Cities and Sustainability
Professor Mark Swilling, Sustainability Institute
School of Public Management and Planning
Stellenbosch University
South Africa
Core argument

• Context: global polycrisis – recession, resource limits, 2nd urbanization wave
• Cities key to sustainability
• Urban infrastructures can be reconfigured – CT is a good example
Global economic crisis...

March 2009

Institute for Economic Research on Innovation
(Krausman 2009)
symptoms of the limits...

(Mudd 2007)
Resource prices

Real Raw Industrials Prices, 1800–2004

Still low in real terms

*Adjusted by the U.S. GDP Deflator.
**Trend from 1900 to 2004.

Source: The Bank Credit Analyst
Who consumes what?

1998 Human Development Report

Richest 20% of the world:

account for 86% of total consumption expenditure, the poorest 20% account for 1.3%
Decoupling and Sustainable Resource Management: Scoping the challenges

Decoupling Working Group

Lead authors:

Mark Swilling and Marina Fischer-Kowalski
Decoupling:
resource decoupling
impact decoupling

economic activity (GDP)
resource use
environmental impacts
Decoupling:

- **relative decoupling**
- **absolute decoupling**

Graph showing economic activity (GDP) and resource use over time.
Three forced future scenarios for 2050

Global metabolic scales in billion tonnes

Global metabolic rates in t/cap

- Construction minerals
- Ores and industrial minerals
- Fossil fuels
- Biomass
Materials: 8t/c  
CO²: 4.5 t/cap

Materials: 6t/c  
CO²: 2.2 t/cap
A Global Green New Deal

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Report prepared for the Economics and Trade Branch, Division of Technology, Industry and Economics, United Nations Environment Programme
GGND – Business as usual

- Global energy demand rises by 45% by 2030, oil price rises to $180/barrel
- GHG increase by 45% by 2030, leading to ave temp increase by 6 degrees
- Global GDP reduced by 5-10%, poor countries by 10% plus
- Ecological degradation & severe water scarcities
- 3 billion live below $2/day by 2015
Goals of a GGND

$2 - $3 trillion economic recovery package over next 2-3 years must be guided by the following 3 objectives:

- **Revive world economy, create employment & protect vulnerable groups**
- **Reduce carbon dependence, ecosystem degradation and water scarcity**
- **Further MDG of ending extreme world poverty by 2025**
What green shoots?
Eco-friendly spending as % of total fiscal stimulus
March 31st 2009 estimates

Source: HSBC
Obama’s ‘Green New Deal’

$100 b of the $827 to create 2 million new jobs by:

- Retrofitting buildings – energy efficiency
- Expanding mass transit & freight rail
- Constructing a ‘smart’ electrical grid transmission system
- RE – wind, solar, 2nd-gen biofuels & bio-based energy
- Which transition?
South Korea’s GND

<table>
<thead>
<tr>
<th>Project</th>
<th>Employment</th>
<th>US$ million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expanding mass transit and railroads</td>
<td>138,067</td>
<td>7,005</td>
</tr>
<tr>
<td>Energy conservation (villages and schools)</td>
<td>170,702</td>
<td>5,841</td>
</tr>
<tr>
<td>Fuel efficient vehicles and clean energy</td>
<td>14,348</td>
<td>1,489</td>
</tr>
<tr>
<td>Environmentally friendly living space</td>
<td>10,789</td>
<td>351</td>
</tr>
<tr>
<td>River restoration</td>
<td>199,960</td>
<td>10,505</td>
</tr>
<tr>
<td>Forest restoration</td>
<td>133,630</td>
<td>1,754</td>
</tr>
<tr>
<td>Water resource management (small and midsize dams)</td>
<td>16,132</td>
<td>684</td>
</tr>
<tr>
<td>Resource recycling (including fuel from waste)</td>
<td>16,196</td>
<td>675</td>
</tr>
<tr>
<td>National green information (GIS) infrastructure</td>
<td>3,120</td>
<td>270</td>
</tr>
<tr>
<td><strong>Total for the nine major projects</strong></td>
<td><strong>702,944</strong></td>
<td><strong>28,573</strong></td>
</tr>
</tbody>
</table>
| **Total for the Green New Deal**                                       | **960,000**| **36,280**

Reforestation in South Korea
Japan: $1B, 10 years = Self-Sustaining Industry

Source: PV Status Report
• “As leaders of the world’s major economies, we are working for a resilient, sustainable and green economy.” – G20 Pittsburgh 24-25 Sept 2009

• "We have an opportunity over the decade ahead to shift the structure of our economy towards greater energy efficiency, and more responsible use of our natural resources and relevant resource-based knowledge and expertise. Our economic growth over the next decade and beyond cannot be built on the same principles and technologies, the same energy systems and the same transport modes, that we are familiar with today." - South African Finance Minister Trevor Manual, Budget speech, Parliament February 20th, 2008
• global population: from 6 b to 9 b by 2050
• by 2007 more than 50% of the world population living in cities
• Africa has the fastest urbanization rate - 375 m in cities by 2010, 1.2 b in cities by 2050
• 40% of cities in the developed world are shrinking
one billion people worldwide live in slums
One third of the total urban population!

6% of urban pop in developed countries live in slums
78% of urban pop in the least developed countries live in slums

The Challenge of Slums – UN-HABITAT Report

Kibera, Nairobi
Car First Planning

All based on cheap oil......oil meets 60% of world energy needs – but IEA says ‘era of cheap oil is over’
Urban Infrastructure

- $41 trillion – energy, water, transport
- Water = $22.6 trillion
- Energy = $9 trillion
- Road and rail = $7.8
- Air/sea ports = $1.6

What kind of urban infrastructure? What technologies? Who sets the criteria?

“...cities that ignore environmental impact will themselves face another collapse of infrastructure 30 or 40 years from now ...” Booz Allen Hamilton, *Strategy and Business*, 2007
...imagining the 'infrading'? ...within sustainable neighbourhoods
Cape Town by class

CLUSTER GROUPS
A - SILVER SPOONS
B - UPPER MIDDLE CLASS
C - MIDDLE SUBURBIA
D - COMMUNITY NESTS
E - LABOUR POOL
F - NEWBONDS
O - TOWNSHIP LIVING
H - TOWERING DENSITY
I - DIRE STRAITS
J - BELOW THE BREADLINE
S - SPECIAL CASES
<table>
<thead>
<tr>
<th>Service</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>6000 l free</td>
</tr>
<tr>
<td>Sanitation</td>
<td>4800 l free</td>
</tr>
<tr>
<td>Electricity</td>
<td>50 KWh free</td>
</tr>
<tr>
<td>Solid waste</td>
<td>Free service on properties valued &lt;R88000 and heavily subsidized for properties in R88000 - R160000 range</td>
</tr>
<tr>
<td>Rates</td>
<td>Properties &lt;R88000 zero rates</td>
</tr>
<tr>
<td></td>
<td>Properties &lt;R199000 20% discount</td>
</tr>
<tr>
<td></td>
<td>Households earning &lt; R1740/month receive 100% rebate and R20 subsidy on services account</td>
</tr>
<tr>
<td>Tariff increases</td>
<td>Ave increases above inflation, but lower increases for poor households (and in some cases even decreases)</td>
</tr>
</tbody>
</table>
Infrastructure spend for 2007/2008: R9.3 billion or 47% of budget – 8% of GGP

‘Large Technical Systems’
<table>
<thead>
<tr>
<th>Energy Use by Source</th>
<th>Energy Use per Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cape Town</td>
</tr>
<tr>
<td>Electricity</td>
<td>29%</td>
</tr>
<tr>
<td>Petrol/Diesel</td>
<td>46%</td>
</tr>
<tr>
<td>Other oil-based products</td>
<td>17%</td>
</tr>
<tr>
<td>Coal</td>
<td>7%</td>
</tr>
<tr>
<td>Wood</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Electricity

- Coal-fired power stations: 2600MW/400KV line
- Nuclear: 1800MW
- Gas turbines: 171MW (Acacia) + 40MW
- Hydro: Palmiet (40MW), Steenbras (160MW)
- Darling Wind Farm: 5.2MW
- SHW: 10000 = 4.2MW
- 10% of CT’s electricity is from RE
# Viable decoupling technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>3 000</td>
</tr>
<tr>
<td>Ocean</td>
<td>1 000</td>
</tr>
<tr>
<td>Solar – PV</td>
<td>247</td>
</tr>
<tr>
<td>Hydro</td>
<td>15</td>
</tr>
<tr>
<td>Solar thermal</td>
<td>1 400</td>
</tr>
<tr>
<td>Pumped Storage</td>
<td>1 800</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7 452</strong></td>
</tr>
</tbody>
</table>
Cape Town’s bulk water infrastructure
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cape Town</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Domestic</strong></td>
<td>51%</td>
</tr>
<tr>
<td><strong>Unaccounted for Water (UAW)</strong></td>
<td>21%</td>
</tr>
<tr>
<td><strong>Commercial and Industrial</strong></td>
<td>15%</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>13%</td>
</tr>
</tbody>
</table>

Unrestricted demand: 510 million m³
Maximum bulk supply: 475 million m³
CCT Demand Projections

- Existing Supply
- Supply incl. BWP
- Unconstrained
- Low Water Demand
- Actual
- 2007/08 IDP
- WDM Strategy

Year

2000
Towards water sustainability

• 2000-2005: fall from 930Ml/day to 745Ml/day – saving of 175 Ml/day

• 2005 Western Cape Reconciliation Study: proposals to save another 323 Ml/day

• 175Ml + 323 Ml/day = more than 50% of 1999 levels without compromising growth
Options

- leak detection and repair; pressure management; use of water-efficient fittings; metering and plumbing repairs in low income areas; use of grey water; use of well points and boreholes; metering; tariffs and surcharges/credit control; water user education; rainwater tanks; exchange reclaimed wastewater for commercial irrigation; industrial re-use; reclamation to potable water standards; urban irrigation; dual reticulation in new housing (so that grey water can be supplied for toilets); and aquifer recharge

- Longer-term: desalination – but only with RE energy source
Sanitation

- 20 wastewater treatment works
- 3 marine outfalls
- 27 major pump stations
- 15 major interceptor sewers
- about 120 km of bulk gravity sewers
- 395 smaller pump stations and associated local-level reticulation networks
- **14 out of 20 WWTW do not comply**
Raw Sewage

Primary Treatment: Remove particulate solids via gravity separation (septic tank) and/or physical screening (septic outlet filter).

Primary Effluent

Secondary Treatment (biological, aerobic): Reduce pathogens, reduce BOD via biodegradation of organic compounds, reduce solids.

Secondary Effluent

Advanced Treatment: Remove additional BOD, solids, N, and/or P.

Disinfection: Reduce pathogens to levels safe for potential human exposure (usually 100% reduction).

Tertiary Effluent

Remove solids for treatment and disposal

Discharge to surface water

Percolate to groundwater/runoff to surface water

Land-surface Dispersal (Spray Irrigation)

Subsurface Dispersal in Soil

To groundwater
Recycling options

- Incineration
- Composting
- High lime process
- Drying and pelletisation
- Co-disposal in landfills
- Direct agricultural use
- Manufacture of organic fertilizer
- Brick making and allied fields
- Co-combustion in coal fired power stations.
Can be done

- **CCT 2007 Review report:** use of treated effluent could increase to 170 M l per day - 40% of daily total or 30% of annual supply from Berg River Dam
- **Life cycle cost:** below R2,0 / kl.
- **Total capital cost:** R202 million, recovered in 4 years from sales
<table>
<thead>
<tr>
<th>Solid Waste to Municipal Landfills</th>
<th></th>
<th>2,454,555</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formal households</td>
<td>t/yr</td>
<td>799,812</td>
<td>33%</td>
</tr>
<tr>
<td>Non-formal households (est.)</td>
<td>t/yr</td>
<td>148,099</td>
<td>6%</td>
</tr>
<tr>
<td>Other cleaning (est.)</td>
<td>t/yr</td>
<td>33,911</td>
<td>1%</td>
</tr>
<tr>
<td>Commerce</td>
<td>t/yr</td>
<td>911,692</td>
<td>38%</td>
</tr>
<tr>
<td>municipal service points</td>
<td>t/yr</td>
<td>65,885</td>
<td>3%</td>
</tr>
<tr>
<td>direct to landfill</td>
<td>t/yr</td>
<td>845,807</td>
<td>35%</td>
</tr>
<tr>
<td>Industry</td>
<td>t/yr</td>
<td>561,041</td>
<td>23%</td>
</tr>
</tbody>
</table>
Figure 1  Solid waste generation, City of Cape Town (kg/pp/day)
Landfill costs:
R54/ton in 2005/6
R192/ton in 2007/8
R235/ton by 2013

(de Wit 2010)
Options

- ‘business-as-usual’ (BAU)
- BAU plus recycling for the richest households
- MaxiMin option

(de Wit 2010)
Advantages of waste sector

- Significant private sector involvement
- Substantial community-based sector
- Demand for waste (hence a significant illegal sector)
- Job creation potential
Dangers of assumptions

- Electricity: 2.7% - 2007/8 & 3.5% onward
- Water: 3% pa
- Waste: 7% without recycling

But in reality, evidence of decoupling...
Conclusion

- Global sustainability depends on cities becoming more sustainable
- City sustainability depends on how urban infrastructures are reconfigured
- Key roles: design professionals, utility managers, logistics & financial investors
- Key challenge: beyond minimisation of damage, growth through restoration