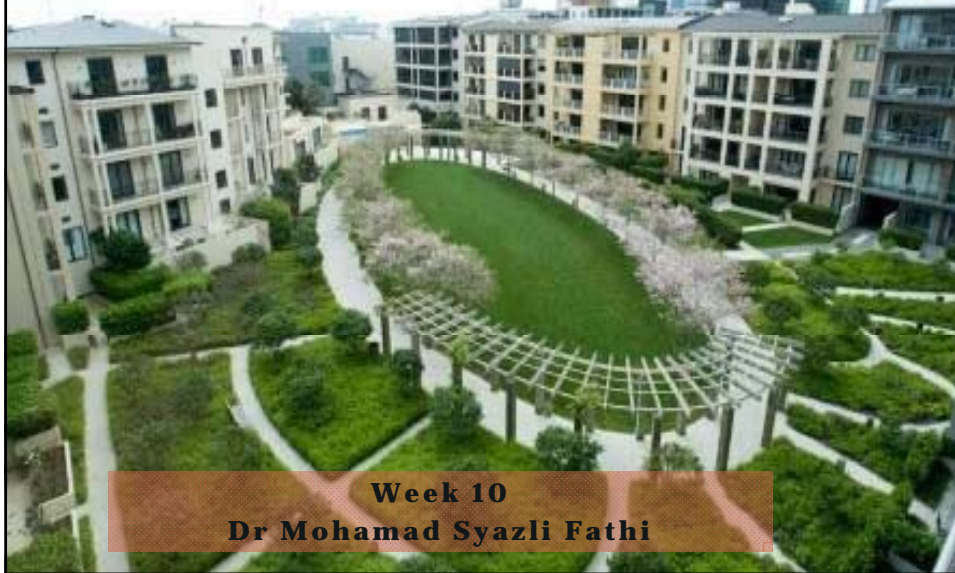


## Advanced Techniques for Assessing Landscape Sustainability (Construction)



### Outline

1. Introduction
2. Urban Landscape
3. Sustainability Issues for Landscaping
4. Type of Landscape Construction
5. Sustainable Landscape
6. System for Landscape Construction
7. Sustainable Landscape Construction
8. Approach of Sustainable Landscape Construction
9. Landscape Sustainability Assessment
10. Indicators of urban landscape sustainability

Syazli2012©

## Sustainability in the Context of Urban Landscape

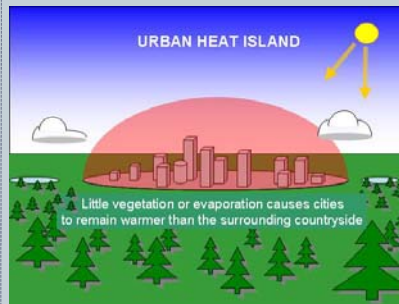
- The environmental problems such as **biodiversity loss, ecosystem degradation, landscape fragmentation, climate change** and **urban heat islands** are already exist and have a great stress upon the natural and built environment.



**Photo Caption:** Smoke and steam pours from the sprawling Mumbai slum of Dheravi. India is home to a third of the world's poor, and migration to city's is fast swelling the ranks of urban poor.

Photo: EPA/Alex Hofford

Source: [http://www.globalasia.org/V7N1\\_Spring\\_2012/Bharat\\_Dahiya.html](http://www.globalasia.org/V7N1_Spring_2012/Bharat_Dahiya.html)



Syazli2012©

Source: [http://www.weatherquestions.com/What\\_is\\_the\\_urban\\_heat\\_island.htm](http://www.weatherquestions.com/What_is_the_urban_heat_island.htm)

## Urban Landscape

- If our cities are unsustainable, urban landscape should be part of the solution to regional and global sustainability problems (Benson & Roe, 2007).
- The concept of sustainability in association with urbanization and landscape includes both:
  - **technical aspects** such as *energy saving, reusing material, environmental management* or *ecology*; and
  - **non-technical aspects** like *social behavior* and *spatial organization*.



## Urban Landscape

- This is to insure that urban sustainability encompasses more than ecologic technology and other quantifiable aspects. From design point of view ***landscape sustainability has to be approached holistically.***
- This insures that the technological side of sustainability should be considered as an accepted standard and a self-evident part of the project requirements rather than a desired ideal (Christianease & Salweski, 2009)



Christianease, K. & Salweski, C. (2009). Do good: Sustainability and urban design, transIt Band, 2, 1-13.

Syazli2012©

## Sustainability Issues for Landscaping

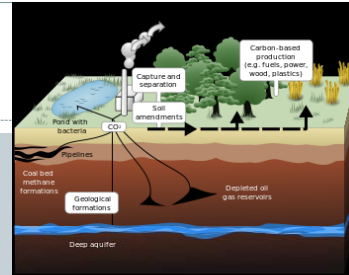
- Encompasses a variety of practices that have developed in response to environmental issues.
- These practices are used in every phase of landscaping, including :
  - design,
  - construction,
  - implementation and
  - management of residential and commercial landscapes.



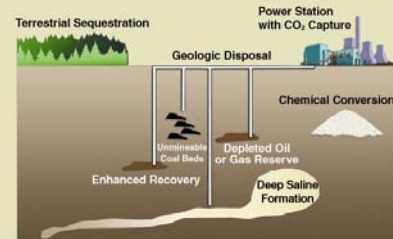
Syazli2012©

## Sustainability Issues for Landscaping

- **Carbon sequestration** is the process of capture and long-term storage of atmospheric carbon dioxide (CO<sub>2</sub>)
- **Carbon Sequestration by**
  - Plants;
  - Global Climate Change;
  - Air Pollution;
  - Water Pollution;
  - Pesticide Toxicity;
  - Non-Renewable Resources;
  - Energy Usage.



### Carbon Sequestration Options



Note:

Carbon sequestration describes long-term storage of carbon dioxide or other forms of carbon to either mitigate or defer global warming and avoid dangerous climate change. It has been proposed as a way to slow the atmospheric and marine accumulation of greenhouse gases, which are released by burning fossil fuels.

## Sustainability Issues for Landscaping

- **Non-sustainable practices encompass:**
  - Contamination of soil, air and water;
  - persistence of toxic compounds in the environment;
  - non-sustainable consumption of natural resources;
  - Greenhouse gas emissions.

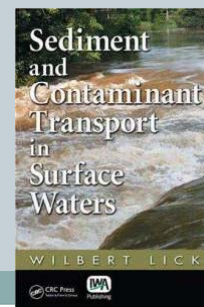


Syazli2012©



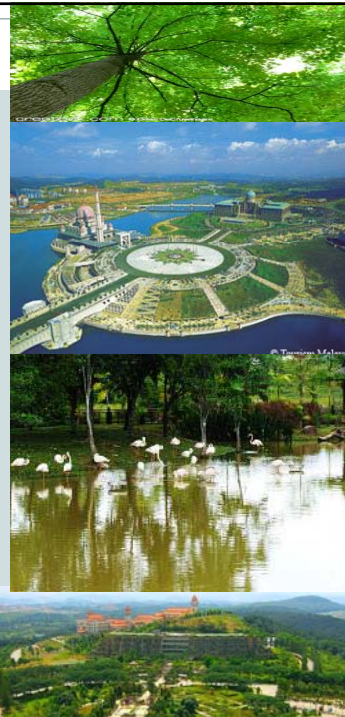
## Effects of non-sustainable practices

1. **Threats to health**, well-being and even survival of humans and other life forms and their habitats;
2. **Sedimentation of surface waters** caused by stormwater runoff;
3. Chemical pollutants in **drinking water** caused by pesticide runoff;
4. **Health problems** caused by toxic fertilizers, toxic pesticides, improper use, handling, storage and disposal of pesticides;
5. Air and noise pollution caused by landscape equipment;
6. Over-use of limited natural resources.



## Sustainable landscapes

- Sustainable landscape should emphasize critical issues and concerns such as:
  - **Aesthetic:**
    - ✦ Although sustainable landscapes may appear more “natural” and less manicured, they still rely on basic principles to create a visually appealing combination of plants and materials. Aesthetic principles including accent, contrast, harmony, repetition and unity ensure the design is attractive, visually compatible and has a “sense of fit” with the context.
  - **Functional:**
    - ✦ This dictates whether the design will be usable and will meet certain health and safety criteria. In addition, Sustainable landscape has to elaborate other important factors such as cost effectiveness and maintainability.
  - **Environmental:**
    - ✦ This focuses on several concerns such as enhancing landscape microclimate, increase biodiversity and maximizes reuse of resources. One of the major environmental concerns is that of using plants that provide habitat as well as aesthetic value.



### The site landscaping patches do contain one of the following systems:

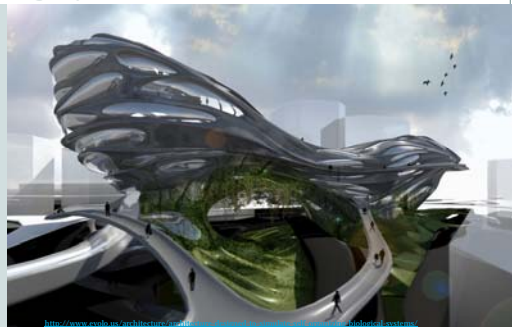
1. **Static** systems that do not interact with their environment and do not change such as *rocks*.
2. **Metabolic** systems that require a throughput of energy, matter such as *waterfalls*.
3. **Self-supporting** systems that have the ability to secure necessary resources such as *simple organisms*.
4. **Selective** systems that respond selectively to environmental challenges such as *plants*.
5. **Protective** systems that can protect themselves from adverse influences.



Bossel, H. (1999). Indicators for sustainable development, theory methods and applications. Canada: International institute for sustainable development. ©

### The site landscaping patches do contain one of the following systems:

6. **Self-organizing** systems that can change their structure to adapt to changes in their environment such as *plants or human activities*.
7. **None isolated** systems that modify their behavior in response to the presence and activities of other systems.
8. **Self-reproducing** systems that can reproduce systems of their own kind such as culture patterns and systems.
9. **Sentient** systems that can experience pain, stress, emotions and so on such as humans.
10. **Conscious** systems that can reflect their actions and subsequent impacts (Bossel, 1999).



Bossel, H. (1999). Indicators for sustainable development, theory methods and applications. Canada: International institute for sustainable development. ©

## Sustainable Landscape Construction



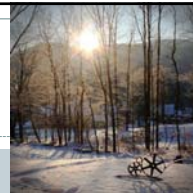
- Sustainable landscaping is defined as **landscaping with a consideration** towards the **balance of** :
  1. **the local climate,**
  2. **minimal resource consumption,**
  3. **the avoidance of toxic chemicals** and
  4. **the conservation of water.**
- There are many things that go into sustainable landscaping and a large part of it is proper landscape construction.



*The Sustainable Sites Initiative, called SITES for short, said 150 projects will test a new rating system for landscape design, construction and maintenance, and 11 are in Washington. - One of the pilot projects is Theater Commons and Donnelly Gardens at Seattle Center. (Source: <http://www.djc.com/news/en/12018283.html>)*

Syazli2012©

## Important things to consider when designing sustainable landscape construction



1. How can the space best be used ?
2. What are the site conditions? Is there a need for renovation ?
3. What is the timeline and what is the budget ?
4. How much time will be needed to maintain the landscape? Is it maintainable ?
5. Visually, what look would you like to achieve ?
6. What are the plant and landscape needs ?



- Sustainable landscape construction should take many different things into consideration.
- The lot, home size, locals and budget all play into the design process.
- The design process generally includes a base plan, site inventory and analysis, construction documents, implementation and maintenance.

Syazli2012©



## Sustainable Landscape Construction

- Sustainable landscape construction should take many different things into consideration.
- The lot, home size, locals and budget all play into the design process.
- The design process generally includes a base plan, site inventory and analysis, construction documents, implementation and maintenance.



©2012

## The Center for Sustainable Landscapes

### Center for Sustainable Landscapes Facts

1. The Center for Sustainable Landscapes was built almost entirely using native material, US made, and the workforce has mostly from neighborhoods and surrounding areas.
2. The Building was designed to achieve net-zero energy consumption; the building will generate the power it will demand.
3. To achieve net-zero energy, the center is equipped with **solar photovoltaic systems, geothermal wells and a wind turbine.**
4. The center also features passive cooling, heating and lighting methods reducing carbon monoxide emissions and reusing all water captured on site, saving natural resources and reducing water pollution.



•The center will be both net-zero energy and net-zero water, which means the site will produce as much energy as it consumes and will treat wastewater and capture rainwater on-site so as to completely offset its water use.

•The CSL will capture, **treat and reuse all water on site** and feature a green roof, a lagoon, rain gardens, permeable paved surfaces, constructed wetlands, and a water distillation system.

Source: <http://landscapevoice.com/center-for-sustainable-landscapes-landscape-architecture/>

©2012 Syazli



## The Center for Sustainable Landscapes

### Center for Sustainable Landscapes Facts

1. The estimated total cost of the project is \$23.5 million
2. A total of \$14.5 million for hard and soft costs
3. More than \$3 million for landscape site work and education projects
4. More than \$1.4 million for building and grounds
5. The photovoltaic array costs were near \$500,000
6. The Center has **14 geothermal wells that are able to absorb soil temperature to heat and cool the building**
7. The Center contains 378 solar panels on the Phipps roof and 125 on the grounds
8. Storm water will be treated in a lagoon system that uses plants in a seven-step cleaning process



Source: <http://landscapevoice.com/center-for-sustainable-landscapes-landscape-architecture/>

Syazli2012©

## The Center for Sustainable Landscapes

### Center for Sustainable Landscapes Facts

9. **Ultra violet lights** and plants in the wetland will be used to treat sanitary or used water bringing it to greywater condition
10. Building orientation maximizes northern and southern exposure for effective day lighting and passive solar controls
11. 10-14 geothermal wells of 500 ft. deep boreholes with PEX (cross-linked polyethylene) tubing loops
12. Construction waste diverted from landfills through efficient site design, recycling and reuse
13. The center is equipped with Ultralow flow plumbing fixtures include waterless urinals and dual-flush toilets
14. Permeable asphalt, unit pavers and stone paving reduces runoff water
15. High performance, low-e (low-emissivity) windows provide state-of-the-art solar and thermal control and energy efficiency, while admitting maximum daylight
16. Rainwater will be stored in two 1,700-gallon underground tanks



Source: <http://landscapevoice.com/center-for-sustainable-landscapes-landscape-architecture/>

Syazli2012©

## Sustainable Landscapes Construction

1. Reduction of **stormwater run-off** through the use of bio-swales, rain gardens and green roofs and walls.
2. Reduction of **water use** in landscapes through design of water-wise garden techniques
3. **Bio-filtering** of wastes through constructed wetlands
4. **Landscape irrigation** using water from showers and sinks, known as gray water
5. **Integrated** Pest Management techniques for pest control
6. Creating and enhancing **wildlife habitat** in urban environments
7. **Energy-efficient** landscape design in the form of proper placement and selection of shade trees and creation of wind breaks
8. **Permeable paving materials** to reduce stormwater run-off and allow rain water to infiltrate into the ground and replenish groundwater rather than run into surface water
9. Use of sustainably **harvested wood**, composite wood products for decking and other landscape projects, as well as use of plastic lumber
10. **Recycling of products**, such as glass, rubber from tires and other materials to create landscape products such as paving stones, mulch and other materials
11. Soil management techniques, including composting kitchen and yard wastes, to maintain and enhance **healthy soil** that supports a diversity of soil life  
Integration and adoption of renewable energy, including solar-powered landscape lighting.

Syazli2012©

## Landscape Sustainability Assessment

- Assessing sustainability becomes more important when striving for enhanced urban landscape environments.
- One way of evaluating the outcome of action is using **sustainability indicators** (Hales, 2009).
- Indicators arise from values as one measures what he cares about and also create values as one cares about what he measures.
- The main feature of indicators is their **ability to summarize, focus and condense the complexity of dynamic landscape environment to a manageable amount of meaningful information**. By visualizing phenomena and highlighting trends (Rosales, 2010).

Rosales, N. (2010). Towards a design of sustainable cities: Incorporating sustainable indicators in urban planning. 46 th ISOCARP Congress. Retrieved from [http://www.isocarp.org/Data/case\\_studies/1715.pdf](http://www.isocarp.org/Data/case_studies/1715.pdf)

## Indicators of urban landscape sustainability

- Sustainability in urban landscape has become an important topic because of perceptions of environmental degradation.
- Faced with diverse and sometimes contradictory goals, many communities have turned to indicators of urban landscape sustainability as an approach to establishing a more specific definition and implementation that are of importance in their context.
- A key question arises:  
***“How does one define the set of indicators? And also what are the measures to be used?”***



Image Source: <http://arcadiasustainabledesign.com.au/landscape-design/>

Syazli2012©

## Indicators of urban landscape sustainability

- The number and nature of Indicators are based on several backgrounds such as theory, empirical analysis. They also cover the variety of orientors and dimensions. Selection requires a balance between simplification and complication. Based on the goal, the components will have to be selected whether it is of universal significance or for local conditions, as shown in table 2. Approaching the proposed framework for assessing urban landscape sustainability has to be combined by an appropriated tools for analysis and combining indicators

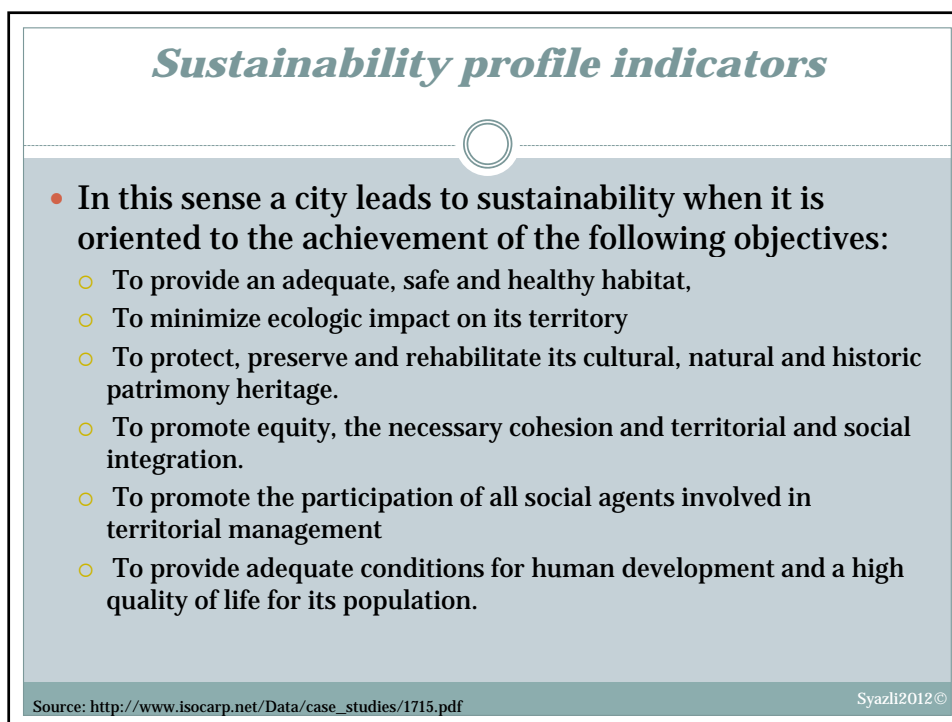
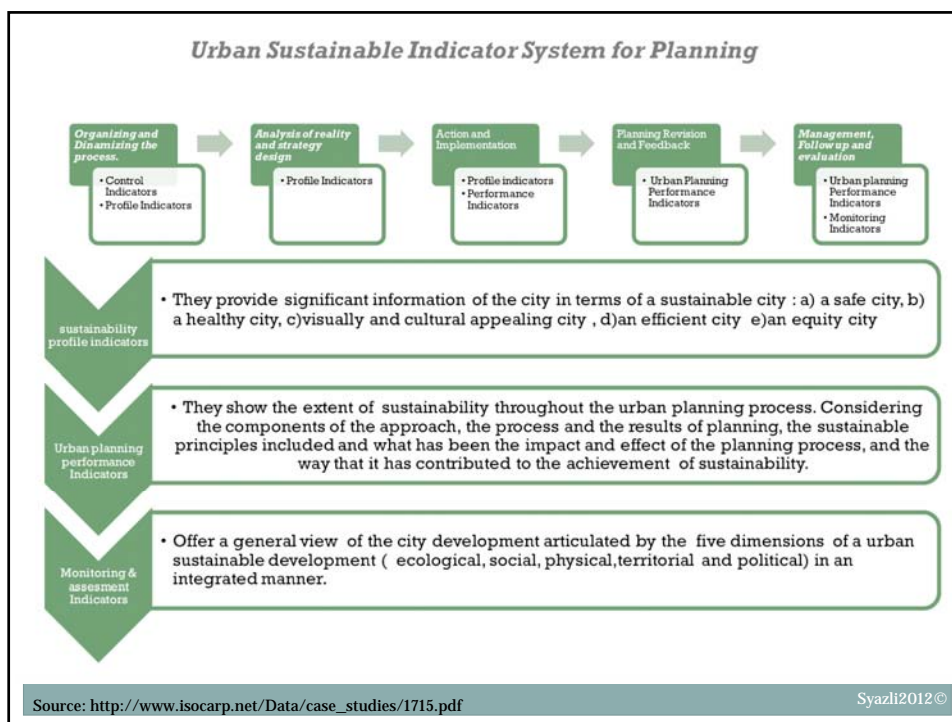
Indicator(s)	Function	Number of activity	Balance between	hardsoft/adequacy of standards-compatibility (see v a setting)
Ecology	Rate of re-vegetation	percentage soil	penetration/area of	resilience/soil/energy/pollution prevention/quality of resources
Energy	both embedded and operational	energy both embedded and operational rate		
Health	of land/development/energy consumption and enhancement			
Maintenace	Number of components	balance between	hardsoft/number of selected elements/number of access / components/integrated patterns	users preference
Quality	Initial cost/maintenance cost	life cycle	costing/maintenance flow	
Sustainability	Numbers of users	group/size of user	number of behavioural units...	
Stability	Number of repeated items	complexity of process/quality of labor		
Unity	Realization of process			

scale	0-20	20-40	40-60	60-80	80-100			
80-100	bad	poor	medium	good	very good			
60-80								
40-60								
20-40								
0-20								
system	Site landscaping							
Subsystem(s)	Core system		Surface system					
Sub-subsystem(s)	soft	hard	water	furniture	irrigation	drainage	infra	horti
Dimension(s)	function	environment	aesthetic	economy	social	maintaining	other	
Oriente(s)	Vital	Safe	Charming	Cost	Diverse	Curing		
	Special	Green	Pleasure	efficient	Steward-	Recycling		
	Flexible	Clean	Attraction	Cost	Ship	Durability		
	useful	Curing	Readable	reduce	Cooperati	Sustained		
		recycling	Convenient	Life	ve	Reuse		
			preference	cycle	Friend			

Source: [http://archnet.org/gws/LJAR/11003/files\\_10621/6.2.06-ahmed%20mohamed%20amin-pp%2098-114.pdf](http://archnet.org/gws/LJAR/11003/files_10621/6.2.06-ahmed%20mohamed%20amin-pp%2098-114.pdf)

Syazli2012©





### Urban Safety Indicators

urban safety indicators	THEME	INDICATORS
	urban vulnerability	natural disaster risk
population located in risk zones		housing standars
		population in informal settelments
land tenure	Tenure	tenure type
		household with secure lan tenure
		right to adecuete housing
		housing Price
		Secure tenure
urban safety	security	urban violence
	underlying factors	urban poverty
		employment
		inequity

Source: [http://www.isocarp.net/Data/case\\_studies/1715.pdf](http://www.isocarp.net/Data/case_studies/1715.pdf) Syazli2012©

### Urban Healthy Indicators

urban healthy indicators	THEME	INDICATOR
	urban environment quality	quality of the environment
water quality		
wild life quality		
public spaces	green spaces	
urban structure	urban form	urban area
		compactness of the city
		land use density
	urban development patterns	urban development patterns
		evolution of urban areas
	movility	public open spaces means of transport commuting time
urban metabolism	water	consumption sewage water
	energy matrix	energy consumption energy production plants
	materials and products	transport of goods
	waste	waste
		final waste disposal recycling waste treatment and disposal
sustainability of the urban local system	selfsufficiency	water selfsufficiency
		energy selfsufficiency
		agruiculture and food
	global/ local impacts	environmental deterioration
		carbon footprint
		water footprint
		environmental foot print impact on human health due to environmental deterioration

Source: [http://www.isocarp.net/Data/case\\_studies/1715.pdf](http://www.isocarp.net/Data/case_studies/1715.pdf) Syazli2012©

### The Visually and Cultural Appealing City Indicator

	THEME	INDICATOR
habitat quality	housing	housing standars
		population density
	service cover	basic services
		water saniation
urban space quality	local services	availability of local services accessibility to open space and
	vitality	culture and leisure
	urban landscape	historic- cultural heritage
		natural heritage
		built environment

**visually & cultural appealing city indicators**

Source: [http://www.isocarp.net/Data/case\\_studies/1715.pdf](http://www.isocarp.net/Data/case_studies/1715.pdf) Syazli2012©

### Urban efficiency indicators

	THEME	INDICATOR	
political administrative instruments	planning and land use	urban planning instruments Local Agenda 21 natural disaster prevention	
		regulations and legislation	policy related to urban environment
	policies	energy consumption	
		urban mobility	
		crime and violence prevention	
	economic instruments	financing measures	Investment for improving quality of housing investment for improving urban environment quality investment for urban safety
taxes			cadastre environmental taxation
cost of services			energy price land price
phisyc intervention instruments		infrastructure	works and actions on environmental infrastructure creation /conservation of green spaces
			knowledge and communication instruments
knowledge for sustainability	knowledge base and comuncations for sustainability		

Source: [http://www.isocarp.net/Data/case\\_studies/1715.pdf](http://www.isocarp.net/Data/case_studies/1715.pdf) Syazli2012©



## Urban planning performance indicators

### Checklist Indicators

#### PROGRAMMATIC COMPONENTS

- ✓ Do the programmatic components of the urban planning scope include the sustainability principles of multidisciplinary, inclusion, and integrality?
- ✓ Is there a sustainability envision of the city included in master plans and other planning instruments?
- ✓ Are the principles of multidisciplinary, inclusion, and integrality built in the Urban Development Plan?

#### PROGRAMMATIC OBJECTIVES

- ✓ Are the notions of urban sustainability included as part of the objectives of the Urban Development Plan?

#### TERRITORIAL STRATEGY

- ✓ Are the notions of urban sustainability included as part of the territorial strategy?

#### PROGRAMMATIC EFFECTS

- ✓ Are the effects, consequences and impacts of urban planning presented in terms of urban sustainability?

Source: [http://www.isocarp.net/Data/case\\_studies/1715.pdf](http://www.isocarp.net/Data/case_studies/1715.pdf)

Syazli2012©

## The monitor and assessment Indicators

	INDICATOR	COMPONENTS
<b>Ecologic</b>	Ecological footprint	energy consumption+ water consumption + materials consumption+ green house gases emissions , total population , carrying capacity
<b>Physical</b>	Urban quality of life index	habitat indicators+ social indicators+economic indicators+perception of the city indicators
<b>Social</b>	GINI index	income distribution at urban level
<b>Economic</b>	City Development Index	( infrastructure+ waste+education+health+ city product)/5
<b>Politic</b>	Urban Governance Index	participation and civic engagement, transparency and accountability, subsidiarity and rule of law

**monitoring indicators**

Source: [http://www.isocarp.net/Data/case\\_studies/1715.pdf](http://www.isocarp.net/Data/case_studies/1715.pdf)

Syazli2012©

## Sydney Water's sustainability performance

This performance summary provides an overview of Sydney Water's sustainability performance in 2007–08.

The performance summary is a scorecard that adopts Sydney Water's goals and integrates the social, economic and environmental aspects of its performance. It includes a performance statement and progress rating for each key performance area. The ratings are based on the evaluation of Sydney Water's sustainability indicators.

Goal	Performance statement	Progress rating
Providing clean, safe drinking water	<b>Water quality compliance</b>	
	<ul style="list-style-type: none"> <li><b>Water quality:</b> Continued full compliance with the <i>Australian Drinking Water Guidelines 2004</i>.</li> <li><b>Customer satisfaction with water:</b> Customer feedback shows satisfaction with water quality remained high.</li> </ul>	▲ ▲
Helping develop a water efficient city	<b>Water efficiency</b>	
	<ul style="list-style-type: none"> <li><b>Reuse and recycling:</b> 15% of drinking water saved through recycling schemes.</li> <li><b>Water leakage:</b> Leakage remained low at 8.2% of drinking water drawn. A number of programs are in place to achieve the target of 105 million litres a day by 30 June 2009.</li> <li><b>Demand management:</b> Investment in demand management has increased significantly since the program began in 1999, resulting in a steady reduction in yearly water use.</li> <li><b>Water drawn:</b> The total amount drawn continued to decline due to ongoing water restrictions and demand management programs.</li> </ul>	▲ ▲ ▲ ▲
	<b>Licence compliance</b>	
	<ul style="list-style-type: none"> <li><b>Sewage treatment system discharges:</b> Treated wastewater discharged increased as a result of increased flows from storms. Despite this, the phosphorus, nitrogen, suspended solids and grease loads remained relatively steady.</li> <li><b>Environmental performance monitoring:</b> Toxicity testing showed no adverse effects from treated wastewater on ecosystem health. Recreational water quality was reduced due to intense and frequent storm events.</li> <li><b>Trade waste agreements:</b> Sydney Water actively managed trade waste inputs to ensure that they did not adversely affect treated wastewater and biosolids production.</li> </ul>	▲ ● ▲
Optimising resource use	<b>Eco-efficiency</b>	
	<ul style="list-style-type: none"> <li><b>Energy consumption:</b> Sydney Water met the first yearly target towards its commitment to become carbon neutral for energy and electricity consumption by 2020. The 2007–08 result represents a 12% reduction in emissions against the 1993–94 baseline.</li> <li><b>Waste minimisation:</b> Maintained high rates of recycling of waste generated from operations and maintenance.</li> <li><b>By-products:</b> Targets for the beneficial use of captured biosolids and water treatment residuals were met.</li> <li><b>Flora, fauna and heritage:</b> Heritage management targets were met. There was a net loss of native vegetation; however, restoration and rehabilitation works are yet to be completed for some major capital works projects.</li> </ul>	▲ ▲ ▲ ▲

Source: [http://www.sydneywater.com.au/publications/Reports/AnnualReport/2008/SustainabilityIndicators/Sustainability\\_overview.cfm](http://www.sydneywater.com.au/publications/Reports/AnnualReport/2008/SustainabilityIndicators/Sustainability_overview.cfm)

SYDNEY WATER SUSTAINABILITY INDICATORS: Measures of sustainability performance		
Goal	Indicators	
Providing clean, safe drinking water	<b>Water quality</b>	<ul style="list-style-type: none"> <li>The percentage of water tests that meet the <i>Australian Drinking Water Guidelines 2004</i> (for system performance monitoring for indicator organisms)</li> <li>Compliance with health guideline values as determined by NSW Health in each water delivery system</li> </ul>
	<b>Customer satisfaction with water</b>	<ul style="list-style-type: none"> <li>Average rating of customers satisfied with the overall quality of drinking water supplied by Sydney Water</li> </ul>
Helping develop a water efficient city	<b>Reuse and recycling</b>	<ul style="list-style-type: none"> <li>Total volume of water recycled on account of recycled water schemes managed by Sydney Water</li> </ul>
	<b>Water leakage</b>	<ul style="list-style-type: none"> <li>Water leakage expressed as a percentage of drinking water drawn</li> </ul>
	<b>Demand management</b>	<ul style="list-style-type: none"> <li>Total volume of drinking water saved per year on account of demand management programs</li> </ul>
Contributing to clean beaches, oceans, rivers and harbours	<b>Water drawn</b>	<ul style="list-style-type: none"> <li>Total volume of water drawn by Sydney Water from all sources</li> <li>Water drawn expressed as a percentage of yield</li> <li>Water drawn expressed on a per capita basis</li> </ul>
	<b>Sewage treatment system discharges</b>	<ul style="list-style-type: none"> <li>Volume of treated wastewater discharged to the environment from inland and ocean sewage treatment plants</li> <li>Wastewater re-used or otherwise prevented from entering waterways</li> </ul>
	<b>Environmental performance monitoring</b>	<ul style="list-style-type: none"> <li>Percentage of sites that complied with the recreational water quality guidelines as reported by DECC's Beachwatch and Harbourwatch more than 90% of the time</li> </ul>
	<b>Ecosystems impacted downstream of Sydney Water's inland sewage treatment plant discharges</b>	<ul style="list-style-type: none"> <li>Ecosystem impacts of deepwater ocean discharges</li> </ul>
	<b>Trade waste agreements</b>	<ul style="list-style-type: none"> <li>Total mass of heavy metals received under trade waste agreements with Sydney Water</li> </ul>
	<b>Energy consumption</b>	<ul style="list-style-type: none"> <li>Total electricity consumed by Sydney Water</li> <li>Total electricity consumed by water assets expressed as a</li> </ul>
	<b>Waste minimisation</b>	<ul style="list-style-type: none"> <li>Solid waste generated by Sydney Water</li> <li>Waste recycled or reused expressed as a percentage of</li> </ul>

SYDNEY WATER SUSTAINABILITY INDICATORS: Measures of sustainability performance		
Goal	Indicators	
Optimising resource use	<b>Energy consumption</b> Total electricity consumed by Sydney Water Total electricity consumed by water assets expressed as a function of water supplied and by sewer assets expressed as a function of wastewater treated Electricity generated and consumed from renewable sources expressed as a percentage of total electricity consumption Net carbon dioxide equivalent emissions from the consumption of electricity, fuel and gas <b>By-products</b> <ul style="list-style-type: none"> <li>Solids capture rate for inland and ocean sewage treatment plants</li> <li>Total mass of biosolids produced by Sydney Water and beneficially reused expressed as a percentage of total mass produced</li> <li>Total mass of water treatment residuals produced and water treatment residuals beneficially reused expressed as a percentage of total mass produced</li> </ul>	<b>Waste minimisation</b> Solid waste generated by Sydney Water <ul style="list-style-type: none"> <li>Waste recycled or reused expressed as a percentage of solid waste generated</li> </ul> <b>Flora, Fauna and Heritage</b> <ul style="list-style-type: none"> <li>Total area of clearing of native vegetation</li> <li>Total area of native vegetation gain due to site rehabilitation, restoration or replanting by Sydney Water</li> <li>The condition of Sydney Water heritage items under s.170A of the <i>Heritage Act 1977</i></li> <li>Number of impact permits granted in relation to Aboriginal cultural heritage under the <i>National Parks and Wildlife Act 1974</i></li> </ul>
	Serving customers	<b>Customer satisfaction</b> <ul style="list-style-type: none"> <li>Average rating of the overall quality of service delivered by Sydney Water, through customer surveys</li> <li>Total number and the number per 1000 properties of complaints received</li> <li>Total number and number per 1000 properties of complaints relating to account payments, billing errors or overcharging</li> <li>The percentage of complaints received by Sydney Water that are resolved within 10 days</li> </ul> <b>Social assistance</b> <ul style="list-style-type: none"> <li>The total number and number per 1000 properties of instalment plans continuing for two or more consecutive quarters (classified by residential and non-residential properties)</li> </ul> <b>Service quality and system performance</b> <ul style="list-style-type: none"> <li>Frequency of planned and unplanned water interruptions</li> <li>Response times for water main breaks and leaks</li> <li>Low water pressure</li> <li>Frequency of sewer main breaks and blockages per 1000 properties</li> <li>Properties affected by uncontrolled sewage overflows</li> <li>Repeat sewage overflows</li> <li>Response times to sewage overflows</li> <li>Customer Contract rebates</li> </ul>

SYDNEY WATER SUSTAINABILITY INDICATORS: Measures of sustainability performance		
Goal	Indicators	
Developing a safe, capable, committed workforce	<b>Safety</b> Lost time injury frequency rate for Sydney Water staff and contractors Safety corrective actions closed on time for Sydney Water staff and contractors	<b>Training and capability</b> Percentage of staff covered by a national competency program Staff training hours completed as a percentage of training hours planned <b>Entry level employment</b> Average number of staff on entry level programs (including graduates, apprentices and trainees)
	Being an economically efficient business	<b>Profitability</b> <ul style="list-style-type: none"> <li>Net profit after tax (versus Statement of Corporate Intent)</li> <li>Revenue</li> <li>Operating expenditure</li> <li>Tax and dividends</li> </ul> <b>Return on assets and equity</b> <ul style="list-style-type: none"> <li>Return on assets</li> <li>Return on equity</li> </ul> <b>Debt servicing</b> <ul style="list-style-type: none"> <li>Funds flow from operations interest cover</li> <li>Treasury management</li> <li>Cashflow</li> <li>Credit worthiness rating</li> </ul> <b>Infrastructure management</b> <ul style="list-style-type: none"> <li>Delivery of Capital Investment Program for renewals / rehabilitation</li> <li>Percentage of planned maintenance completed for:                             <ul style="list-style-type: none"> <li>water</li> <li>wastewater</li> <li>stormwater</li> <li>property</li> </ul> </li> </ul>