Reconciling the land-sea interface and marine spatial planning in support of healthy coastal ecosystems



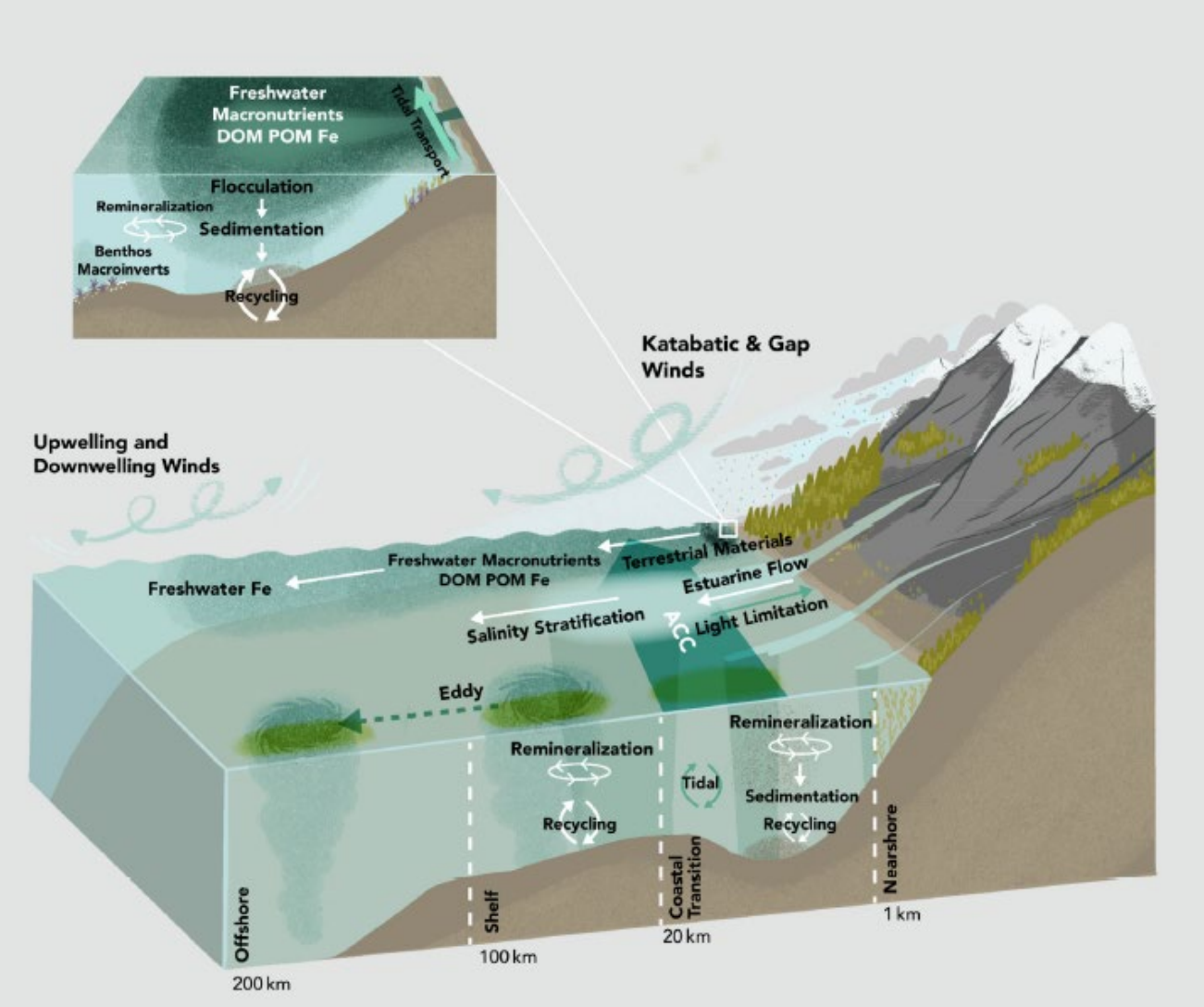
Brian Hunt

UBC

PELAGIC ECOSYSTEMS LABORATORY

PETER WALL LEGACY AWARDS
THE UNIVERSITY OF BRITISH COLUMBIA

The Land-Sea Interface (LSI) concept



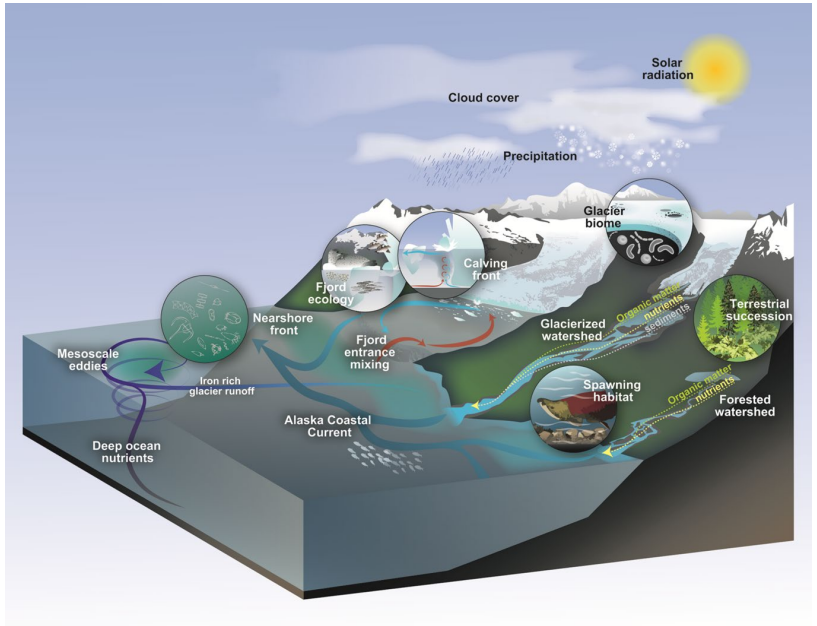
Hunt et al. 2024

Land-sea interactions are critical to marine **ecosystem function**, provision of **ecosystem services**, e.g.,

- Biogeochemical cycling
- Food provision
- Shoreline protection

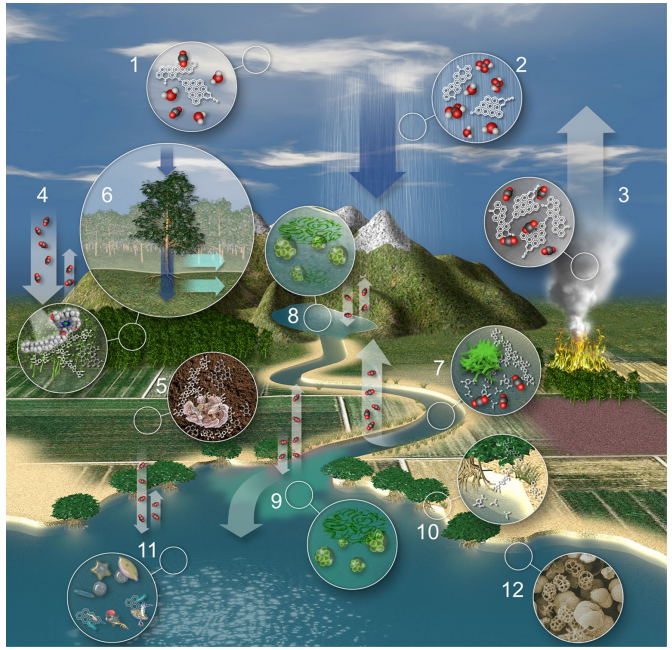
Importance of LSI is globally recognised

Icefields-to-Oceans



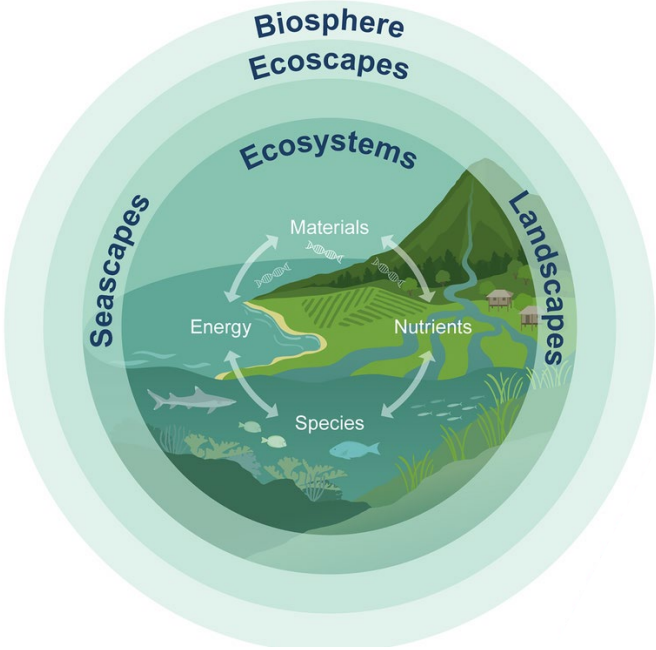
O'Neel et al 2015

Aquatic Continuum



Ward et al 2017

Ecoscapes



Wedding et al 2025

Global mechanisms of land-sea interaction

Physical connectivity – freshwater runoff, wind transport

Biogeochemical connectivity – material flux

Ecological connectivity – food webs & organism movement

Socio-economic activities – e.g., ports & shipping, industry, agriculture

Socio-cultural aspects – e.g., cultural heritage, practices, identities

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LSI physical connectivity

Small scale (10-100 m) – **estuarine salinity gradients**

e.g., coastal rainforest watersheds;



Medium scale (10-100s km) – **large river plumes**

e.g., Fraser River plume;



Large scale (> 100 km) – **buoyancy boundary currents**

e.g., Alaska Coastal Current (Riverine Coastal Domain).

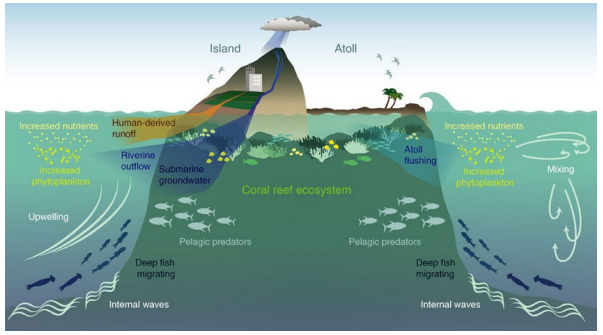


LSI biogeochemical connectivity

Small scale (10-100 m) – local **sub-marine groundwater** discharge;

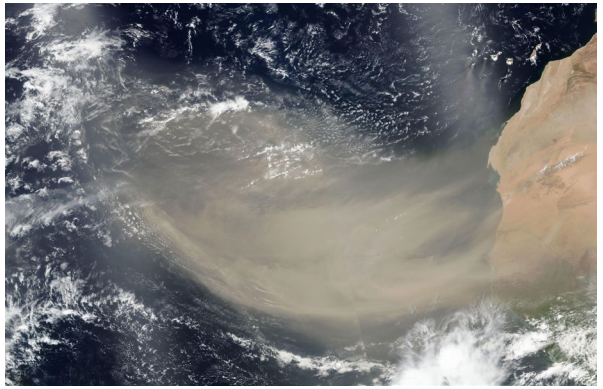


Medium scale (10-100s km) – **Island Mass Effect,** terrestrial nutrient subsidies to island marine ecosystems;



Large scale (> 100 km) – **atmospheric dust transport** from continents to ocean basins

e.g., Saharan dust.



LSI ecological connectivity

Small scale (10-100 m) – **tidal movements of fish** to feed in estuaries;



Medium scale (10-100s km) – **diadromous fish species** migrating between freshwater and marine habitats;

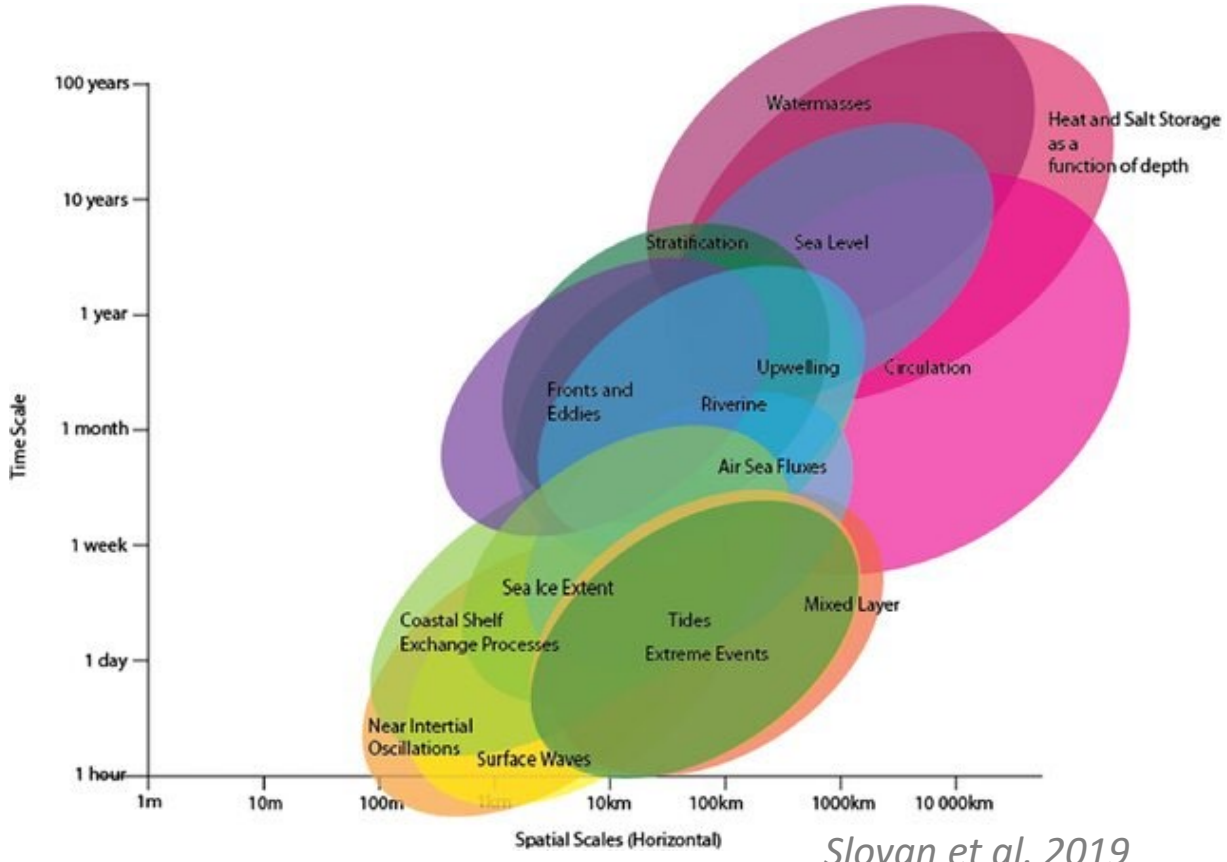


Large scale (> 100 km) – **migratory birds** using coastal corridors at continental scales.



Mechanisms of land-sea interaction

- Operate across spatial and temporal scales
- Start in headwaters and extend to the open ocean
- Can have place specific characteristics



Sloyan et al. 2019

Human activities are disrupting the LSI

Hydrological cycles

e.g., damming – reduced freshwater flow to estuaries leading to salinization e.g., Colorado River estuary;



Biogeochemical pathways

e.g., stormwater amplification of particle flux;



Ecological functioning

e.g., habitat loss and fragmentation



Climate change is amplifying LSI stressors

Freshwater discharge – volume, timing, and amplitude,

e.g., atmospheric rivers, monsoon, drought;



Quantity and quality of nutrient flux (organic and inorganic) to the ocean,

e.g., wildfire;



Compounding impacts of other anthropogenic activities,

e.g., impact of eutrophication + warming on coral bleaching.



Addressing LSI in marine management is urgent

Climate change, sea level rise, extreme events, and growing populations increase pressure on coastal ecosystems

LSI protection and restoration

- enhance coastal resilience
- positive feedbacks from sea to land
- positive feedback to communities



Construction a living shoreline Charleston, South Carolina. Credit: City of Charleston. (NOAA Fisheries)

International agreements and policy frameworks calling for LSI integration

Ramsar Convention on Wetlands - 1971

United Nations Convention on the Law of the Sea (UNCLOS) - 1982

Global Programme of Action (GPA) - Protection of the Marine Environment from Land-based Activities - 1995

United Nations Sustainable development goals and the 2030 Agenda

SDG 14 (life below water); SDG 6 (clean water and sanitation); SDG 15 (life on land)

International agreements and policy frameworks calling for LSI integration

LAND-SEA INTERACTIONS ARE STILL ONLY RARELY INCORPORATED INTO MARINE SPATIAL PLANNING

(Morph et al. 2019)

Challenges go beyond ecosystem understanding

GOVERNANCE AND INSTITUTIONAL FRAMEWORKS OFTEN SEPARATE LAND AND SEA PLANNING FRAMEWORKS

e.g., in Canada:

Natural Resources Canada (energy, forestry, mining sustainability, and groundwater);

Water Resources Canada (freshwater);

Environment and Climate Change Canada (environmental rules, pollution prevention, wildlife conservation, and weather forecasting);

Fisheries and Oceans Canada (marine ecosystems, fisheries and their habitats).

Changing the paradigm of land-sea separation

STEPS TOWARDS REDRESSING THIS SEPARATION:

- **Formal recognition of LSI** as a common principle amongst agencies;
- **Allocation of resources** to support inter-agency communication and coordination to implement an LSI framework;
- **Allocation of funding** to support integrated and interoperable land-sea data systems;
- **Engagement across sectors**, rightsholders, and stakeholders.

Working towards positive outcomes

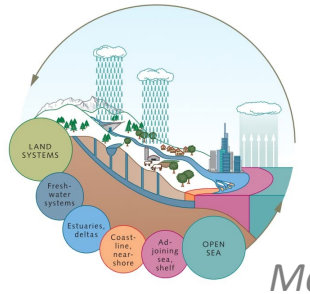
There are examples of successes

səlilwətaɬ
Tsleil-Waututh Nation
PEOPLE OF THE INLET

BRITISH COLUMBIA

Ridge to Reef
Enhancing biodiversity. Sustaining ecosystems.
https://nowgrenada.com

Source-to-Sea (S2S)



Mathews et al 2019

New global initiatives supporting incorporation of LSI in management

marine spatial planning global

UNESCO International Guide Volume 4 – Land-Sea Interactions



Thank you
Questions?

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