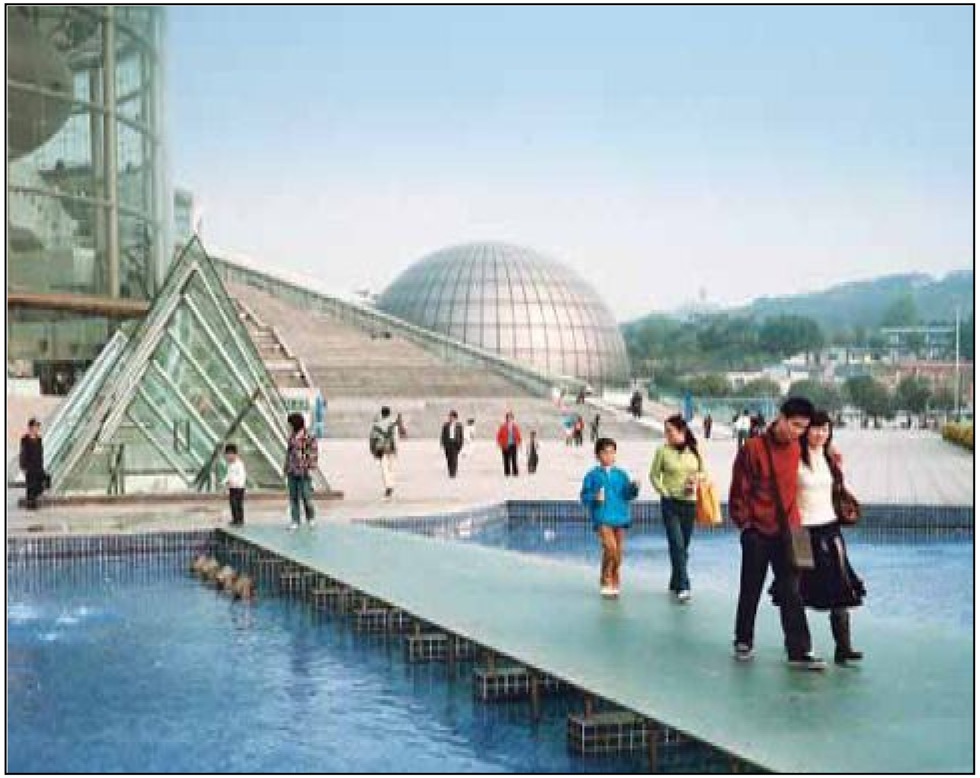
The issue of water
in sustainable wards and ecocities

PECC – April 12th, 2011

Although there is no standardized label for ecocities, it can be defined as follows

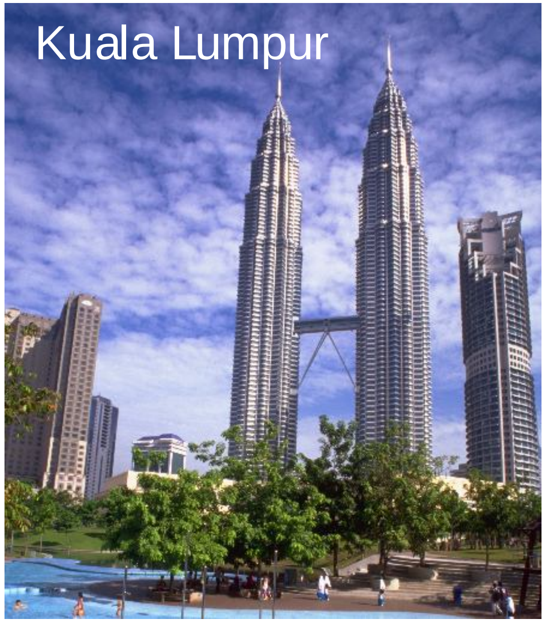
- *« An ecocity is a city that balances social, economic and environmental factors to achieve sustainable development ».* *
- It is designed, so as to minimize:
  - ➔ inputs of energy, water and materials
  - ➔ polluted outputs (heat, air contaminants, wastewater discharged,…).
- *« Ideally, an ecocity powers itself with renewable sources of energy and produces the lowest quantity of pollution possible. It also efficiently uses land and recycles or converts waste to energy ».* *
- Please note that this presentation focuses only on environmental issues.



Source: Water 21, Augsut 2010, Adapted from Register (1987) and Novotny et al (2010)

Part I – Water and ecocities, a challenging context:
Before dreaming of ecocities, let's have a look at the starting point…

Water scarcity is increasing in Asian and American cities



- Many cities are living beyond their hydrologic means:
  - In few decades, many Asian coastal cities have consumed a large part of their groundwater resources, which sometimes took centuries to fill.
  - Some conurbations like Los Angeles are on the verge of "*aquatic bankruptcy*"
  - The south-western United States, south-eastern Australia, and north-eastern China are already extracting more than 75 % of the flows of their rivers.
- Many cities are wasting their scarce water resources:
  - In the networks of Colombo, Delhi, New Orleans, losses can be as much as 50%. Out of 2 m^3 of water treated, 1 m^3 is lost during its transport to the consumer!
  - The carefree era of profusion has to end.
- In terms of water services, the challenges from urban growth are enormous
  - The urban population increases by the size of a city like Hanoi each month.
  - With 230 m^3 of water / inhab. / year, Beijing is one of the world's water poorest cities
- Rising urban demand in finite resources means that there will no longer be sufficient water to afford ourselves the luxury of misusing it

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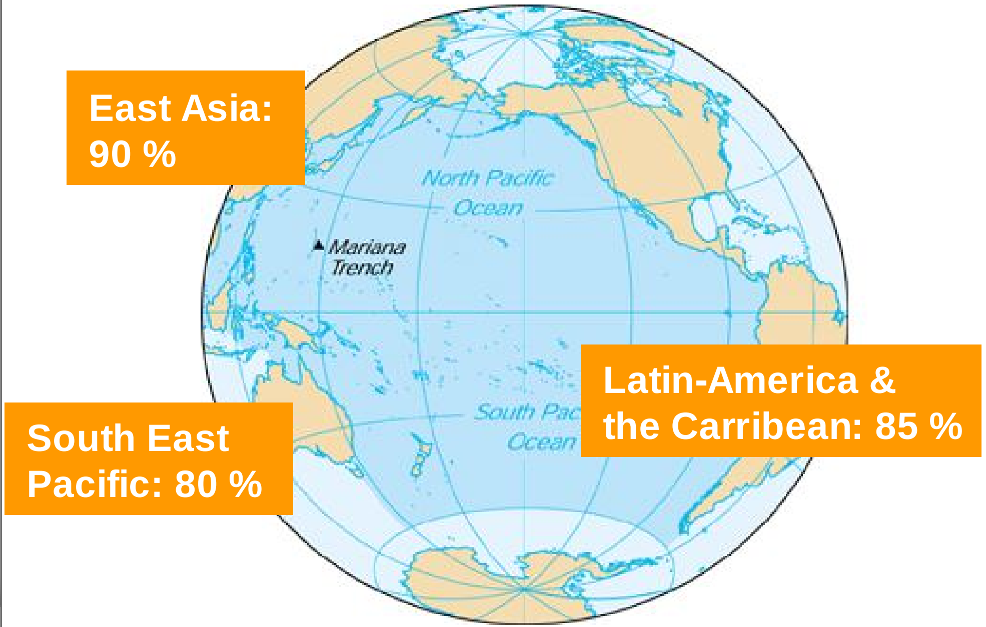
Sanitation is still the poor cousin of the water sector

- Many cities have achieved a minimal level of sanitation service at household.
  - ➔ But in most cases, these investments have not been followed by the development of public infrastructure, such as trunk sewerage systems.
  - ➔ Other cities have wastewater pipes, but no or very limited sewage treatment capacity.
- In the huge urban areas with their teeming population, urban inflation generates pollution at unbearable levels.
  - ➔ It concentrates large quantities of liquid waste in confined areas.
  - ➔ The destructive potential of wastewater that is neither collected nor treated is truly explosive.
  - ➔ For obvious reasons of hygiene, the bigger cities become, the more urgent will be the challenge of sanitation.

% of wastewater discharged into rivers and seas without treatment – Source: UNEP



The long road to a sustainable management of water and to ecocities

1) Responding to current water challenges

- Halting domestic and industrial pollution of water, the "*collateral damage of urbanization*"
- Coping with current and emerging water resources scarcities

Conventional city

Eco-city

2) Moving towards ecocities

- Establishing an urban development model that consumes less of water, energy, materials and space
- Achieving a zero-carbon urban footprint (in the long run)

How can water and wastewater services contribute to this objective ?

Reducing the water footprint of cities

Reducing the carbon footprint of water services

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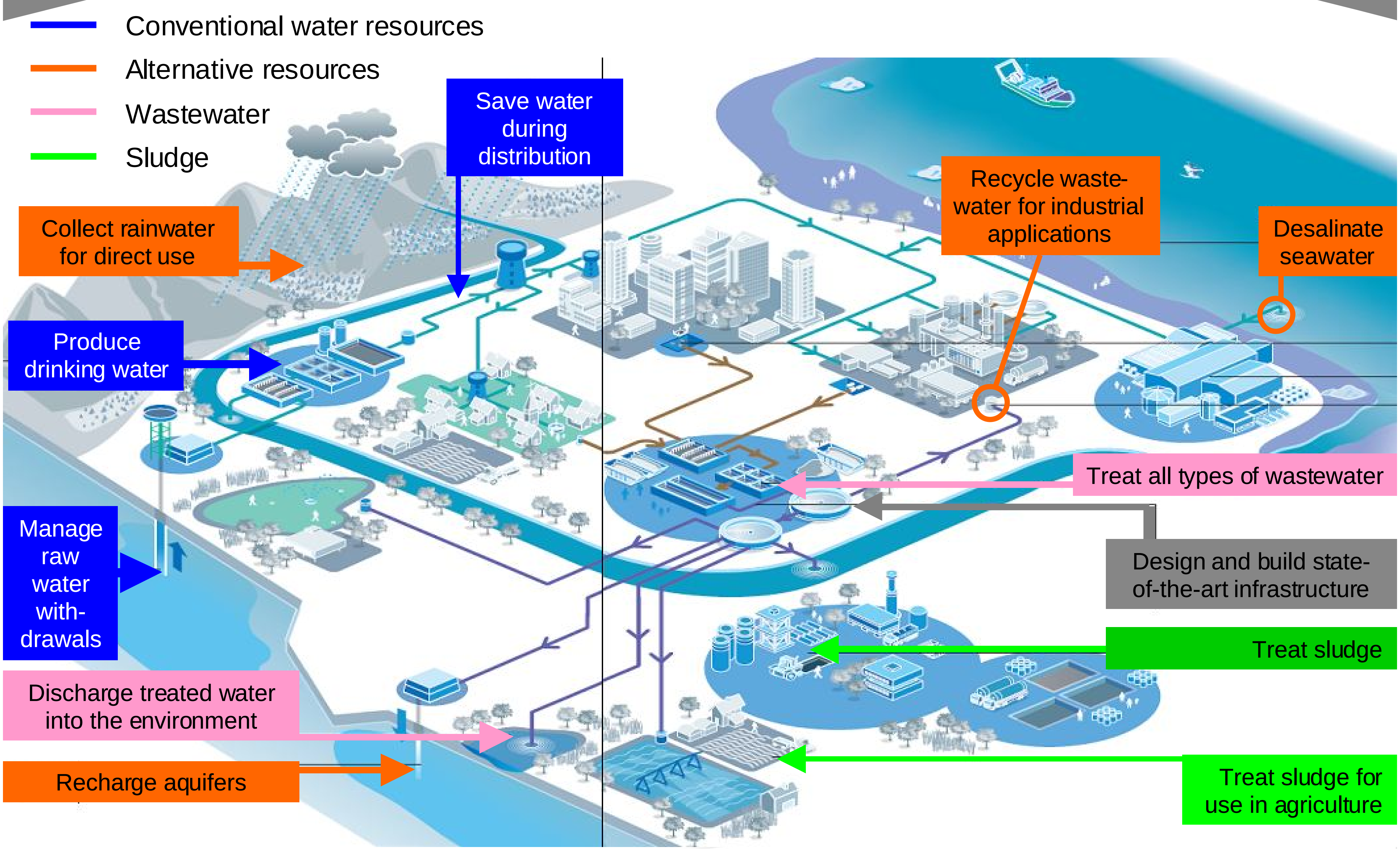
Part II – Towards a coherent management of all the urban water cyles

Managing all the water cycles with a focus on saving water and protecting resources



Reducing the water footprint

- Stopping policy-induced scarcity: (> water footprint)
  - ➔ The underpricing of water creates disincentives for conservation.
  - ➔ In ecocities, a key target of pricing policies should be to give a price to nature and a cost to pollution.
  - ➔ Since 2009, various Chinese cities (e.g. Luoyang) proposed water-price increases by 20 to 50%.
- Saving water resources: (> water footprint)
  - ➔ Water savings in urban network are often the resource that is immediately available in the largest quantity.
  - ➔ A good operator of urban water services is both a "*water saver*" and a new resources creator (in particular thanks to the mobilization of alternative water resources) .
- Increasing water productivity in cities and industrial areas: (> water footprint)
  - ➔ China is 5 times less water-efficient than Japan. This figure signals an immense margin for improvement. *(Source: Mc Kinsey Global Institute, 2009).*

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Reducing the water footprint and preserving the environment

- Moving from a culture of supply management to demand management: (> water footprint)
  - It is crucial to involve consumers more so that they can take actively control of their consumption and safeguard their environment.
  - But the adoption of behaviour which saves water will not increase unless inhabitants are given the means by which to control their consumption.
  - This can be done by the widespread installation of household water meters and remote meter-reading or text-message information systems (eg: in Shenzhen)

New generation of remote meter reading

- Planning sanitation coherently with urban development and economic activities:
  - It is vital to work simultaneously on all the sources of pollution of aquatic environments. None of them can be left out.
  - It is possible to escape from the spiral of "*more and more treatment for water that is more and more polluted*." In 10 years, Chile increased its wastewater treatment rate from 16% to 84%.

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Part III – Reducing the energy and carbon footprints in drinking water production

The nexus between energy and water is a critical issues for ecocities

- A lot of energy may be expended… or saved in urban water services:
  - ➔ In USA, 4% of total power generation is used to supply, purify, distribute and treat fresh water and wastewater *(Source: Managing our future water needs, World Economic Forum, January 2009).*
  - ➔ In Sweden, only 1 % is used for the same purpose *(Source: IWA 21, June 2009)*
- Saving water means saving energy: *(Source: California Energy Commission, 2005)*
  - ➔ In California, 19 % of the state's electricity are used for water. Thus *"rationalising water use saves more energy than introducing other measures of energy efficiency*"
- How to move towards low energy water service?
  - ➔ Water production requires more advanced technologies, that require more energy, except if innovative process invert this trend.
  - ➔ Achieving energy and carbon neutral wastewater treatments plants is feasible. The issue is disseminating recent innovation on the field.
  - ➔ Drinking water production plant cannot be energy neutral but they can be carbon neutral.
- For power production:
  - ➔ "*The best alternatives from a water perspectives are wind and photovoltaics, that require effectively no water*" *(Peter Gleick, Pacific Institute, International Herald Tibune, May 18th, 2010)*
  - ➔ For thermoelectric plant, the cooling technology used is the biggest factor in its water needs

How much energy is needed to produce drinking water?

Average electricity consumption of drinking water production, according to treatment process

	Drinking water production process	Electricticy consumption in Wh /m³
Freshwater	Conventional treatment	50 - 150
	Membrane treatment (*ultrafiltration / microfiltration)*	100 - 200
	Advanced membrane treatment	250 - 700
Seawater or brackish water	Brackish water desalination *(nanofiltration or reverse osmosis)*	600 - 1500
	Sea water desalination with energy recovery system *(reverse osmosis)*	3000 - 5000
	Sea water desalination without energy recovery system *(reverse osmosis)*	5500 - 8000
	Thermal desalination (distillation) *	> 6000
Wastewater	Wastewater recycling	25 - 1500
	Sludge treatment	5 - 15

Increasing energy conumption

** Electricity + heat converted into electricity equivalent*

Source: TSM n° 9 - 2007

Carbon footprint of desalination, according to technologies selected

- Survey on Veolia Water operated plants: average carbon footprint

	Greenhouse Gas rejected
Reverse osmosis	1.8 kg CO_2 per m^3
Thermal desalination (MED – Multi-Effect Distillation)	18.0 kg CO_2 per m^3
Thermal desalination (MSF – Multi Stage Flash Distillation)	23.4 kg CO_2 per m^3

Comparison: 1 metric ton of wheat	25.0 kg CO_2 per ton

These are indicative figures, since CO_2 emitted is function of the local energy mix.

- R&D aims at lowering the energy consumption of membrane systems by 30% to 50% and developing low energy desalination plants. But whatever future progress, seawater desalination will never compete with freshwater treatment.
- A "*Green desalination plant*" is feasible subjected that large renewable energy source is available (e.g.: with wind energy for desalination in Sydney…).

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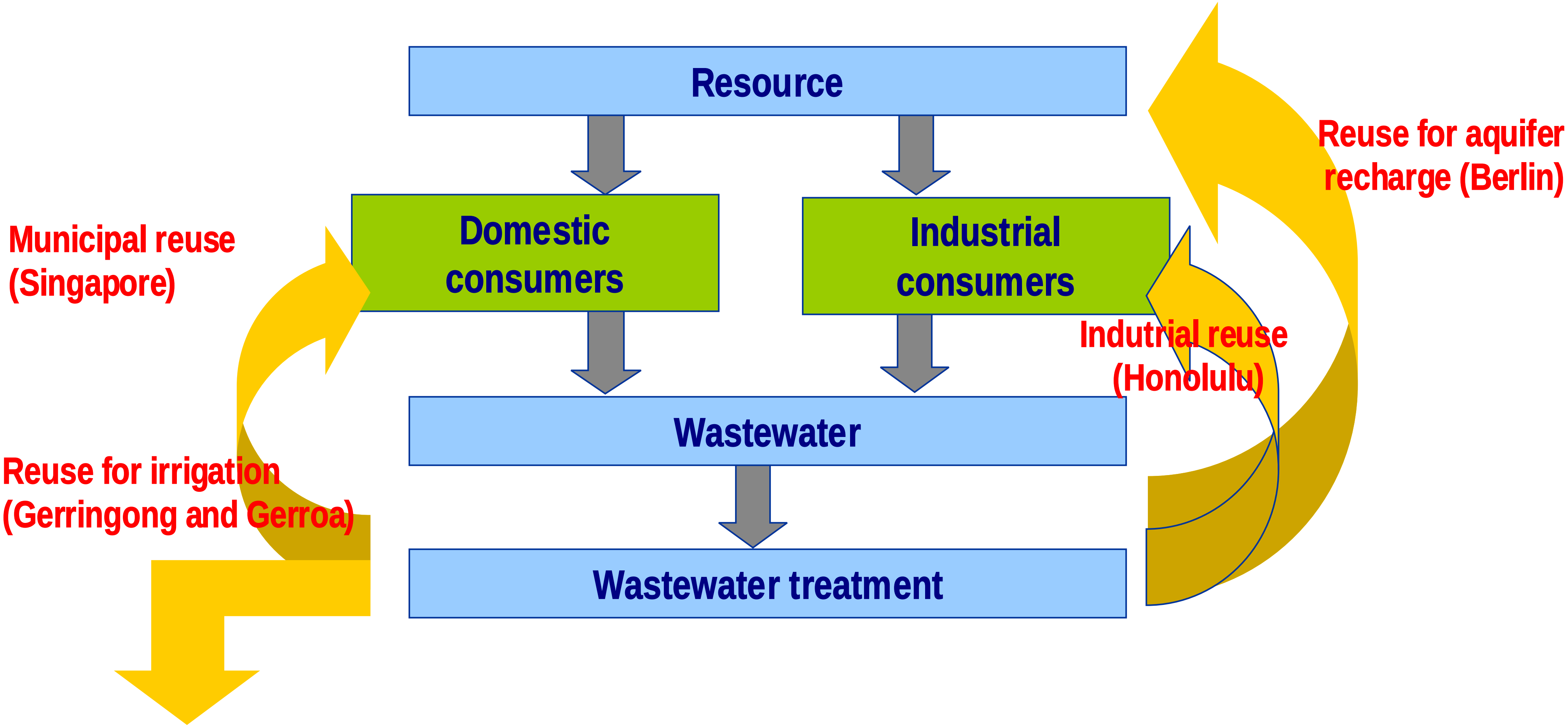
Part IV – Wastewater recycling and rainwater collection, two key issues for the water management of ecocities

Recycled wastewater, a resource that reduces the water footprint of cities



- Wastewater recycling prevents water being returned to nature after only 1 use

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The many advantages of wastewater recycling in order to build ecocities

Water withdrawals

- Wastewater recycling is a fast track for increasing the productivity of water and therefore reducing the water footprint of cities.
  - ➔ Separating water use from water abstraction means that maximum use can be made of the same quantity.
  - ➔ Reusing water before it is finally discharged back into the environment increases the productivity of each m^3 borrowed from nature (by 2, 3, 10,…, as much as wastewater is reused without new withdrawals from nature).
  - ➔ It is also the only resource that increases with economic development, in parallel with the growth in need for water.

Pollution

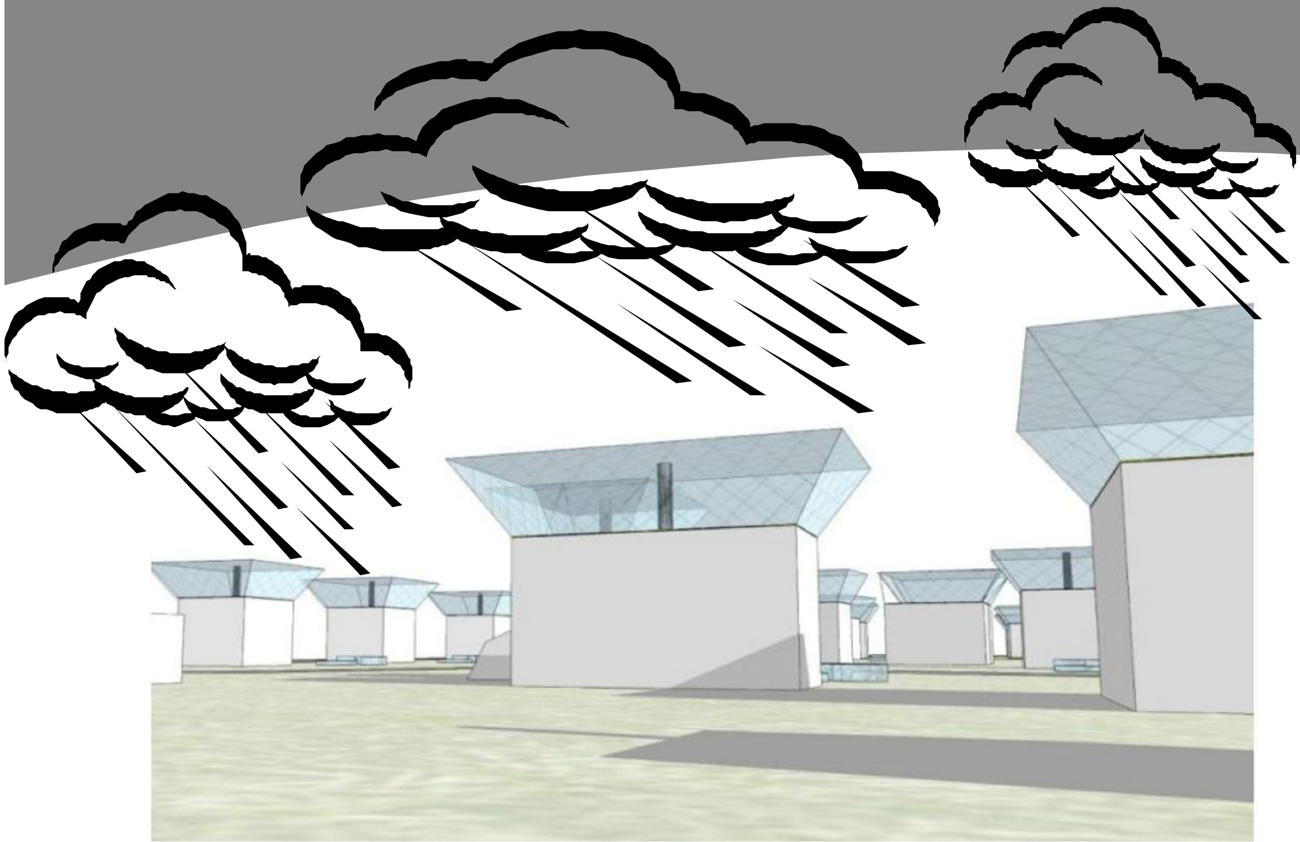
- Recycling reduces the amount of purified waste water returned to the environment and, in so doing, helps to break the all too common link between urban growth and pollution of aquatic environments.

Energy

- Wastewater recycling is a less-energy consuming solution compared with seawater desalination and brackish water desalination.

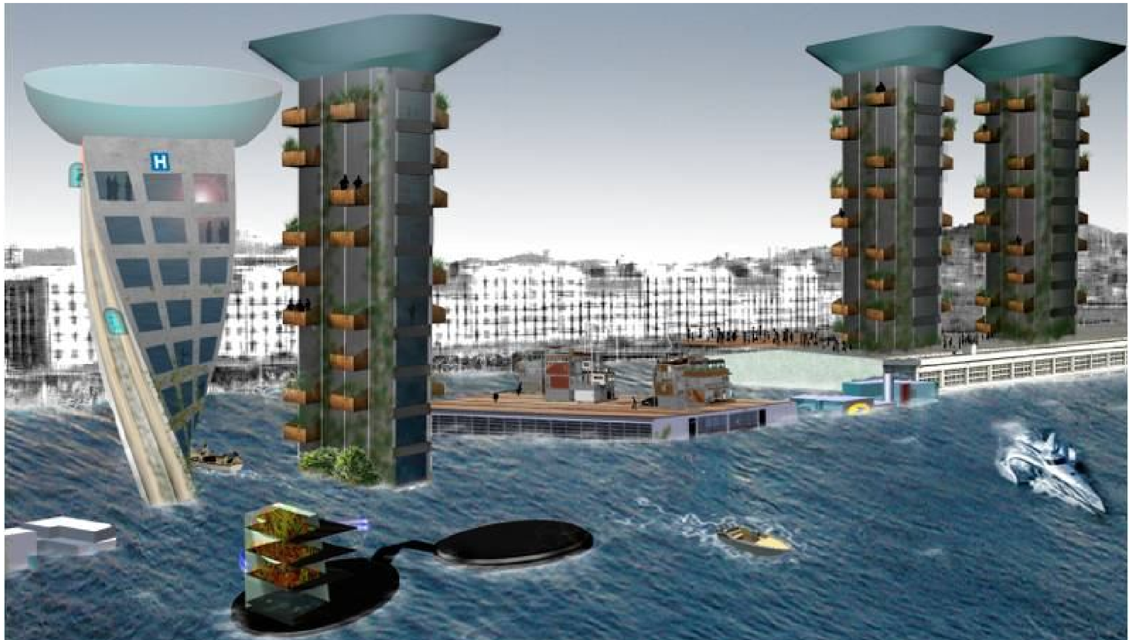
Developing rainwater collection, a useful resource, but not without its risks

- Making use of rainwater clearly shortens the water cycle and creates a direct supply exactly where it is needed:
  - ➔ For private users, the simplest, the least dangerous and the most ecological method of collecting rainwater to water the garden is to use a water butt.
  - ➔ Rainwater can also be used by industry for part of a production process.
- Conversely, experience has shown that directing rainwater inside homes has not been a good idea:
  - ➔ Bringing it inside the home introduces germs, close to vulnerable people such as children and the elderly.
  - ➔ Faulty plumbing could inadvertently connect the rainwater system to the drinking water system, making the risk of polluting the drinking water system difficult to control.



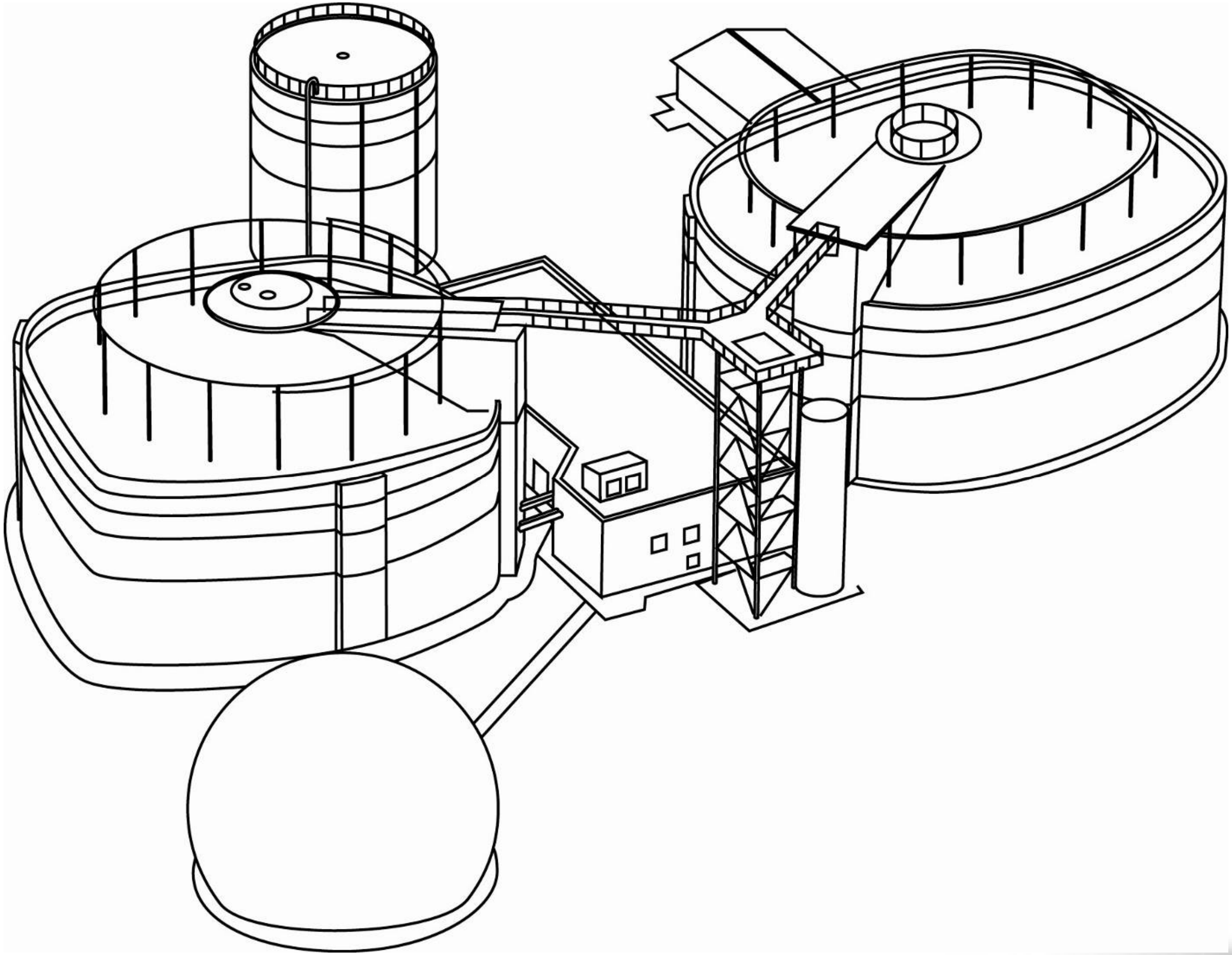
New ideas
of building design to
maximize
rainwater collection

Collecting rainwater is
a new responsibility for
urban planners and architects.

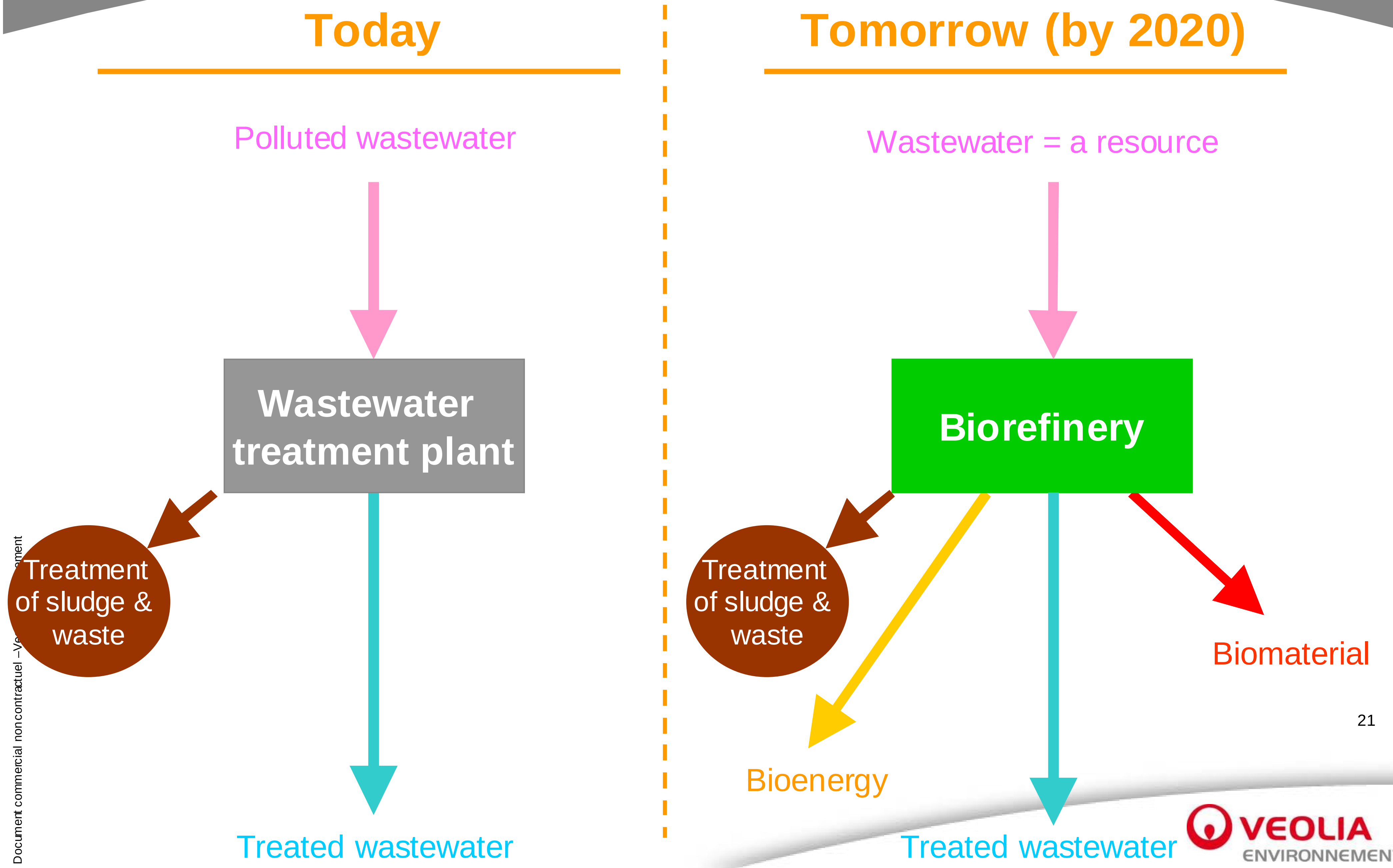


Source: Michel Micheau, Incheon Water Forum, August 2009

Part IV – The future wastewater treatment plants of ecocities



Over the coming 10 years, wastewater treatment plants will undergo profound changes



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A major shift in attitude: rather than viewing wastewater as water laden with pollutants, we need to see it as a resource.

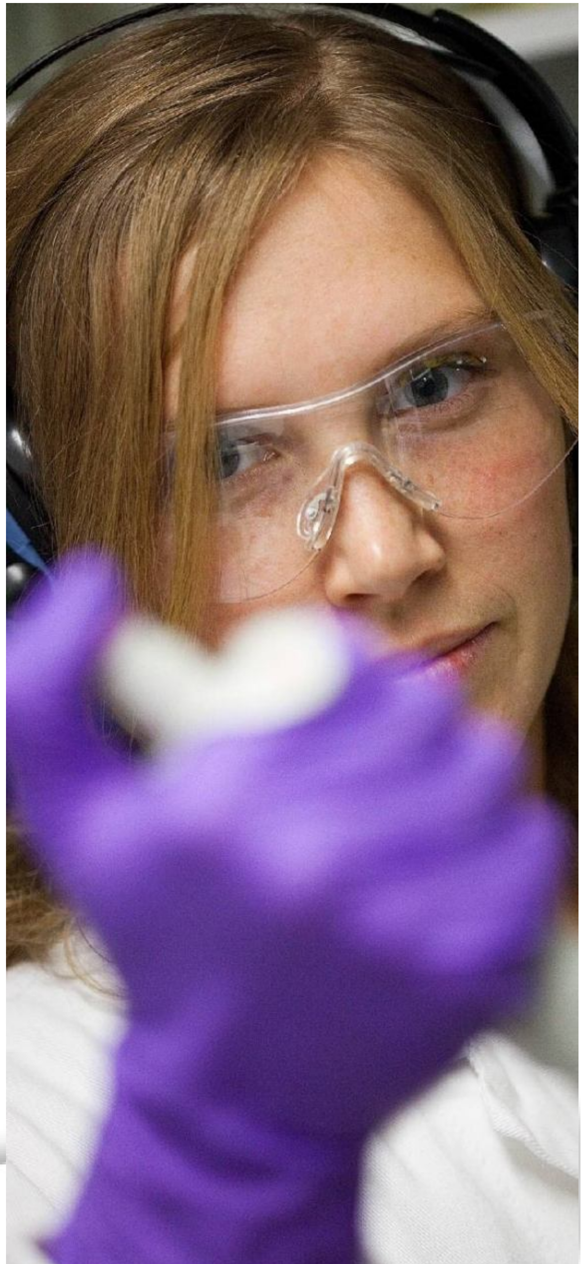
- The main function of a wastewater treatment plant today is to remove the pollution from wastewater to make it clean enough to be discharged into a river without harming the natural environment or causing a public health risk.
  - ➔ A WWTP consumes a lot of energy and chemical products, indirectly generates greenhouse gases and produces a large volume of waste, especially sludge.
- How can we convert what we are finished with into something useable? In other words, how can we recycle wastewater as completely as possible?”
  - ➔ This objective will entail a shift in attitudes and will deeply change our processes.
  - ➔ Instead of removing the pollutants in successive stages to obtain clean water, we have to extract the resources one after the other, starting with the water, to recycle it as clean water, followed by the energy and the organic and mineral matter.
  - ➔ We treat pollutants at the end of the process, after they have been concentrated.
- Today, we are already capable to design wastewater treatment plants that produce as much energy as they burn.

Turning wastewater into a raw material: how would wastewater solid substrates and energy be recovered?

- The materials would have to be sorted so that they could be directed towards the most appropriate recovery system depending on their characteristics.
- There will be 3 alternatives recovered: energy, green chemistry and mineral chemistry.
  - ➔ Part of the material with a high energy content (sugars, oils and proteins) would be directed towards a reactor to produce biogas.
  - ➔ The remainder of the organic matter would be directed towards green chemistry, providing there were direct or indirect outlets.
  - ➔ Lastly, the components, such as nitrogen, phosphorus and sulfur would be extracted and delivered to fertilizer manufacturers or compounders.

Tomorrow's wastewater treatment plants will do more than just remove pollution. They will become real biorefineries.

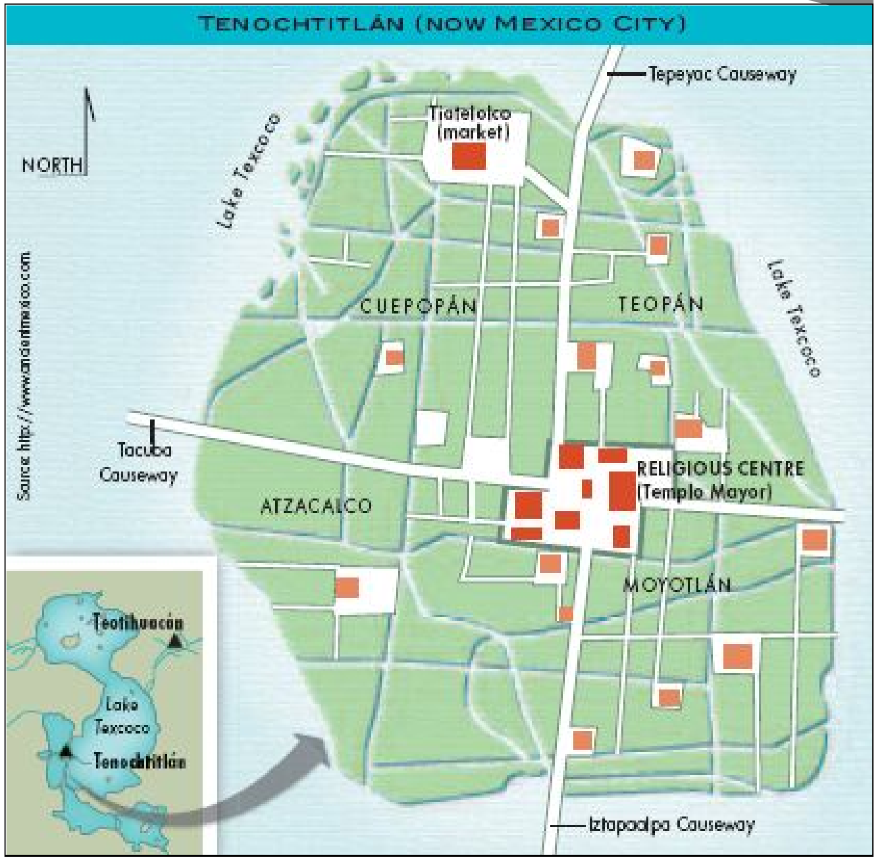
- By around 2020, treatment plants will not only produce clean water, but also various resources:
  - ➔ green energies (CH_4, H_2 and ethanol biofuels),
  - ➔ mineral materials ingredients (fertilizers),
  - ➔ biomaterials such as PHA biopolymer, which can be used to manufacture bioplastics.
- The treatment plant's functions will change, as will its physiognomy and its place in the economy:
  - ➔ The current treatment plant is a **<u>cost center</u>** as it consumes energy and produces sludge that is costly to treat.
  - ➔ Tomorrow, self-sufficient in terms of energy, it will be a producer of recoverable and marketable substances, and generating less waste,
  - ➔ Tomorrow, it may present a completely different economic balance. Wastewater will be recovered as a "*raw material*" for the **<u>production of added-value products</u>**



Part VI – Reintroducing water in cities

The evolution of the place of water in cities

- The vast majority of the world's greatest cities are built near water – either close to the sea or on the banks of large rivers or lakes:
  - ➔ Water plays a significant role in urban life – traditionally for commerce (river ports) or for manufacturing and trade (water-powered industry)
  - ➔ In some instances, water has proved a vital factor in the manifestation of political power.
  - ➔ This is the case of the Aztec city of Tenochtitlán (Mexico), built on Lake Texcoco



World Water Atlas, David Blanchon, Autrement, 2009

- During last century, in many cities, water has been expelled, hidden or channeled away:
  - ➔ "*Great conurbations no longer live on the river which often generated them*" *
  - ➔ Most of the surface water has been harnessed and buried. For instance, in Bangkok, many old "*Khlongs*" have disappeared.
  - ➔ "*Even where the river flows, it is regimented, boxed in between embankments*". *

Source: Water seen from the sky, Guido Alerbto Rossi, Gabriele Zaneto

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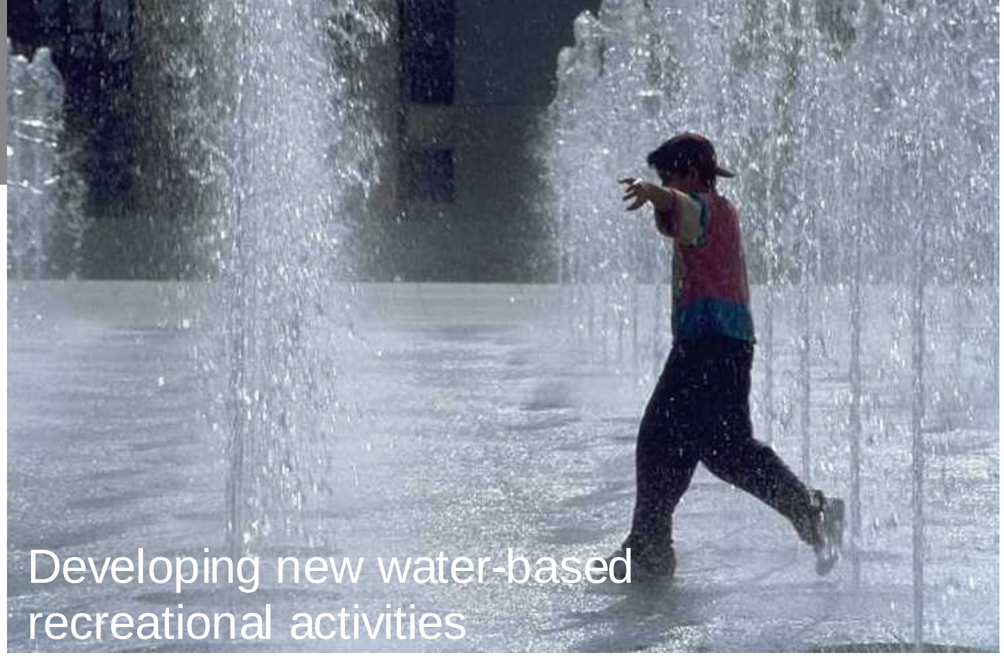
Today, water is back in the city, with…

- The development of "*water landscape*":
  - ➔ Stormwater is currently considered a major element of urban planning, in particular with the reintegration of a "*water landscape*" in the city.
- The rediscovery of urban water, as a key component of a pleasant living environment:
  - ➔ Hence the opening of canals and rivers to the public and the creation of open-air basins, thereby combining storage, leisure, landscape and risk control.
- A softer wetland management, for the sake of urban biodiversity


Indianapolis, USA


Eco-ward of Hammardy Sjöstad,
in Stockholm, structured around canals



Animating
the
city life
with
water
activities

Conclusion

Water management is a key component for establishing an urban development model that consumes less of nature

- To become ecocities, conventional cities must reduce:
  - ➔ their water footprint;
  - ➔ their carbon footprint at all the stage of the drinking water and wastewater service;
  - ➔ the carbon footprint of all their other public services and activities;
  - ➔ their energy footprint

- Therefore they need:
  - ➔ reliable tools for assessing urban water footprint;
  - ➔ radical new solutions (as biorefinery to subsitute wastewater treatment plant);
  - ➔ appropriate and continuous public policies to save natural resources (eg: raw water).

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Thank you for your attention