THE METABOLISM OF ISLANDS

risk and resilience in a climate challenged world

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What is social or island metabolism?

"Metabolism" is a biological concept that refers to the chemical conversion and breakdown of organic matter to sustain reproduction.

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"Society's metabolism" means…

- that societies organize (similar to organisms) material and energy flows with their natural environment;
- they extract primary resources and use them for food, machines, buildings, infrastructure, heating and many other products and finally return them, with more or less delay, in the form of wastes and emissions to their environments.
- *Flows* create *Stocks*, that provide important wellbeing contributions or services, such as housing, transport, waste management, health, education, etc.
- As economies develop, they stimulate the demand for essential services that are provided by the stocks, that require more flows. This creates a dynamic feedback loop and is called the *Stock-Flow-Service* (SFS) nexus.

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Socio-metabolic flows create, operate and maintain biophysical structures of society such as buildings, infrastructures or machinery usually denoted as 'material stocks' to provide crucial societal services (shelter, transport, health, food, energy, etc.)

Haberl et al. (2017). The Material Stock–Flow–Service Nexus: A New Approach for Tackling the Decoupling Conundrum. *Sustainability*, *9*(7), 1049.

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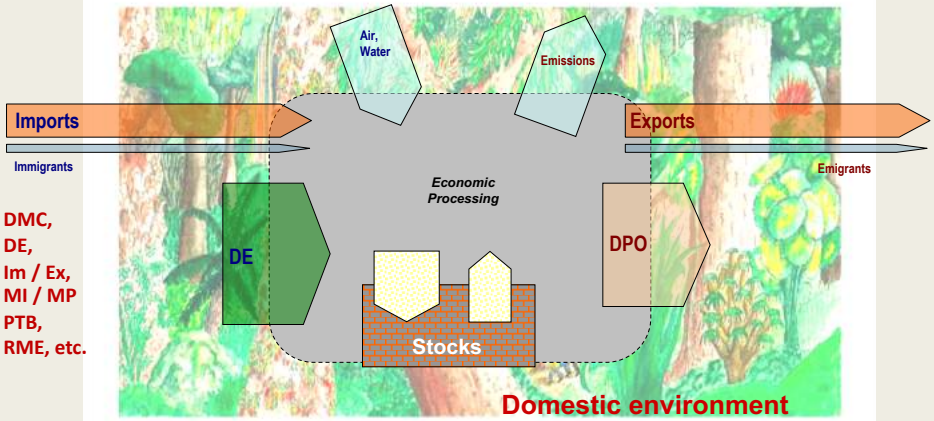
Operationalising Socio-metabolic Research through Material & Energy Flow Accounting (MEFA)



DMC,
DE,
Im / Ex,
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PTB,
RME, etc.

Specific methods exist for Material Stock Accounting (MSA)

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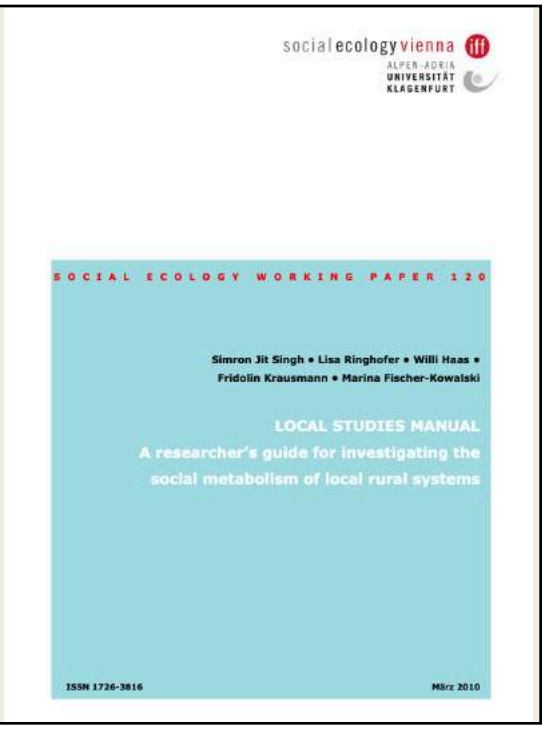

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Why analyze material and energy flows (or conduct Socio-metabolic Research)?

- Materials and energy are biophysical categories necessary for human survival and reproduction;
- They are finite both in terms of availability and productivity;
- Patterns of material and energy use (in both quantitative and qualitative terms) affect the future survival of humans and other species;
- The world is presently experiencing an unprecedented environment crisis due to the ways we consume our resources (materials, energy, land) causing sustainability problems on the input side (scarcity) and the output side (pollution).

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Socio-metabolic research allows researchers to:

- Analyze the material throughput (quantity and quality) from extraction, through processing, transport, final consumption and disposal (metabolic rate, regimes and transitions);
- Undertake a circularity gap assessment (how circular is the physical economy?);
- Analyze the spatial dimension of material flows (where extraction, production, consumption and disposal takes place);
- Analyze concepts such as decoupling, rebound effect, etc.
- Interpret the impact of these flows within the framework of sustainability science (ecological economics, industrial ecology, human & social ecology);
- Relate these flows to development concerns (ecological unequal exchange, uneven development, distributional conflicts, environmental justice and embedded power relations) - political ecology.

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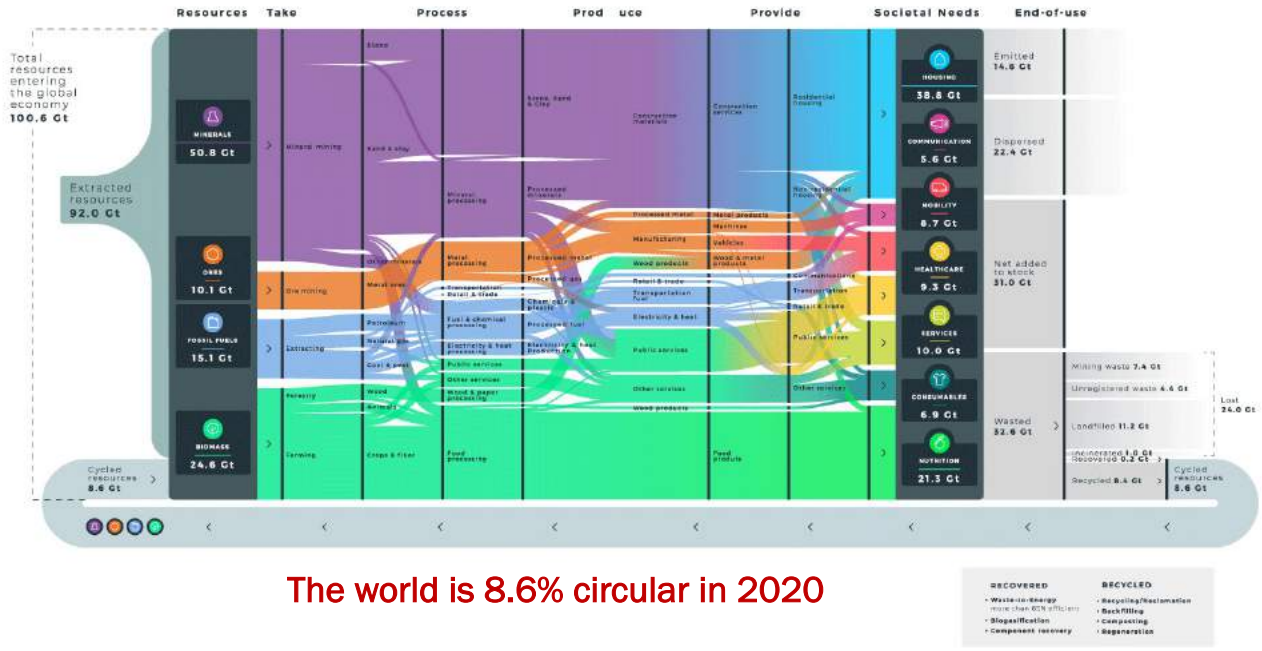

The world is 8.6% circular in 2020

Source: Circularity Gap Report 2020 - https://www.circularity-gap.world/2020

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What influences social metabolism?

(1) The size of human and livestock population, and man-made artifacts that need to be reproduced

(2) The productive / exploitative technology (incl. those for transport and services)

(3) Affluence, lifestyle and consumption patterns

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Risk and resilience on islands: a socio-metabolic approach

Island metabolism analyzes and asks questions related to:

- an island's characteristic metabolic profile;
- the circularity rate and gap of material flows;
- the metabolic risk (or systemic vulnerabilities) arising from specific combinations of resource-use patterns;
- the potential for metabolic collapse from maladaptive practices (tipping points);
- strategies to reconfigure the biophysical structure to enhance adaptive capacity and system resilience

Singh, S. J., Fischer-Kowalski, M., & Chertow, M. (2020). The Metabolism of Islands. *Sustainability*, *12*(22), 9516.

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Why Islands?

- tenuous resource security and supply, reduced waste absorption capacity;
- limited means to develop economies of scale systems;
- dependency on imports to meet basic needs and undiversified exports;
- Highly vulnerable from climate change impacts;
- Damages to infrastructure result in loss of critical services and the accumulation of a large volume of debris
- Restoring the services comes with large fiscal and material requirements

Singh, S. J., Fischer-Kowalski, M., & Chertow, M. (2020). The Metabolism of Islands. *Sustainability*, *12*(22), 9516.

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Metabolism of Islands – Select projects

- The Weight of Islands: A GIS-based material stock analysis of Grenada
- Measure to manage: an outflow study of Grenada's waste management system
- A Material Vulnerability Account of Building Services in Grenada from a Spatial Perspective
- Dynamics of socioeconomic metabolism on Islands: Material Stock-Flow-Service nexus of the Bahamas and Aruba
- Can the Caribbean live within the doughnut? Assessing the social and environmental performance of 5 island nations
- You can't manage, what you can't measure: Accounting for material stocks and flows on Antigua and Barbuda
- E-waste in the Caribbean: Is there a potential for a circular economy?
- Jamaica's biomass metabolism 1961 - 2013
- The self (in)sufficiency of the Caribbean

https://metabolismofislands.org/

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Some examples of MOI findings

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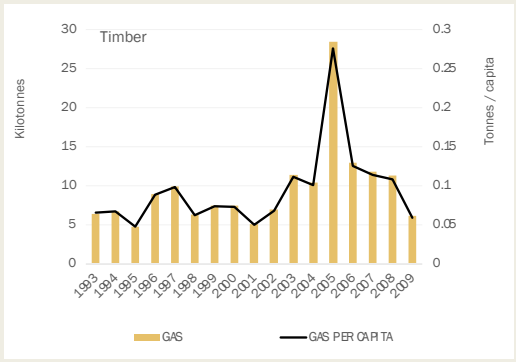
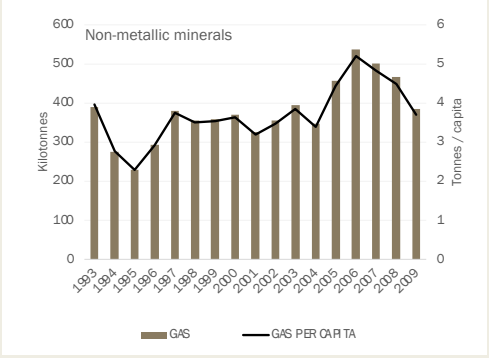
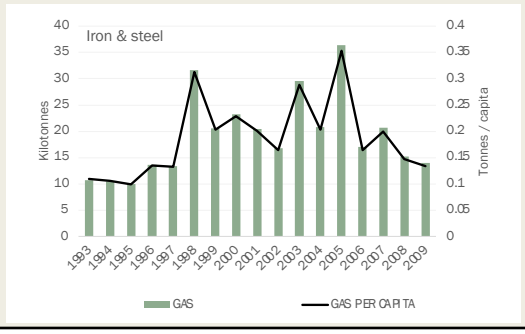
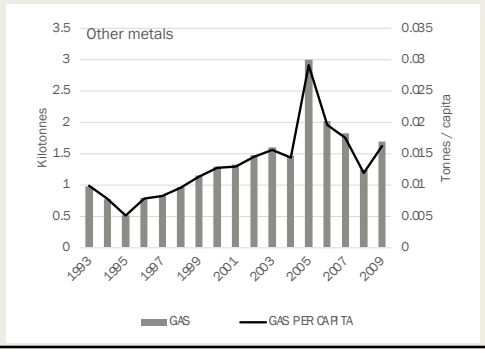
Material requirements in Grenada after 2004 Ivan hurricane

Symmes et. al. (2019). The weight of islands: Leveraging Grenada's material stocks to adapt to climate change. *Journal of Industrial Ecology*, *24*(2), 369–382.









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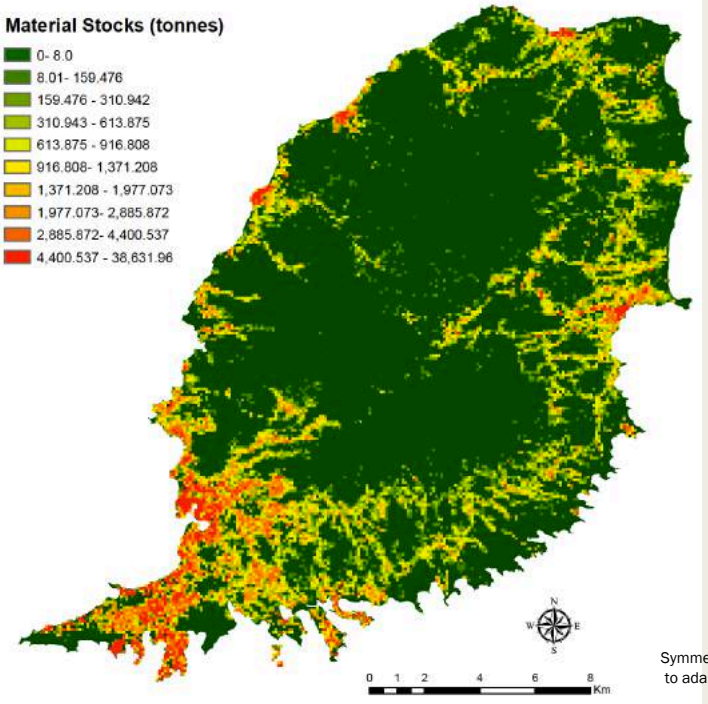

Grenada's stocks distribution

Highest service type is residential at 68% of total material stock.

Tourism is next with 13% of total building stock.

Mixed Use is next with 5% of the building stock.

Education makes up 4% of building stock

These top 4 make up 90% of Grenada's total building stock.

Symmes et. al. (2019). The weight of islands: Leveraging Grenada's material stocks to adapt to climate change. *Journal of Industrial Ecology*, *24*(2), 369–382.

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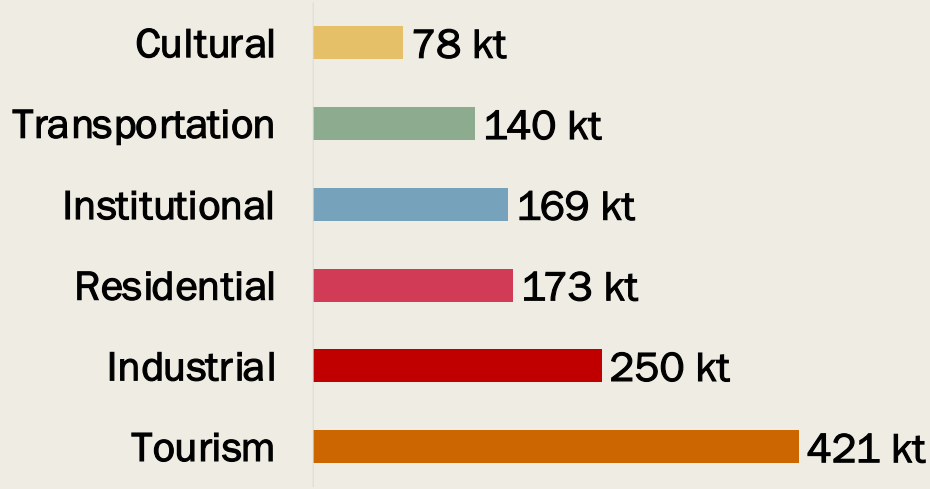
Grenada's material stocks under risk (with 1 meter sea level rise scenario)



Adapted from Symmes et al. 2019

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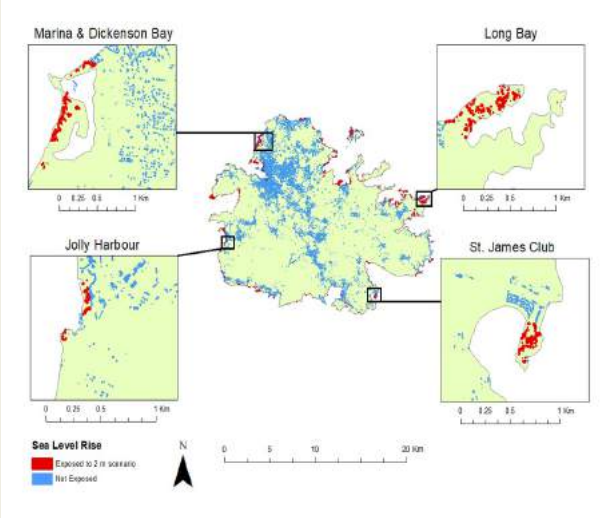
Risk exposure to Antigua's stocks from 1m SLR



- Threatened Building classes:
  - *Tourism 18% of MS*
  - *Transportation and Historical Sites 14% of MS exposed respectively.*
- Due to the concentration of tourism centered development on the cost they are at high risk of exposure levels.

Bradshaw et al. (2020). GIS-based Material Stock Analysis (MSA) of Climate Vulnerabilities to the Tourism Industry in Antigua and Barbuda. *Sustainability*, *12*(19), 8090.

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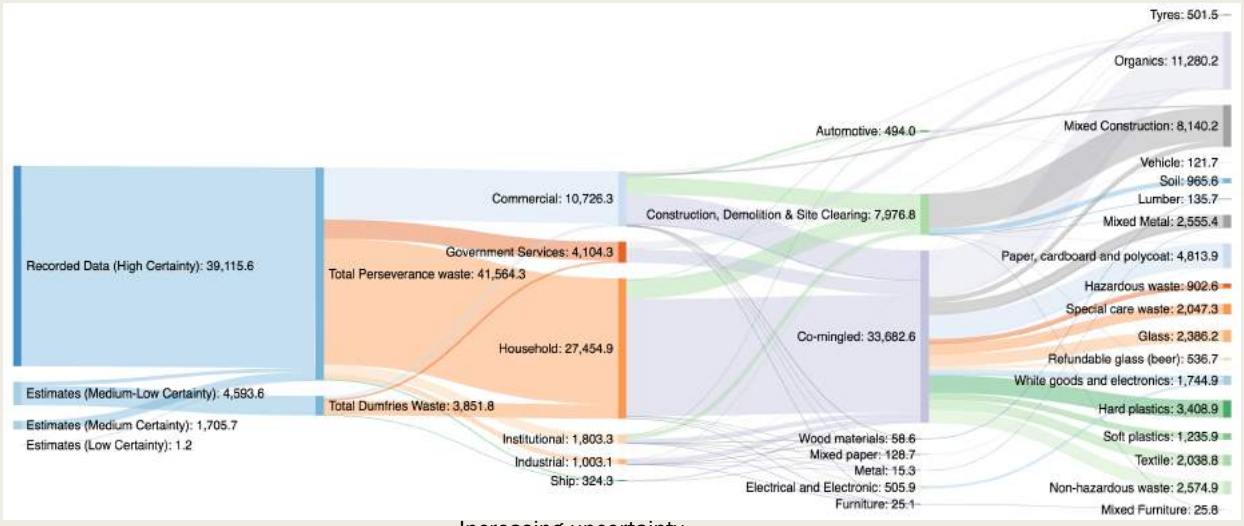
Waste flows on Grenada – a one-way linear system



Elgie et al. (2021). You can't manage what you can't measure: The potential for circularity in Grenada's waste management system. *Resources, Conservation and Recycling, 164*, 105170.

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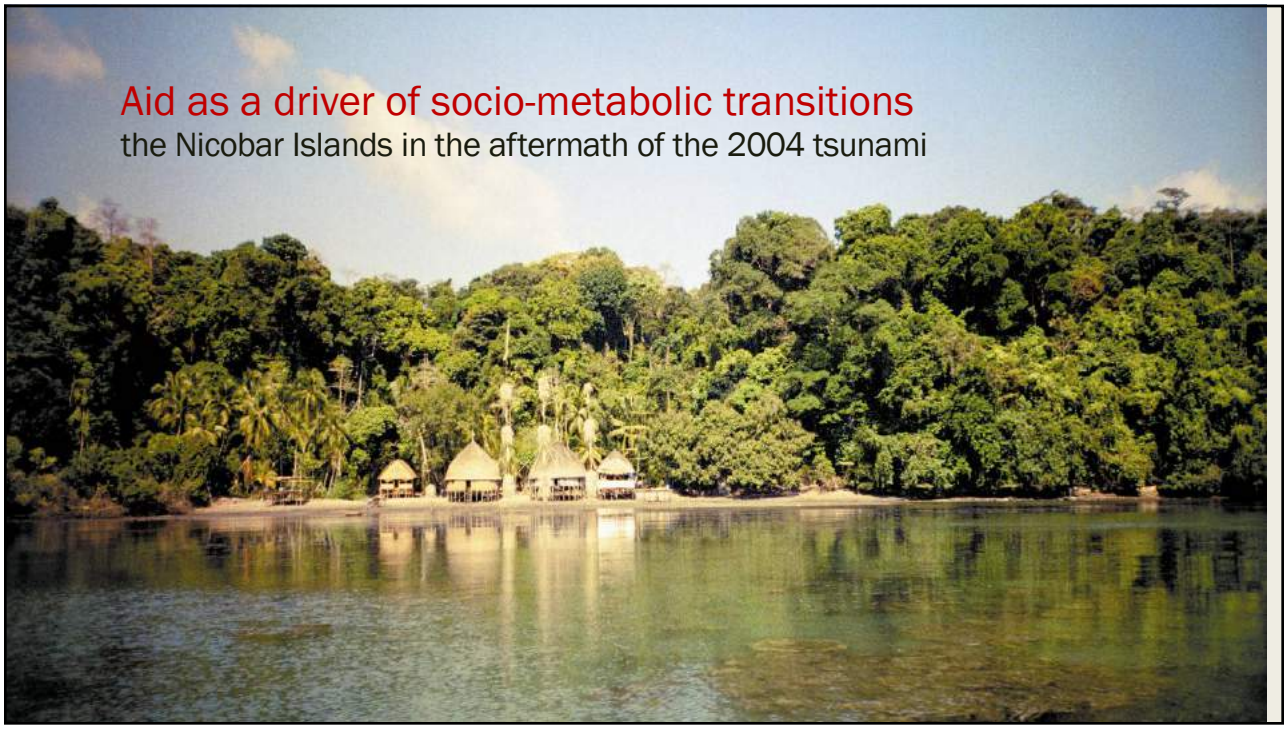

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A subsistence community of hunter-gathers, fishing, and raising coconuts…

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The tsunami of 2004 changed the order of things…

Humanitarian aid was mostly supply driven, less need driven; consumption patterns increased drastically and rapidly, mostly from aid;

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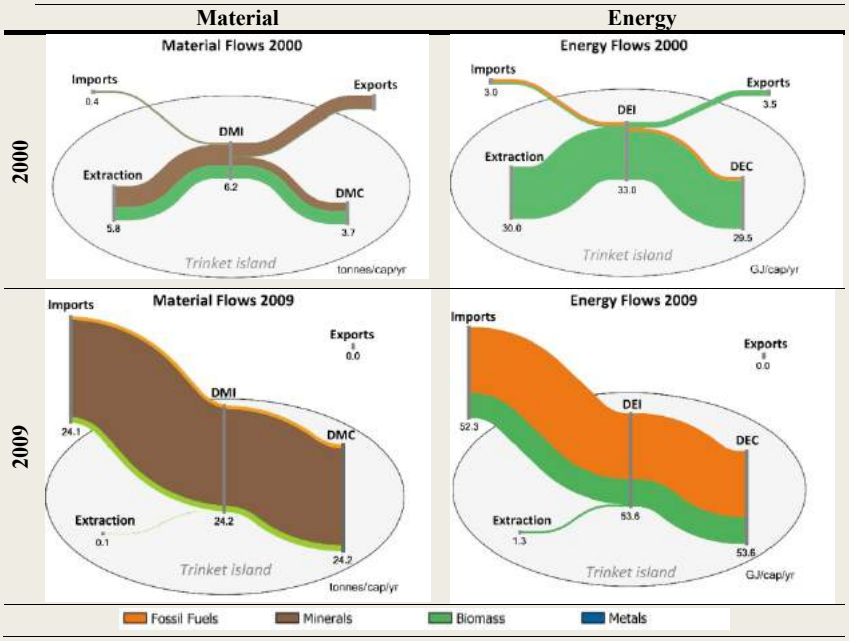
Material use grew 6-fold; energy 20-fold



Singh et. al. (2018). The Sustainability of Humanitarian Aid: The Nicobar Islands as a Case of "Complex Disasters". In S. Reddy (Ed.), *The Asian Tsunami and Post-Disaster Aid*. Springer.

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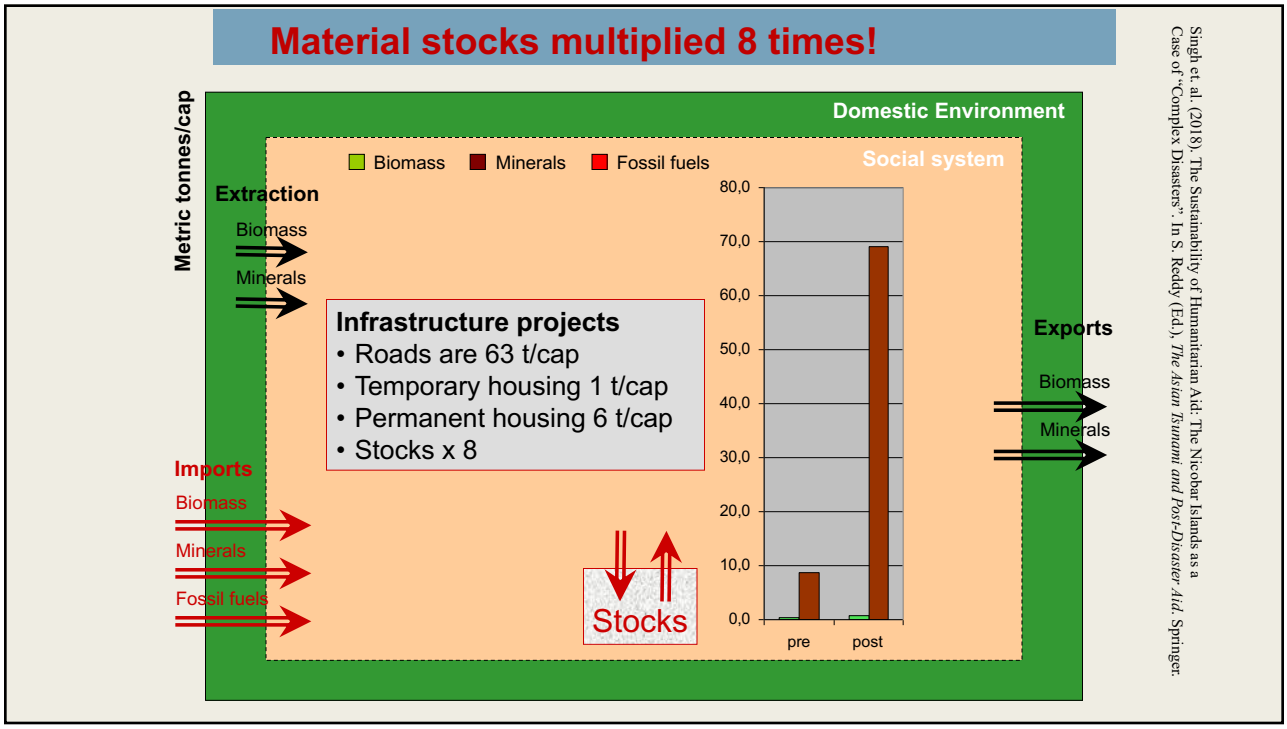

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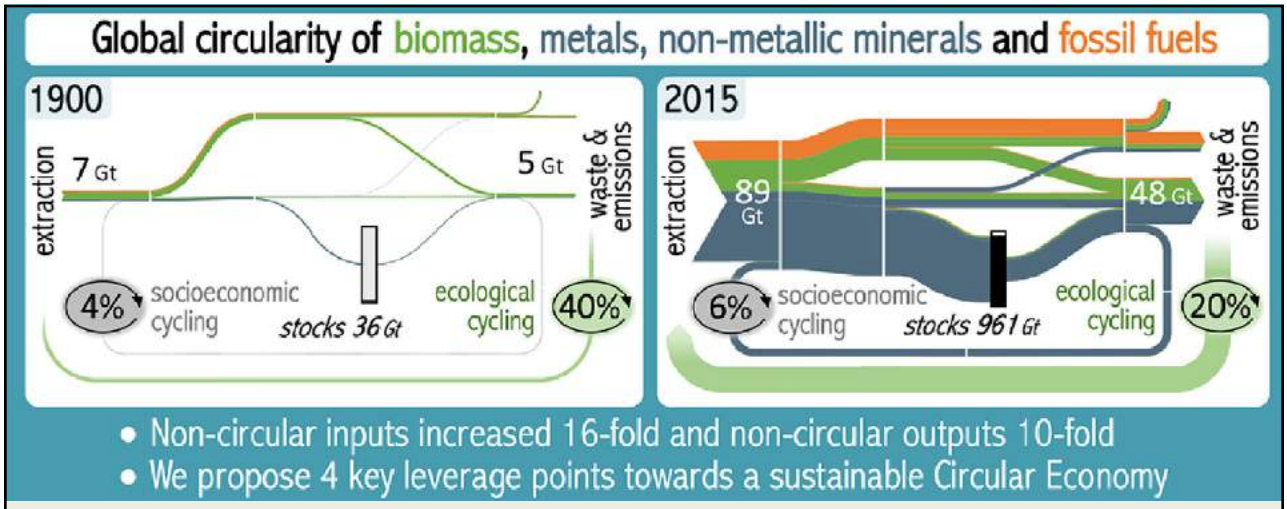

A transition similar to the Nicobar Islands took place on a global scale over a 100 years!

Haas et al. (2020): Spaceship earth's odyssey to a circular economy – a century long perspective. *Resources, Conservation and Recycling* (RCR).

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So, what does all of this mean?

- Exhibit high metabolic risk, vulnerable to impacts from climate change, with respect to both flows and stocks;
- Enhance circularity rate through a circular economy (enabling policies, institutions and collaboration are key);
- Prioritise nexus approaches such as food-water-energy, or stock-flow-service to increase efficiency;
- Spatial planning should consider climate models;
- Infrastructure (materials and design) should consider ease of material recoverability and reuse after disaster;
- Optimise infrastructure use throughout the year, while localising energy, food and construction materials (sufficiency).

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Socio-metabolic research (SMR) in India

- SMR in India is still at an infant stage; very few studies exist;
- As India grows materially, need to optimize resource-use (through efficiency and sufficiency) are urgently needed;
- Local and regional SMR can feed into policies that enhance resource security;
- Whole system approaches should be favored, not only industrial ecosystems, or specific sectors;
- Collaboration between institutions and sectors are key;
- INSEE can encourage SMR and promote training of highly qualified personnel who can conduct robust SMR.

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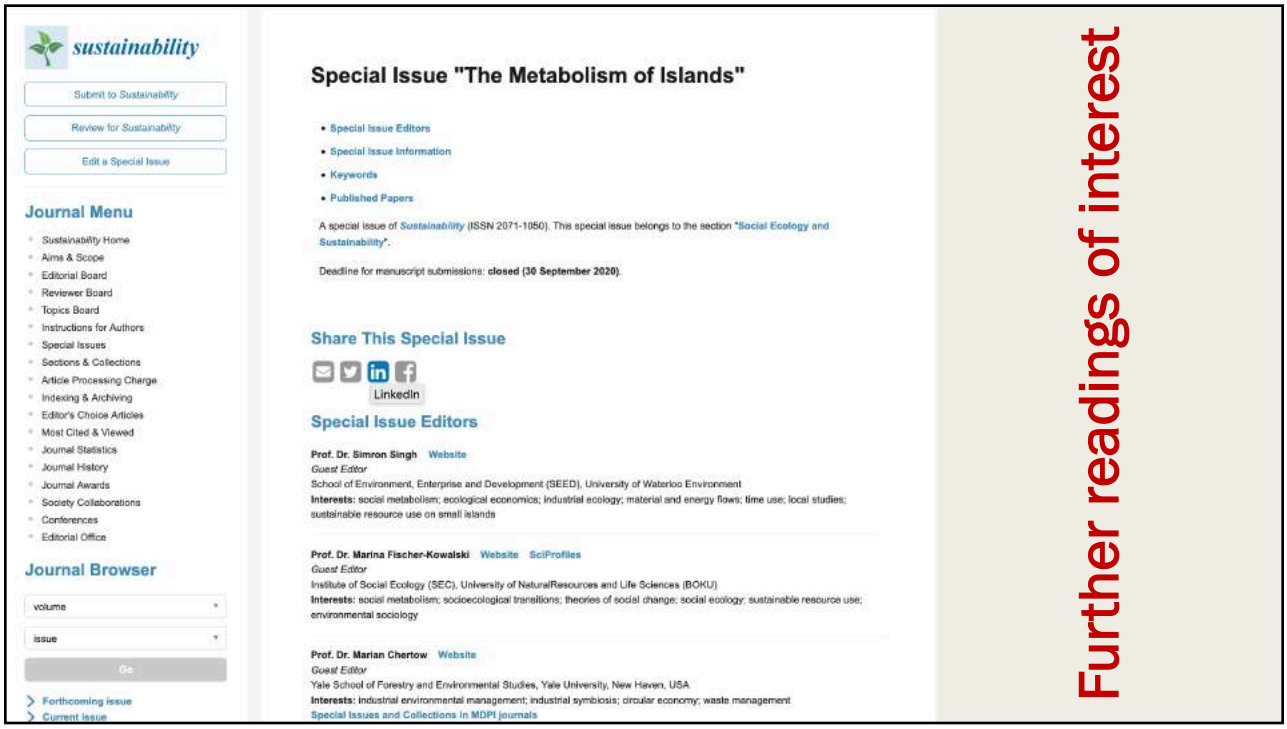

Further readings of interest

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