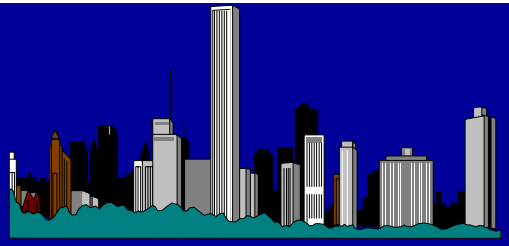
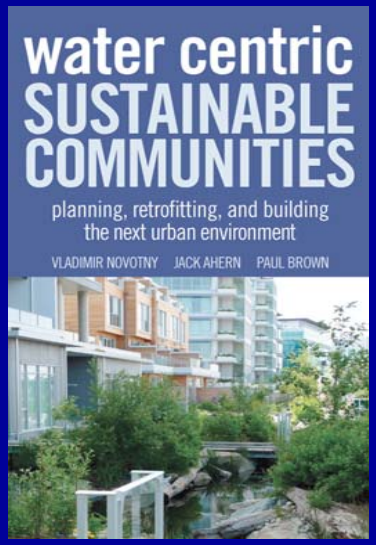


From Current Status to Cities of the Future

Concepts and designs of water/used water management in ecocities to reach OPL criteria



© **Vladimir Novotny**
AquaNova, LLC

Sustainable development

- Defined as one that meets the needs of the present without compromising the ability of future generations.
- Urban sustainability is compromised by
  - Population increases and migration
    - In the next 50 years the world population is expected to increase 50% and the US population by 30-40%. The largest increases will occur in urban areas.
  - Increasing imperviousness of watersheds, more polluted runoff
  - Unbalanced hydrology by sewers and switch from community water and wastewater works to large regional transfers of water and sewage
  - Excessive use of water
  - Fast conveyance type drainage relying on sewers
  - Competing uses

PARADIGM

- A model and a set of rules how ideas are linked together and form a conceptual framework by which people build and operate the cities and manage their water resources
- It is based on logic, common sense, generational experience, and later, scientific knowledge
- It is derived by a discourse in the political domain; science or good engineering alone may not be the primary determinant of a paradigm
- A wrong or outdated paradigm may persist because of tradition, lack of information about the pros and cons of the outdated paradigm or lack of resources to change it

Trinity of sustainability

Society

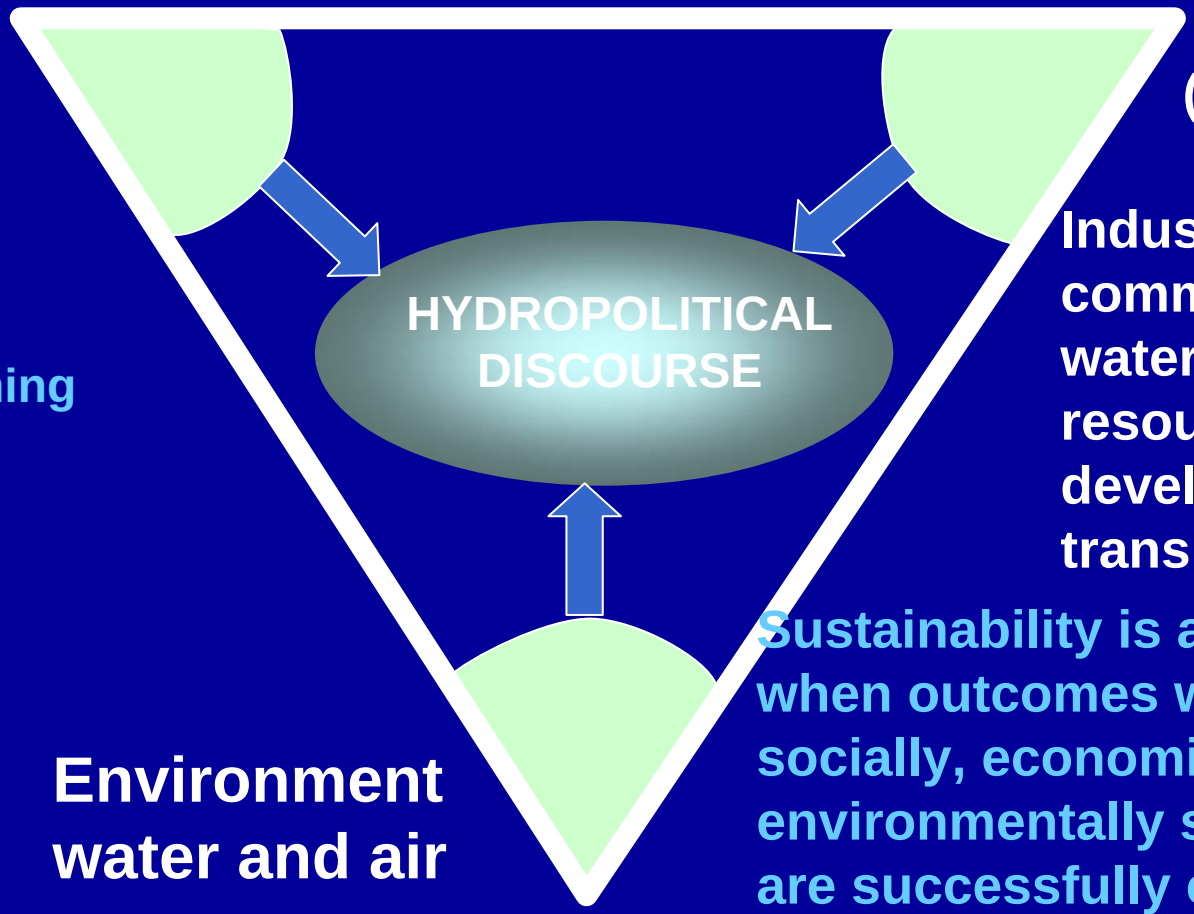
Domestic use, basic food production

Global warming

Economy

(Infrastructure)

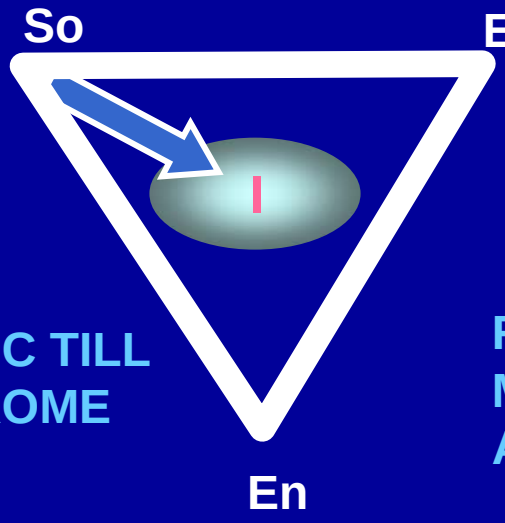
Industrial and commercial use of water and water resources, land development, transportation



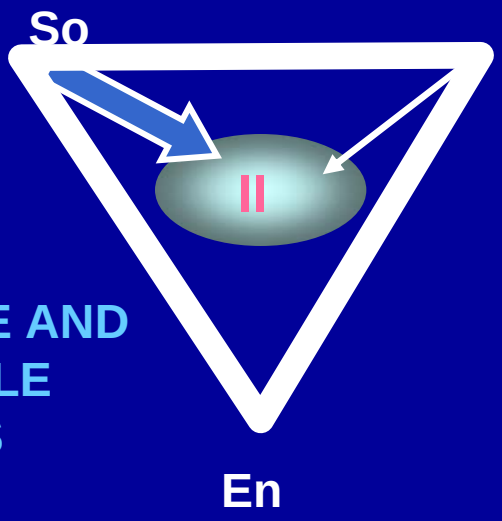
Environment water and air

Sustainability is achieved when outcomes which are socially, economically and environmentally sustainable, are successfully contended in the itergenerational context

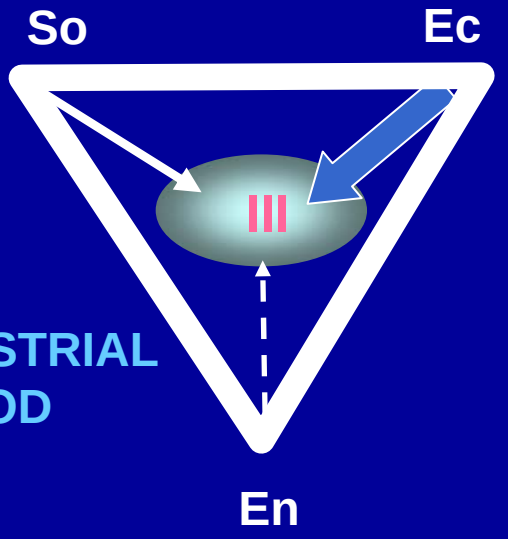
Change of the paradigm to urban water sustainability



BC TILL ROME

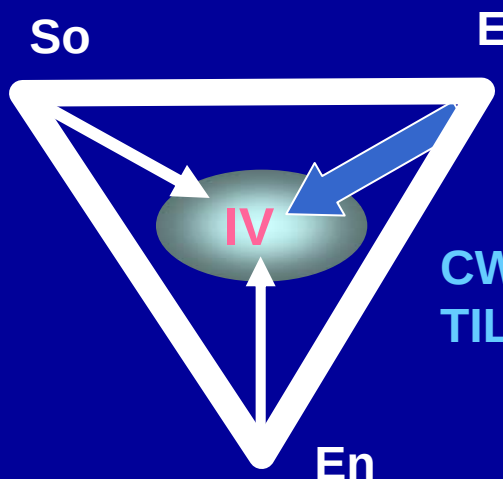


ROME AND MIDDLE AGES

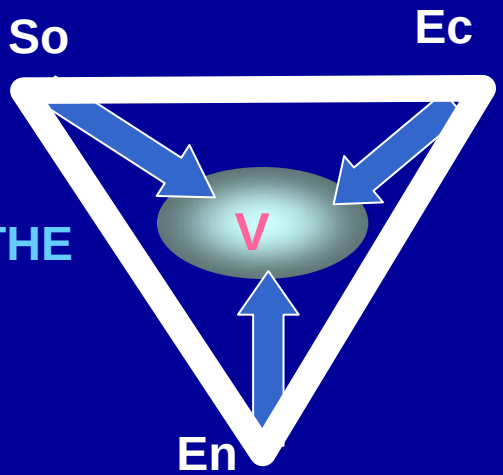


INDUSTRIAL PERIOD

PARADIGMS OF URBAN WATER MANAGEMENT



CWA PASSAGE TILL TODAY



CITIES OF THE FUTURE

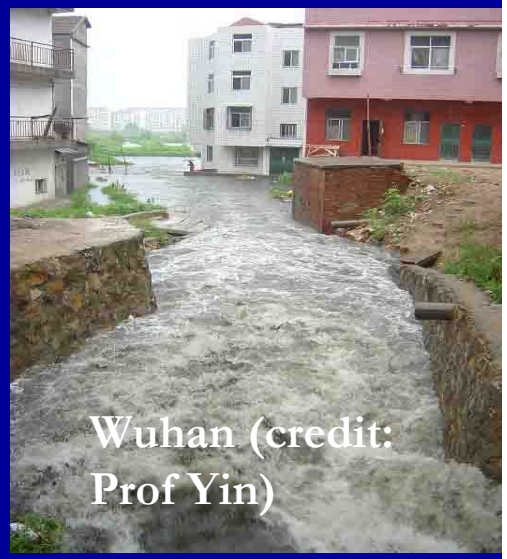
Change of the paradigm to urban water sustainability

PARADIGMS OF URBAN WATER MANAGEMENT

Fifth Paradigm

PROBLEMS WITH THE 4th PARADIGM

- Natural hydrologic status of urban water bodies and watersheds has been modified by imperviousness, building sewers and stream modifications with the impacts on
  - Streams
    - Increased high flows (more flooding).
    - Peak flows increase by a factor of 4 to 10
    - Less base flow - not enough base flow to sustain viable fish population
    - Increased variability (flow, temperature, DO)
    - Increased stream bank erosion
  - Groundwater recharge is diminished
    - Effect on foundations (Boston, Venice, Mexico City, Philadelphia
    - Diminishing groundwater supply
    - Diminish base flow in river
  - The goals of the Clean Water Act and OPL goals cannot be attained using the IVth paradigm infrastructure heavy and energy demanding concepts



Wuhan (credit: Prof Yin)

Mexico City

Driving Forces towards Sustainability

- Increasing water scarcity, excessive flooding and conversion into effluent dominated waters will require management of the total urban water hydrological cycle and decentralization of the urban sewerage
- Goals of achieving good ecological status and integrity are mandated by Clean Water Act in US and Water Framework Directive in EU and desired by public
- Limits have been reached and something has to be done
- Cities are rapidly expanding and new large cities have to be build to accommodate population growth and movement from rural to urban areas

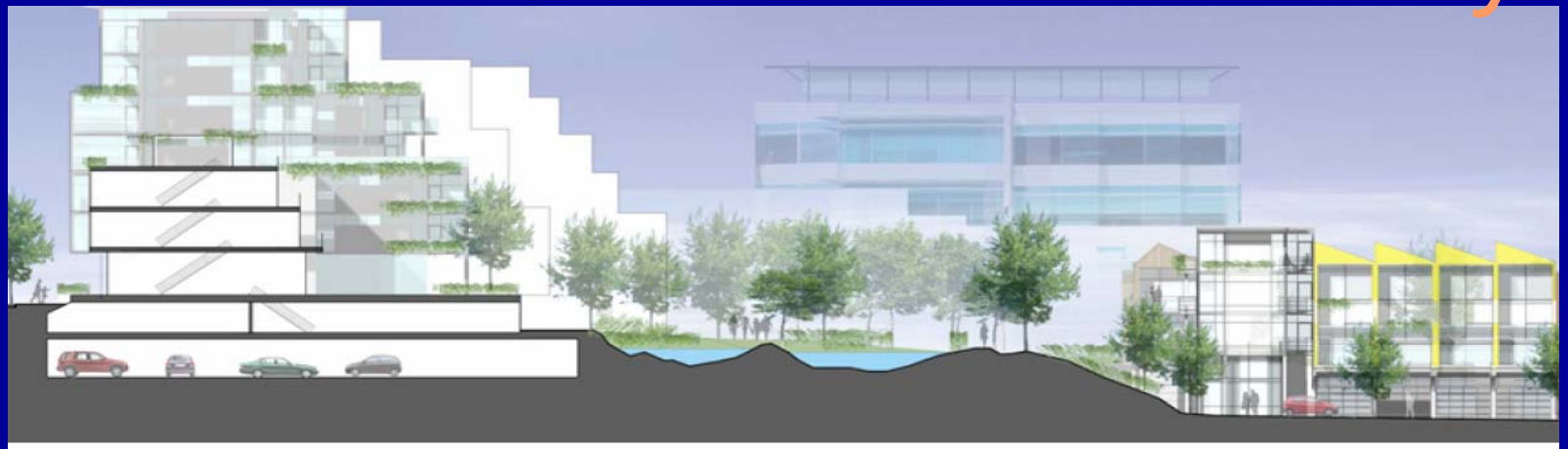
Vision of the Cities of the Future

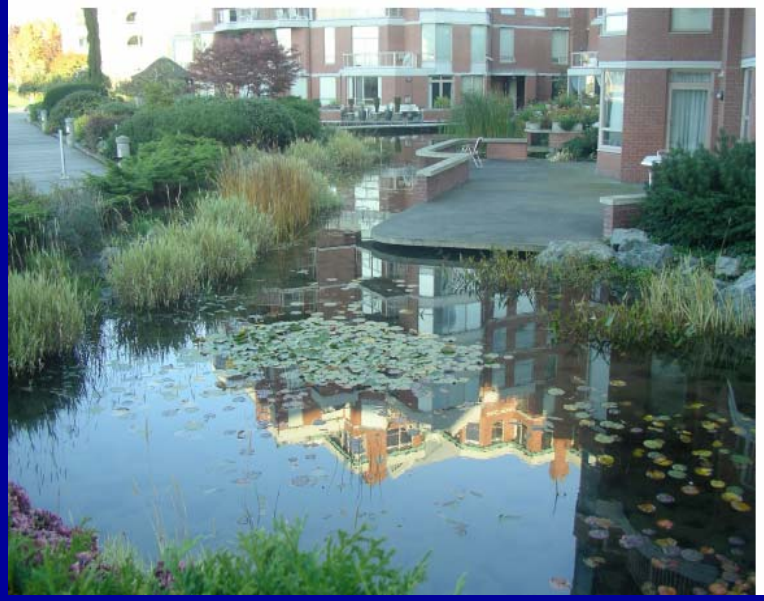
Definition/Vision of an Ecocity:

An ecocity is a city or a part thereof that balances social, economic and environmental factors (triple bottom line) to achieve sustainable development. A sustainable city or ecocity is a city designed with consideration of environmental impact, inhabited by people dedicated to minimization of required inputs of energy, water and food, and waste output of heat, air pollution - CO2, methane, and water pollution. Ideally, a sustainable city powers itself with renewable sources of energy, creates the smallest possible ecological footprint, and produces the lowest quantity of pollution possible. It also uses land efficiently; composts used materials, recycle or convert waste-to-energy. If such practices are adapted, overall contribution of the city to climate change will be none or minimal below the resiliency threshold. Urban (green) infrastructure, resilient and hydrologically and ecologically functioning landscape, and water resources will constitute one system

Adapted from R. Register UC-Berkeley

What is a Water Centric Ecocity ?





Credit Patrick Lucey, Aqua Tex, Victoria , BC

What is a Water Centric Ecocity ?

- **Water conservation**
- **Distributed stormwater management (surface)**
- **Distributed water treatment**
- **Water reclamation and reuse in buildings, irrigation and for ecologic stream flow**
- **Infiltration and repair of hydrology**
- **Stream restoration – multi-functional water bodies are a life line of the ecocity**
- **Heat and energy recovery**
- **Organic solids management for energy recovery**
- **Source separation**
- **Nutrient recovery**

- **Renewable energy source (solar, wind, hydropower)**
- **Sustainable low carbon traffic emissions**
- **Recreation, walking, biking**
- **Suburban organic agriculture**

Microscale Assessment

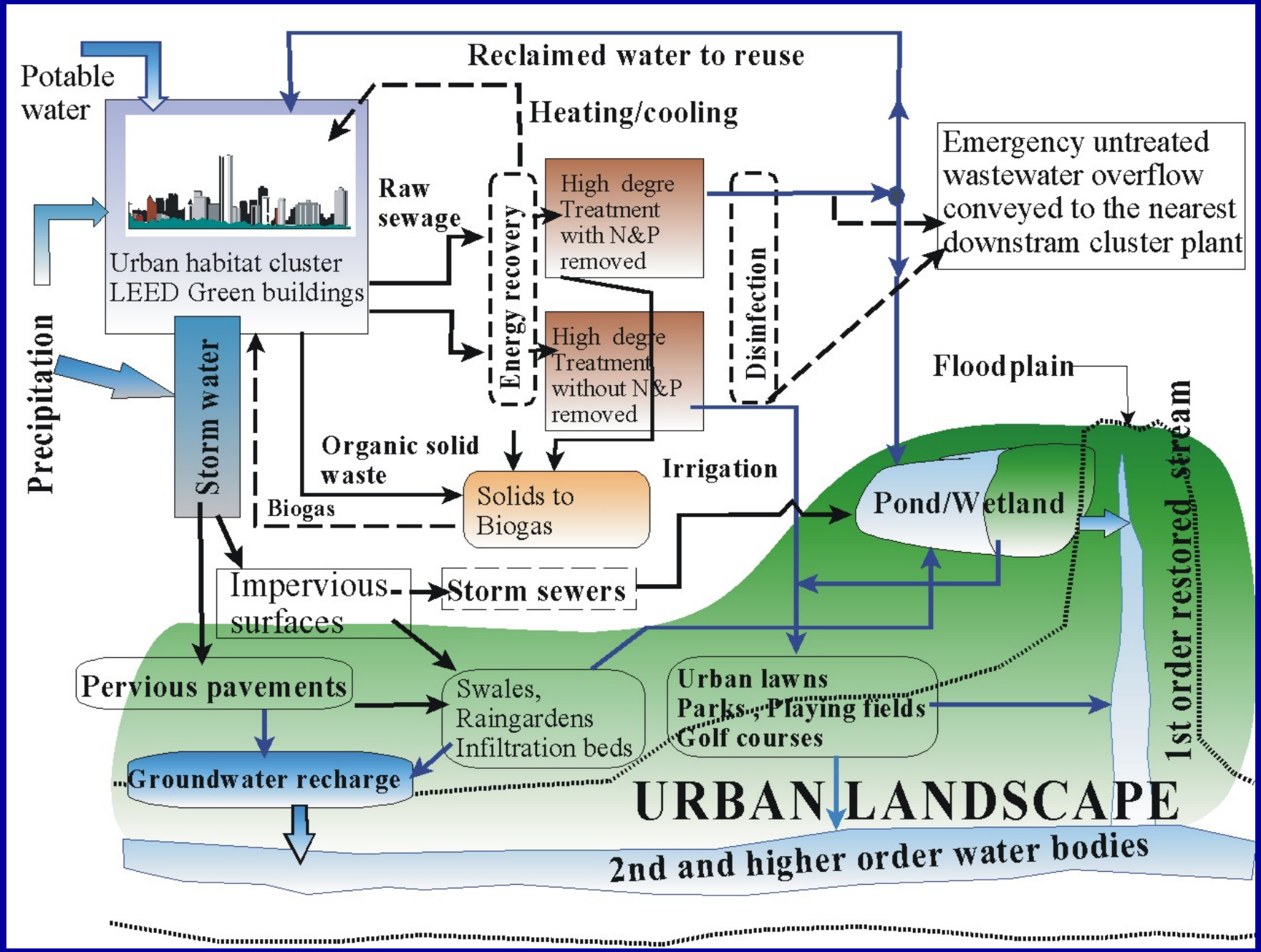
- Microscale (buildings, neighborhoods, subdivision
  - Leadership in Energy and Environmental Design-LEED
    - Sustainability of the site – smart location
    - Green design
    - Energy efficiency
    - Indoor environmental quality
    - Innovation and design
    - Neighborhood patterns, etc.
  - Low Impact Development (LID)
    - Capture, storage and infiltration of precipitation, mimicking predevelopment hydrology

Pond design AquaTex

Credit CDM

Decentralized Management Clusters and Ecoblocks

- A cluster (Ecoblock) is a semiautonomous part of the city that, for most part, has its own water/stormwater/wastewater management
  - Cluster may range in size from a high-rise building to a subdivision or a section of the city with thousands of inhabitants
  - Cluster infrastructure
    - Distributes water and practices water conservation and reuse
    - Implements energy saving in buildings (e.g., green roofs, solar energy)
    - Provides stormwater conveyance (mostly surface), storage and infiltration (groundwater recharge) and nature mimicking BMPs
    - Water reclamation units (high efficiency WWT)
    - Energy recovery from wastewater
  - Centralized or distributed biogas/Energy recovery
  - Ecologically and hydrologically functioning landscape
- Clusters are interconnected for increased resiliency


Potable water
Reclaimed water to reuse
Heating/cooling
Urban habitat cluster
LEED Green buildings
Raw sewage
Energy recovery
High degre Treatment with N&P removed
High degre Treatment without N&P removed
Disinfection
Emergency untreated wastewater overflow conveyed to the nearest downstram cluster plant
Precipitation
Storm water
Floodplain
Organic solid waste
Biogas
Solids to Biogas
Irrigation
Pond/Wetland
1st order restored stream
Impervious surfaces
Storm sewers
Pervious pavements
Swales, Raingardens Infiltration beds
Urban lawns Parks, Playing fields Golf courses
Groundwater recharge
URBAN LANDSCAPE
2nd and higher order water bodies

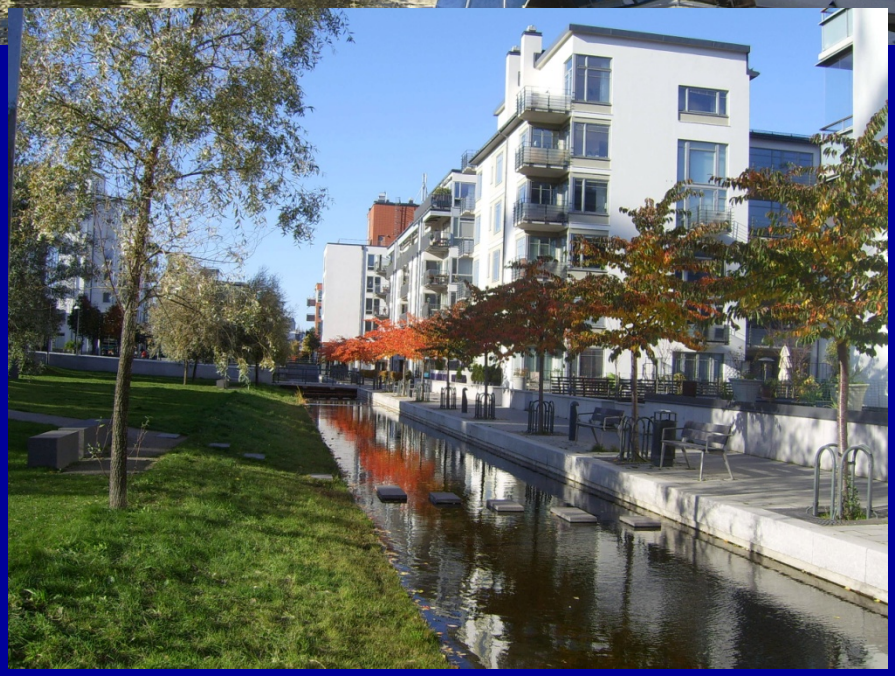
A water reclamation plant does not have to be far from the community

Courtesy AquaTex, Victoria, BC

One Planet Living (WWF)

- zero net carbon emissions- 100% of the energy from renewable resources;
- zero solid waste
- sustainable transportation with zero carbon emission in the city;
- local and sustainable materials used throughout the construction;
- sustainable foods, outlets providing organic and or fair trade products:
- 50% reduction in water use from the national average;
- natural habitat and wildlife protection and preservation;
- preservation of local culture and heritage ;
- equity and fair trade with wages and working conditions; and
- health and happiness for every demographic group.

Seven Ecocities Reviewed



Water Centric Hammarby Sjostad

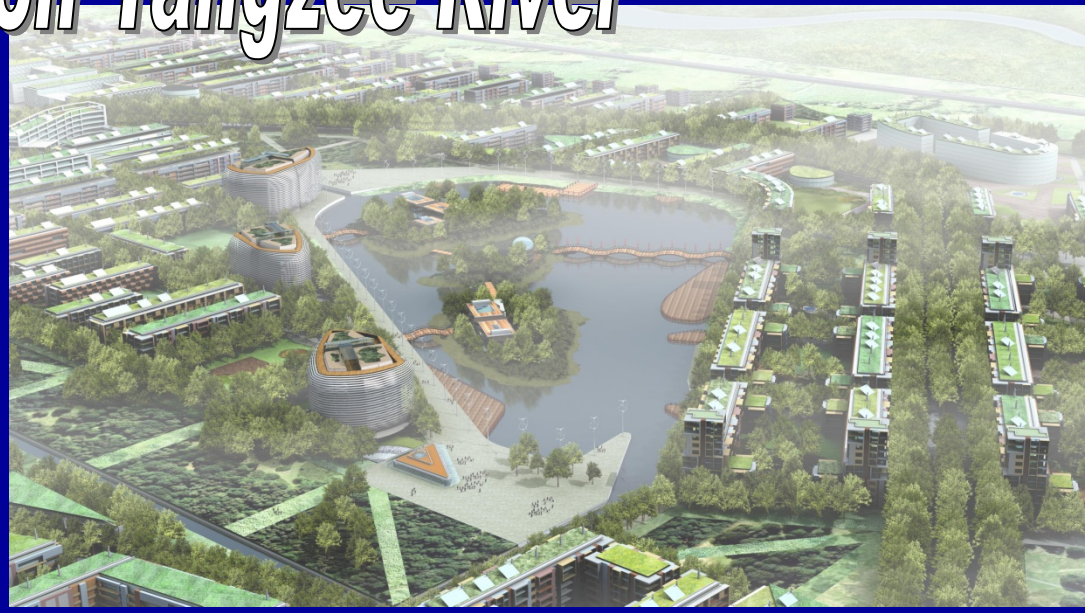
Picture credit Malena Karlsson
GlashusEtt, Stockholm


BEIJING
TIANJIN
Tianjin
ecocity
Qingdao
Shaanxi
XI'AN
Dongtan
Shanghai
North Ko
© 2008 ZENRIN
© 2008 Europa Technologies
© 2008 Kingway Ltd.
© 2008 NFGIS
Google
Pointer 36°15'53.60" N 116°35'42.81" E
Streaming 100%
Eye alt 891.93 mi

Dongtan

Venice -type ecocity on Yangzee River

Water centric

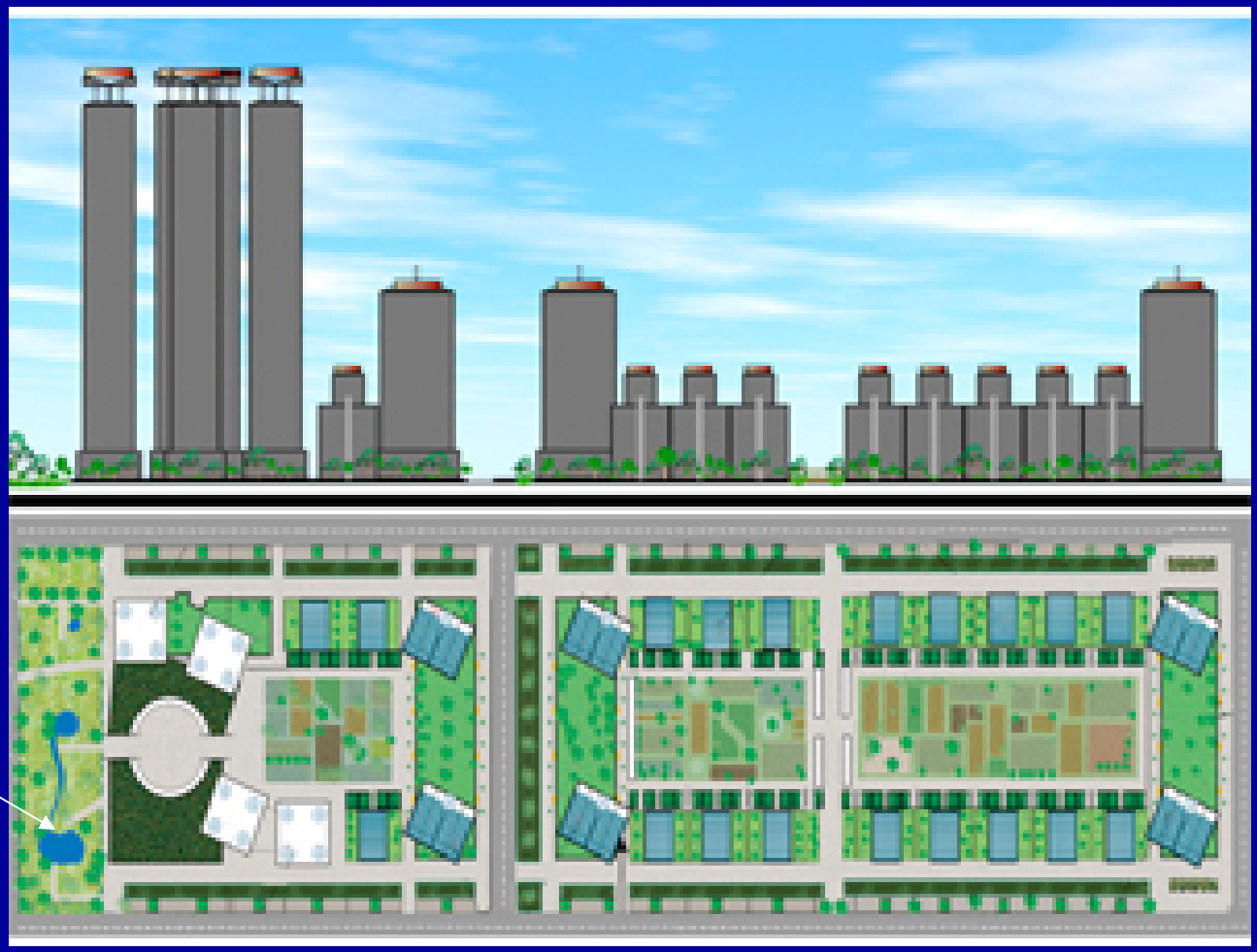


Picture credit Arup

QINGDAO (China) Ecoblock

Size 3.5 ha

1530-1800 pop



Treatment wetland

Picture credit Prof. Harrison Fraker – University of California - Berkeley

Qingdao EcoBlock:

Changing the paradigm for fast-paced Urban Development in China

GOALS:

- Mass replicable
- Economically viable
- Resource self-sufficient (water, waste, energy)
- 100% waste water recycled on site
- 75%+ reduced potable water demand
- 100% on-site renewable energy generation
- Encourage journeys by foot, bicycle and transit
- 40% to 60% site area to be green space

Source Harrison Fraker and ARUP

600 units on 2.7 ha (6.5 acres)

Sino-Singapore Ecocity Tianjin

Masdar (UAE)

Credit Masdar Development Co., UAE

Treasure Island (CA)

Credit City of San Francisco

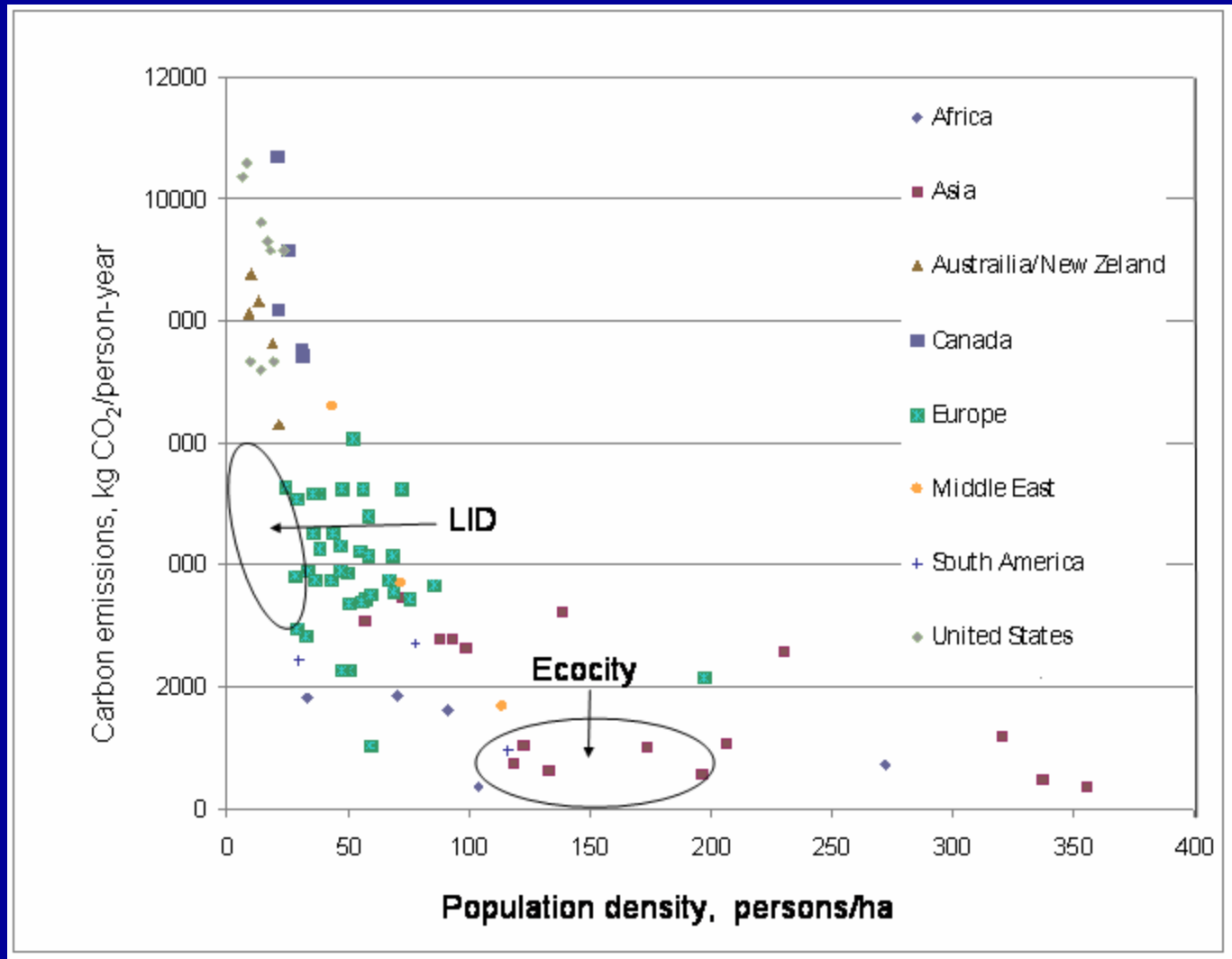
Sonoma Mountain Village (CA)

What have we learned?

Credit Sonoma Mountain Village

City	Population Total	Population Density #/ha	Water use L/cap-day	% water recycle	Water System	% Energy savings renewable	Green area m^2/cap	Cost US$/unit*
Hammarby Sjőstad	30,000	133	100	0	Linear	50	40	200,000
Dongtan	500,000 (80,000)++	160	200	43	Linear	100	100	~40,000
Qingdao	1500+	430 - 515	160	85	Closed loop	100	~15	?
Tianjin	350,000 (50,000)++	117	160	60	Partially closed	15	15	60,000 – 70,000
Masdar	50,000	135	160	80	Closed loop	100	<10	1 million
Treasure Island	13,500	170	264	25	Mostly Linear	60	75	550,000
Sonoma Valley	5,000	62	185	22	Linear	100	20	525,000

Population density matters



Difficult to compare US cities with Asian Cities or countries with different economic levels

Based on Newman and various other sources

Qingdao

Footprints and Framework

- **SOCIAL**
  - Water Shortages and Availability
  - Global Climatic Change
  - Health and Food Security
  - Environmental Justice
- **ECOLOGICAL**
  - Urban Waterways and Impoundments
    - Responsible Nutrient management
  - Restoring Ecological Corridors
  - Restoring Hydrology
- **ECONOMICAL**
  - Land use/urban form – resilience
  - Water/used water/ stormwater management - virtual water use
  - Solid waste recycle, minimizing landfilling
  - Energy (frugality, renewable sources)
  - Economic base/jobs/income inequality