Risk-KAN Working Group: *Islands and Coasts*

Working Group Leads

- **Simron J. Singh**, SEED, University of Waterloo, Canada (simron.singh@uwaterloo.ca)
- **Tailin Huang**, CauseMatters Ltd. Inc., Taiwan (tailinhuang@gmail.com)

Rationale

Small Island Developing States (SIDS) confront immense sustainability challenges due to heavy reliance on imports, tenuous resource availability, coastal squeeze, and reduced waste absorption capacity. The adverse effects of global environmental change, such as global warming, extreme events, and sea level rise, significantly hinder SIDS' progress toward sustainable development. Between 1970 and 2020, SIDS collectively lost US$153 billion from extreme events, largely stemming from infrastructure damage and the consequent breakdown of critical services. Their limited resources and small size amplify the impacts of these challenges, positioning SIDS as "canaries in the climate change coal mine." (Singh, et al., 2025).

This Working Group frames the vulnerability of small islands and coastal areas from the perspective of **Socio-Metabolic Risk (SMR)**. SMR is defined as systemic risk associated with the availability of critical resources, the integrity of material circulation, and the equitable distribution of derived products and societal services within a socio-ecological system. We position SMR as a critical subset of the broader concept of systemic risk (Singh et al., 2022).

Specific configurations of material stocks and flows, combined with "**resistance to change**", accumulate SMR over time and influence the system's ability to provide critical services. Tracking material and energy flows reveals hidden dependencies and inefficiencies that shape vulnerability to climate shocks, enabling adaptation strategies that enhance self-reliance, promote business models, reduce import dependency, and build resource-secure futures. The proliferation of SMR and its resulting systemic risks are complex, leading the Working Group to explore fundamental questions critical for climate action:

- How do current resource-use patterns (island metabolism) lead to increased vulnerability and reduced climate adaptation capacity? Who is most affected/vulnerable?
- What are the key drivers contributing to this metabolic trend of increasing climate risks and declining resilience, including institutional resistance to change and policy gaps?
- What opportunities exist for enhancing climate change adaptation by transforming socio-metabolic pathways to support the most vulnerable communities?

Explore these systemic challenges and pathways to resilience in the documentary film, "Metabolism of Islands" (Waterloo Climate Institute, 2025).

Aims

Our aims include:

Advance scientific understanding: Promote the use of Island Metabolism thinking and the SMR framework to identify leverage points and adaptation strategies for managing complex, systemic risks.

Knowledge creation and sharing: We aim to create new knowledge through collaborative research and the development of open-source tools. We also aim to gather and curate this knowledge onto a central platform to make it accessible to diverse target audiences.

Support policy application: Process and visualize data to assist policymakers and practitioners in tackling their challenges using Island Metabolism thinking. This involves providing evidence on problematic resource-use patterns and possible scenarios.

Foster an inclusive community: We aim to foster a collaborative community of stakeholders to collectively address island sustainability challenges.

Induce positive tipping dynamics: Focus interventions on governing socio-metabolic flows to avoid disruptions in critical resources, while guiding the system towards "positive tipping dynamics" through strategies that reconfigure resource-use patterns to be sustainable and socially equitable.

References

Singh, S. J., Hossain, M., Clayton, A.(a), Clayton, A.(b), Drakes, C., Drescher, M., Fekete, A., Fishman, T., Gooroochurn, M., Haberl, H., Hill, L., Jurgens, S., Mani, L., Mijts, E., Mohamed, S., Pisini, S., Thammadi, S., Thorenz, A., Wood, M., and Welch, A. (2025). Infrastructure, risk, and resilience on Small Island Developing States (SIDS): Navigating the nexus Part 1: Conceptual foundations (Waterloo Climate Institute Technical Brief). University of Waterloo. 2025_Technical Brief_Singh_Part 1_Final.indd

Singh, S. J., Huang, T., Nagabhatla, N., Schweizer, P.-J., Eckelman, M., Verschuur, J., & Soman, R. (2022). Socio-metabolic risk and tipping points on islands. Environmental Research Letters, 17(6), 065009. https://doi.org/10.1088/1748-9326/ac6f6c

Waterloo Climate Institute. (2025, October 15). "Metabolism of Islands": A deep dive into the path to small island resilience. University of Waterloo. "Metabolism of Islands": A Deep Dive into the Path to Small Island Resilience | Waterloo Climate Institute | University of Waterloo

Metabolism of Islands. (n.d.). Homepage | Metabolism of Islands.

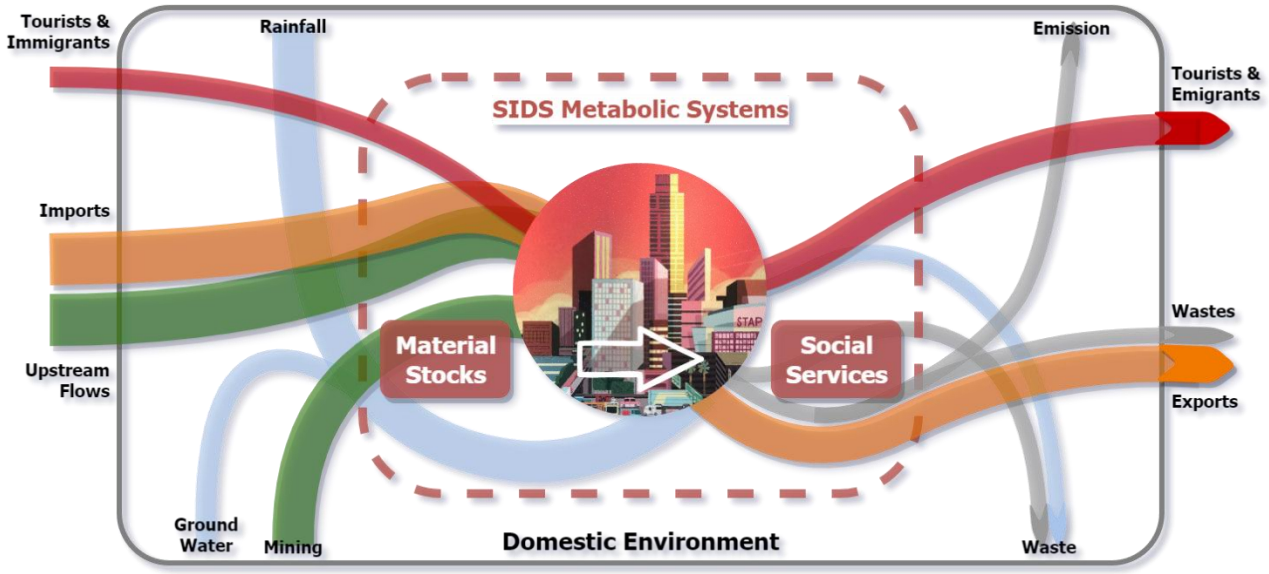

Figure 1. Specific combinations of material stocks and flows, which are used, consumed and/or controlled by humans for their purposes, contribute to the system's proliferation of risk. (Singh et al., 2022)