# CHALLENGES IN DEVELOPING INFRASTRUCTURE TO SUPPORT SUSTAINABILITY FOR SMALL ISLAND DEVELOPING STATES

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# SIDS

- 52 SIDS (Small Island Developing States) are listed by UN-OHRLLS[1]
  - **Pacific**: American Samoa, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Micronesia, Nauru, New Caledonia, Niue, Northern Marianas, Palau, Papua New Guinea, Samoa, Solomon Islands, Timor-Leste (East Timor), Tonga, Tuvalu, Vanuatu
  - **Caribbean**: Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, British Virgin Islands, Cuba, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Montserrat, Netherlands Antilles, Puerto Rico, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Trinidad and Tobago, U.S. Virgin Islands
  - **AIMS**: Bahrain, Belize, Cape Verde, Comoros, Guinea-Bissau, Guyana, Maldives, Mauritius, São Tomé and Principe, Seychelles, Singapore, Suriname

1. http://www.unohrlls.org/en/sids/44/

# SPECIFIC RISKS: ECONOMY

- Low diversity
  - Tourism[1, 2]
  - Fisheries/fishery licensing[1]
  - Subsistence agriculture[1]
- High dependence
  - Remittances[3, 1]
  - Foreign aid/external debt
  - Imports for food, energy, goods[1,3]
  - Transport: shipping (imports) and flying (tourists)


1. Kerr, S. A. (2005) "What is small island sustainable development about?" *Ocean and Coastal Management,* **48***(7-8)*, 503-524.
2. Mimura, N. et al. (2007) "Small islands" *in:* IPCC 4th Assessment.
3. CIA World Factbook. (2010) "The World Factbook." *Various websites.* Data retrieved from https://www.cia.gov/library/publications/the-world-factbook/index.html on 11 June 2010.

# SPECIFIC RISKS: SOCIETY

- Emigration[1]
  - 4.5 per 1000 people across all SIDS; 16.7 per 1000 people in the Pacific
  - Tertiary-educated: 63% leaving (median across all SIDS); LQ 27%, UQ 78%
- In some areas…[2]
  - Rapid population growth
  - Rampant urbanisation
  - Rising poverty
  - Widening gap between rich and poor
  - Political instability/lack of governance
  - Unemployment
  - Reduced social cohesion

1. Calculated from CIA World Factbook. (2010) "The World Factbook." *Various websites.* Data retrieved from https://www.cia.gov/library/publications/the-world-factbook/index.html on 11 June 2010.
2. Mimura, N. et al. (2007) "Small islands" *in:* IPCC 4th Assessment.

# SPECIFIC RISKS: ENVIRONMENT[1]

- Freshwater scarcity
  - Freshwater lenses prone to faecal and landfill contamination due to inadequate sanitation practices
  - Lack of water management has lead to saltwater intrusion in many SIDS
- Erosion
  - Sand erosion due to mangrove removal (increasing vulnerability to storm surges and king tides) reduces tourism resources
  - Soil erosion due to modern agriculture techniques reduces agricultural resources
- Waste management problems
  - Imports much higher than exports, and tend to be inorganic
  - Solid waste is typically burned, buried in unsanitary conditions, or dumped (usually in ecologically sensitive lagoons or mangroves)
- Over-exploitation of fisheries
  - Critical for both local food supply and GDP (exports and licensing)

1. Mimura, N. et al. (2007) "Small islands" *in:* IPCC 4th Assessment.

# SPECIFIC RISKS: CLIMATE CHANGE[1]

- Sea level rise
  - IPCC: 18 to 59 cm by 2100 excluding glacial melting (other estimates up to 25 m by 2100 if feedback mechanisms are included)[2]
  - Atolls are the most vulnerable; Anguilla, Bahamas, Kiribati, Maldives, Marshall Islands, Nauru, Niue, Tuvalu are the most low-lying islands
  - 'King tides': partial inundation
  - Possible saltwater intrusion into groundwater (stress on freshwater supplies)
- Extreme weather
  - Increased frequency and intensity of hurricanes/cyclones
  - Stronger and more frequent storm surges
  - Longer intervals between rain during dry periods; heavier rainfall in wet periods
- Changes in temperature
  - Changes to agriculture
  - Increased competition for endemic species against introduced species
  - Coral bleaching and seagrass degradation


1. Mimura, N. et al. (2007) "Small islands" *in:* IPCC 4th Assessment.
2. Vince, G. (2009) "Paradise lost: Islanders prepare for the flood." *New Scientist,* **2707**, 37-39.

# SIDS HISTORY

- Samoa: ~ 2700 years isolated
  - Settled c. 1000 BC and may have been the base for Polynesian expansion to other Pacific Islands
  - Europeans arrived early in 18th century
- Barbados: ~ 3000 years isolated
  - Settled c. 1500 BC
  - Portugese first claimed the island in mid-16th century before abandoning it (after killing or abducting all of the indigenous people, leaving it uninhabited)
- Tonga: ~ 2900 years isolated
  - Settled between 1500 and 1000 BC
  - First European visitors in 1616
- Marshall Islands: ~ 3000 years isolated
  - Settled between 2000 and 1000 BC
  - First European contact in 1529

# LONG-TERM STABILITY?

- Historically, SIDS would have had much lower populations
  - High infant mortality
  - Low life expectancy
  - Low technology
  - Low carrying capacity, naturally determined
- Today we have technology that has enhanced the carrying capacity of wherever we want to live
  - Populations on SIDS are much higher
  - Standards of living are much higher
  - Change in ‘needs’
  - How can carrying capacity be determined, and what are the factors impacting carrying capacity?

# SELF-SUFFICIENCY?

- Historically:
  - Sustainable societies from knowledge of island resource limits
  - Inherent self-sufficiency = sustainability
  - Influence and pursuit of Western lifestyle is relatively recent (WWII?)
- Today: Enormous dependency on long-distance transport
  - Importing products: goods, food, energy (fossil fuels)
  - Importing and exporting tourists
  - Exporting products, to a lesser extent
- Current long-distance transport technologies are not sustainable
  - Non-renewable resource use
  - $CO_2$, $SO_2$ emissions
  - Low resilience
- Improve carrying capacity through developing self-sufficiency
- Modern self-sufficiency hinges on (e.g.):
  - Willingness to eat/use only what can be produced locally
  - Economic advantage of locally-produced food/goods compared to imported
  - Governments' drive to implement self-sufficiency

# URBAN METABOLISM

- Mass balance (quantitative) analysis
- Theoretically applicable to any geographically defined area
- Four metabolisms identified in literature
  - Water
  - Nutrients
  - Energy
  - Materials
- Data requirements
  - System inputs
  - System outputs
  - System production/consumption

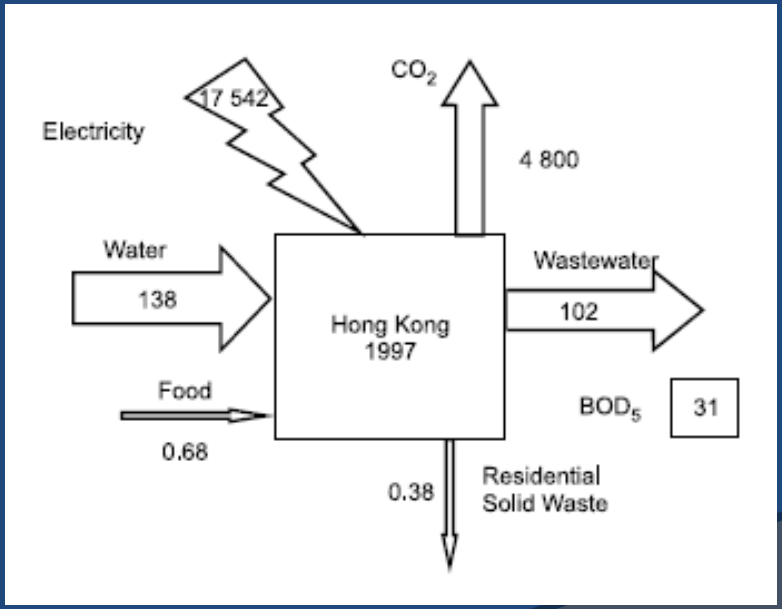
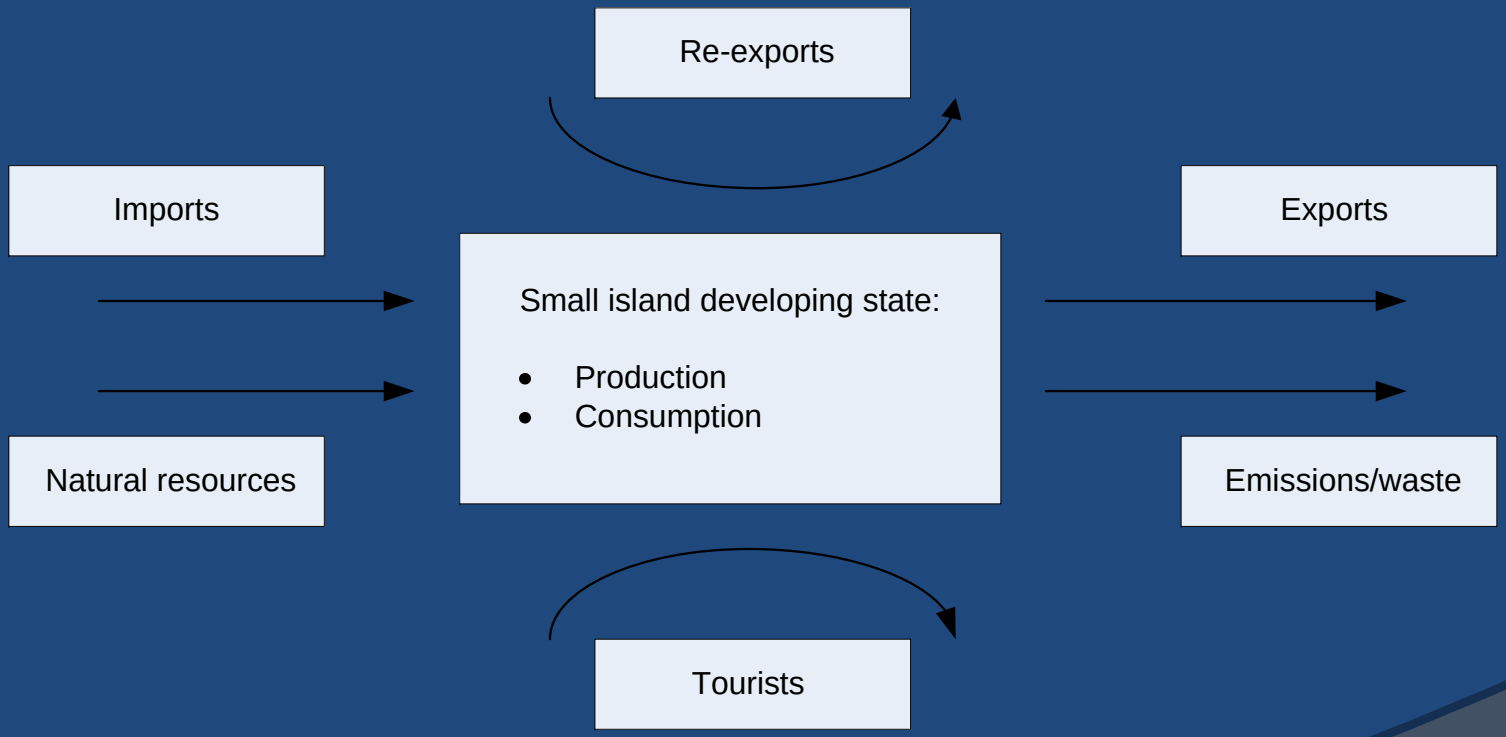



Diagram from Sahely, H., S. Dudding, and C. Kennedy. (2003) "Estimating the urban metabolism of Canadian cities: Greater Toronto Area case study." *Canadian Journal of Civil Engineering*, **30**, 468-483.

# SIDS METABOLISM



# CONCLUSIONS

- SIDS face numerous growing risks in the coming century
- To ensure their long-term survival, SIDS must improve their resilience, beginning with increasing their ability to provide for their inhabitants
  - Resilience = self-sufficiency = sustainability
- Analysis of an island's inputs, outputs, and indigenous production will reveal its carrying capacity
  - Carrying capacity will indicate the maximum population an island can sustain with no imports (i.e. 100% self-sufficiency)
  - In other words, carrying capacity can indicate what percentage of an island's needs can be met indigenously
- Islands can be seen as a microcosm for larger areas/countries
  - Implementing infrastructure that supports sustainability in SIDS acts as proof of concept for any area
- With knowledge of carrying capacity and resource flows, appropriate infrastructure planning can maximise an island's resilience
  - Adapt and apply model to other islands

# QUESTIONS?