social improvement (Wilkinson and Pickett 2009). This is particularly true for developed economies where most of the population's basic needs for food and shelter are already met.

Governments that achieve a more equitable distribution of wealth and invest in social services, including education, achieve higher levels of development while simultaneously keeping their demand on nature's services low. For example, countries such as Cuba and Ecuador obtain similar longevity and literacy levels as the USA but at a fraction of the per capita energy and materials consumption (Moore and Rees 2013). Germany and Japan surpass the USA in terms of quality of life (e.g., human health and social wellbeing) while simultaneously consuming less (Moore and Rees 2013; Wilkinson and Pickett 2009).

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Lifelong Education

Residents have access to lifelong education including access to information about history of place, culture, ecology, and tradition provided through formal and informal education, vocational training and other social institutions.

Access to education is a fundamental human right (People's Movement for Human Rights Education 2013). Knowledge of one's home place provides both an important context for self-identity and can instill an ethic of care to steward that which sustains us (Martin and Beatley 1993).

Bioregionalism provides an orientation to our home place that is informed by nature. Specifically, the watershed provides a framework for locating and learning about the ecological processes that support our cities and villages. The concept and term, originally introduced by Peter Berg in the 1960s, remains an underlying premise for ecocity development (Register 2006).

Ecocity mapping is an important tool for locating centers of vitality within a city, where density and a mix of services to support complete community development should be concentrated. Bioregional mapping expands the scope of social learning to include an understanding of the ecological processes in the territory that surrounds clusters of eco: villages, towns, and cities (together they comprise an "ecotropolis"). Engaging communities in mapping their bioregion contributes to eco-literacy and the development of a healthy culture (Aberley 1993, 1994; Carr 2004).

David Orr (2004, 11) suggests that "it is possible that we are becoming more ignorant of the things we must know to live well and sustainably." This includes knowledge about socio-cultural history in addition to knowledge about locally appropriate technologies for securing sustenance and stewarding local resources. In a globalizing world, local knowledge is important but potentially insufficient as well. Michael Maniates (2013) argues that it is also important to learn about the political processes and international relations that shape the global processes that shape our world. Without a broader understanding of these things, the ability to use local knowledge may risk being overwhelmed in the face of turbulent times that are to come.

Lifelong education that fuels a desire to learn and helps one understand both how to live in place as well as how to contribute to a changing global world is an important aspect of building, sustaining and living in ecocities.

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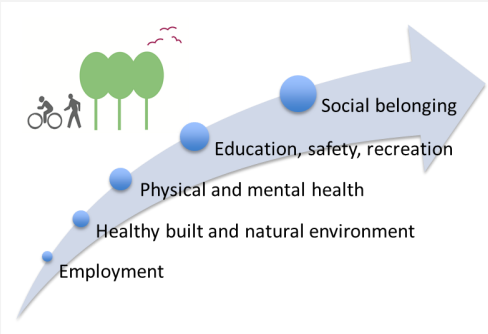
Well being / Quality of Life



Residents report satisfaction with their quality of life including employment, the built, natural and landscaped environment, physical and mental health, education, safety, recreation and leisure, and social belonging.

Human well-being depends on access to resources sufficient to lead a dignified life (Raworth 2013). This includes access to natural resources such as clean air, water and energy, as well as nutritious food. It also includes access to social resources including education, healthcare, employment and recreation, participation in decisions that affect one's life, and freedom from persecution for one's beliefs.

Ecocities not only support well-being and quality of life through provision of affordable shelter and services, they also enable people to: access jobs close to where they live, breath clean air in car-free cities, and enjoy nature at their doorstep (Register 2006). This is achieved through compact design of the built environment that takes advantage of roof-tops (e.g., for parks and restaurants) and spaces below ground (e.g., for storage and shopping). Landscaped environments at grade blend with the natural environment to foster ecological connections that invite nature into the city (Register 2006).

Residents of ecocities enjoy a high quality of life regardless of their socio-economic status. This means that social services are provided based on need, not just an ability to pay.

An important measure for well-being is the Genuine Progress Indicator (GPI). Invented by Redefining Progress in 1995, the GPI considers changes in income distribution, volunteerism, crime, pollution and resource depletion as factors that affect quality of life (Redefining Progress 2013). This stands in contrast to Gross Domestic Product (GDP) which measures the sum of a nation's financial transactions, but does not consider whether those contribute or detract from the well-being of citizens, particularly those who are most vulnerable.

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Healthy Biodiversity

Biodiversity of local, bioregional and global ecosystems is sustained, including species diversity, ecosystem diversity and genetic diversity; natural habitat and biodiversity is restored.

Biodiversity refers to the vast array of species, both flora and fauna, that populate the Earth. Their interactions create the ecosystems upon which we depend, characterized by various biomes including: deserts, rainforests, grasslands, and coral reefs (Newman and Jennings 2008).

Healthy biodiversity needs intact nutrient cycles, no net loss of soils, and no accumulation of pollutants (in soil, air or water). Although approximately 12% of Earth's wild places have been dedicated as natural reserves, global change processes, including climate change, mean that the systemic conditions needed for these places to thrive are being undermined. Biodiversity losses are being driven in part by urbanization processes that fragment natural habitats and nutrient cycles, deplete soils and aquifers, and increase pollution levels (Newman and Jennings 2008).

To achieve the "Ecocity: Level 1 Condition" requires that the geo-physical and socio-cultural features of a city are in harmony with its surrounding bioregion (www.ecocitystandards.org). This means that indigenous flora and fauna are allowed to flourish. Equally important, ecocities do not draw down the resources or increase pollution levels in areas outside the bioregion either. This could happen through trade imbalances and/or taking advantage of global common

resources, such as the waste sink capacities of oceans and atmosphere. Therefore, ecocities are concerned both with preserving and enabling healthy biodiversity in their bioregion as well as in the world generally.

The ecocity vision includes tightly clustered development immediately adjacent to naturally preserved areas (Register 2006). This allows people to experience nature at their doorstep despite living in high-density urban environments. By shifting from sprawl to compact development, ecocities leave room for regeneration of natural and agricultural landscapes, specifically focusing on rebuilding soils, naturally sequestering carbon, daylighting streams, and recreating wetlands and aquatic sediments. Ecocities also utilize clean and renewable energy, healthy and accessible food, and responsible resources and materials. These choices support stewardship of natural resources within and outside the city, including in remote locations.

Biomimicry, which refers to design informed by nature, can also support healthy biodiversity. For example, Alan Savory's work on natural carbon sequestration through compact herding of cattle to regenerate grasslands was inspired by watching the impacts of migratory wildebeest in Africa. Natural carbon sequestration techniques could also be applied in forests, peatlands, wetlands, aquatic and marine environments.

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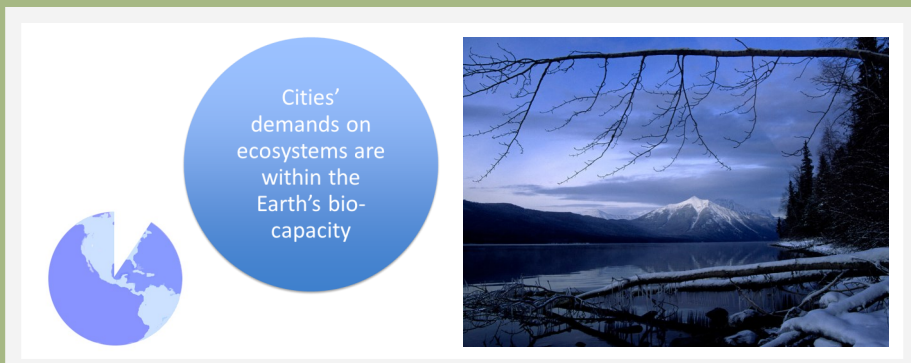
Earth's Carrying Capacity



Demands on ecosystems are within the limits of the Earth's bio-capacity, resources are converted restoratively and support regional ecological integrity.

An important ecocity condition is to live within ecological carrying capacity, specifically that "the city keeps its demand on ecosystems within the limits of the Earth's biocapacity, converting resources restoratively and supporting regional ecological integrity" (www.ecocitystandards.org).

The ecological footprint measures whether we are living within ecological carrying capacity (www.footprintnetwork.org). An ecological footprint refers to the amount of land and sea area required to support a specified population at their current levels of affluence and technology (Wackernagel and Rees 1996). In short, it is a measure of demand on nature's services relative to nature's capacity to supply those services (i.e., its biocapacity).

The term "one-planet living" refers to a society that, on average, lives within Earth's carrying capacity (www.oneplanetliving.org). It uses the ecological footprint to assess whether an individual or a society is living within average per -capita globally available biocapacity. If the world's ecologically productive ecosystems were distributed across the global human population, such that each individual was attributed an equal share, and with approximately 12% of total biocapacity set aside for nature, then each person would need to live within the ecologically productive capabilities of just 1.7 hectares of land and water area (Moore and Rees 2013).

While most of the world's population achieves this goal, high consuming societies located mostly in Europe, North America, and Australia use much more. For example societies in Europe typically demand the ecologically productive capabilities of more than 4.5 hectares per capita while North Americans and Australians demand even more (WWF 2010). If everyone in the world lived the same way as these high consuming societies, we would need three to four additional earth-like planets to both supply the energy and resources demanded as well as absorb the wastes produced.

Since we only have one Earth, we need to learn how to live equitably within the ecological carrying capacity of this planet. Ecocities are an important part of the solution. Building cities that are compact, so as to eliminate the need and even desire to use a car, and designing the built-environment in such a way that it collects solar radiation, produces naturally ventilated spaces, harvests rainwater, and provides spaces for growing food and wildlife to flourish are all important steps.

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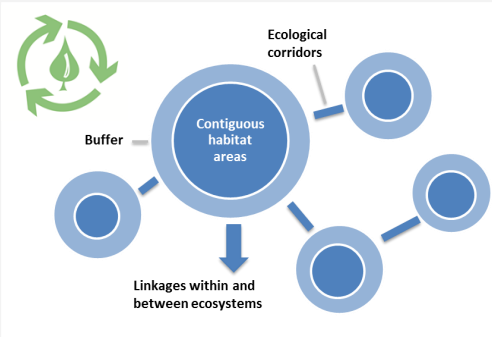
Ecological Integrity



Essential linkages within and between ecosystems are maintained and provide contiguous habitat areas and ecological corridors.

Ecological integrity refers to the capacity of life, be it an organism or ecosystem, to organize, regenerate, reproduce, and evolve itself (Pimental et al. 2000). For example, a desert ecosystem can withstand long periods of drought yet retain its integrity such that when the rains come, the desert blooms and the organisms that comprise its ecology flourish (Pimental et al. 2000). This enables the desert ecosystem to withstand the next drought.

Ecosystem integrity is closely tied to health. An ecosystem can be degraded, but so long as it has the ability to survive (meaning to reorganize, regenerate, reproduce, etc.), its integrity remains intact. Ecocities support ecological integrity by maintaining essential linkages within and between ecosystems (www.ecocitystandards.org). For example, ecocities concentrate development of built space within a compact area and provide contiguous habitat and ecological corridors that enable natural systems to thrive.

Living sustainably requires preserving ecosystem integrity (Pimental et al. 2000). Therefore, to be in balance with nature, ecocities require that both citizens and their cities operate within the ecological carrying capacity of the bioregion in which they are located as well as the global ecological carrying capacity of Earth. Trade offers opportunities to exchange information and materials with others from places both near and far. However, it is important

that trade activities do not compromise the ecological integrity of bioregions (both locally and abroad) through depletion of resources or accumulation of wastes.

References:

Pimental, David, Laura Westra, Reed Noss. 2000. Ecological *Integrity: Integrating Environment, Conservation, and Health.* Washington DC: Island Press.

Ecocity Education at BCIT

The School of Construction and the Environment is a leader in education and applied research concerned with the natural environment, the built environment and the relationship between them. We can teach people how to build ecocities.

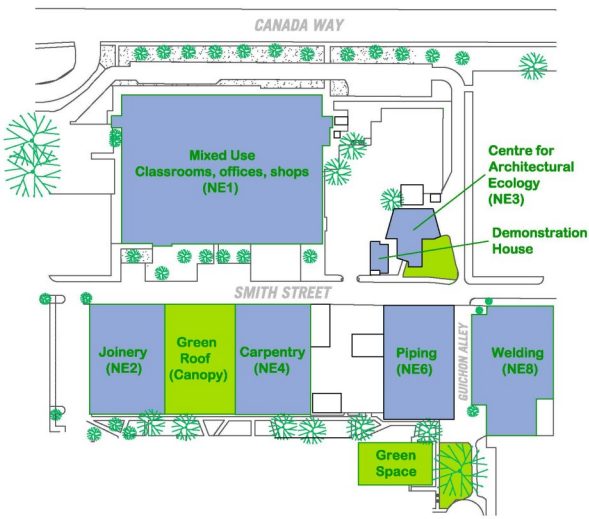
Cities in Balance with Nature

The World Business Council for Sustainable Development has identified that a factor of four to a factor of ten reduction in energy and materials throughput in the global economy is needed in order to stay within Earth's ecological carrying capacity. This represents a 75% to 90% reduction from business as usual. Since the built environment accounts for 30% of global energy consumption and 40% of materials consumption, how we design, build, maintain, and restore our cities has a profound effect on global sustainability.

What is the Factor Four Initiative?

The School of Construction and the Environment has set a goal to achieve a 75% reduction in energy and materials consumption in its educational program delivery without compromising service levels. The aim is to adaptively restructure the built environment of BCIT's campus to create a living lab for students that is also an ecocity fractal.

In 2009, the School of Construction and the Environment brought Ecocity Builders to Vancouver to work with our Architectural Science students and faculty as well as BCIT staff from Facilities Management, Food Services and Campus Development to explore what a factor four to factor ten improvement in resource productivity could look like on campus. Faculty from applied research centers including: Centre for Architectural Ecology, Building Science Centre of Excellence, BCIT Rivers Institute, Centre for Infrastructure Management, and the Group for Advanced Information Technology also contributed important insights.



The Factor Four Area

The North end of BCIT's main campus in Burnaby, British Columbia, Canada has been selected because: the buildings are all part of the School of Construction and the Environment and they represent the entire range of building types from industrial, to commercial, to residential. Change can be demonstrated effectively by working in a concentrated area.

The BCIT School of Construction and the Environment maintains a suite of applied research centers and industry services that advance the state of practice and educational delivery in engineering and building science, sustainable built environments, and ecological restoration. Visit us at: (www.bcit.ca/construction).

The School is also the lead academic partner with Ecocity Builders (www.ecocitybuilders.org) in developing the International Ecocity Standards (www.ecocitystandards.org).

BCIT's Factor Four initiative engages students, faculty, instructors and staff in educational opportunities and applied research to explore how a community adaptively restructures their built environment and changes behavior to support a 75% reduction in energy and material consumption on the path to becoming an ecocity. To learn more visit: http://commons.bcit.ca/factorfour.

Real-time energy data from all Factor Four meters can be viewed online at: commons.bcit.a/factor four - search 'live data.'

ECOCITY BUILDERS

WWW.ECOCITYBUILDERS.ORG

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WWW.BCIT.CA/CONSTRUCTION