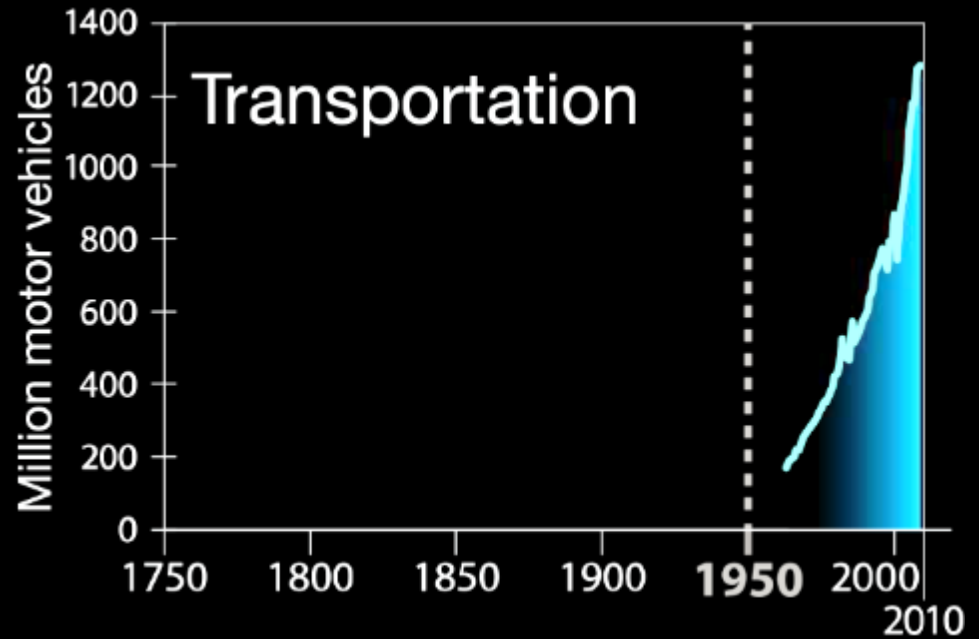
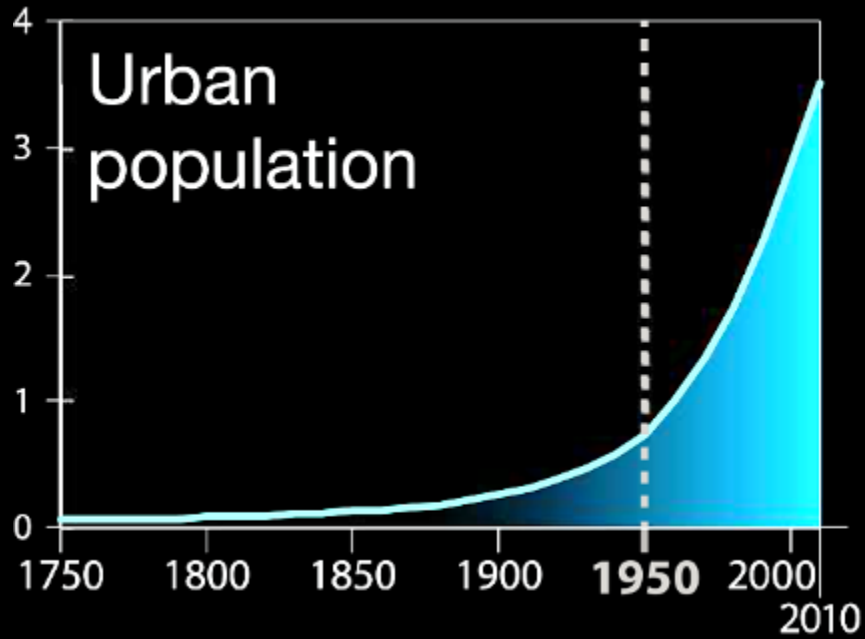


TELECOUPLINGS OF LIMITED RESOURCES:

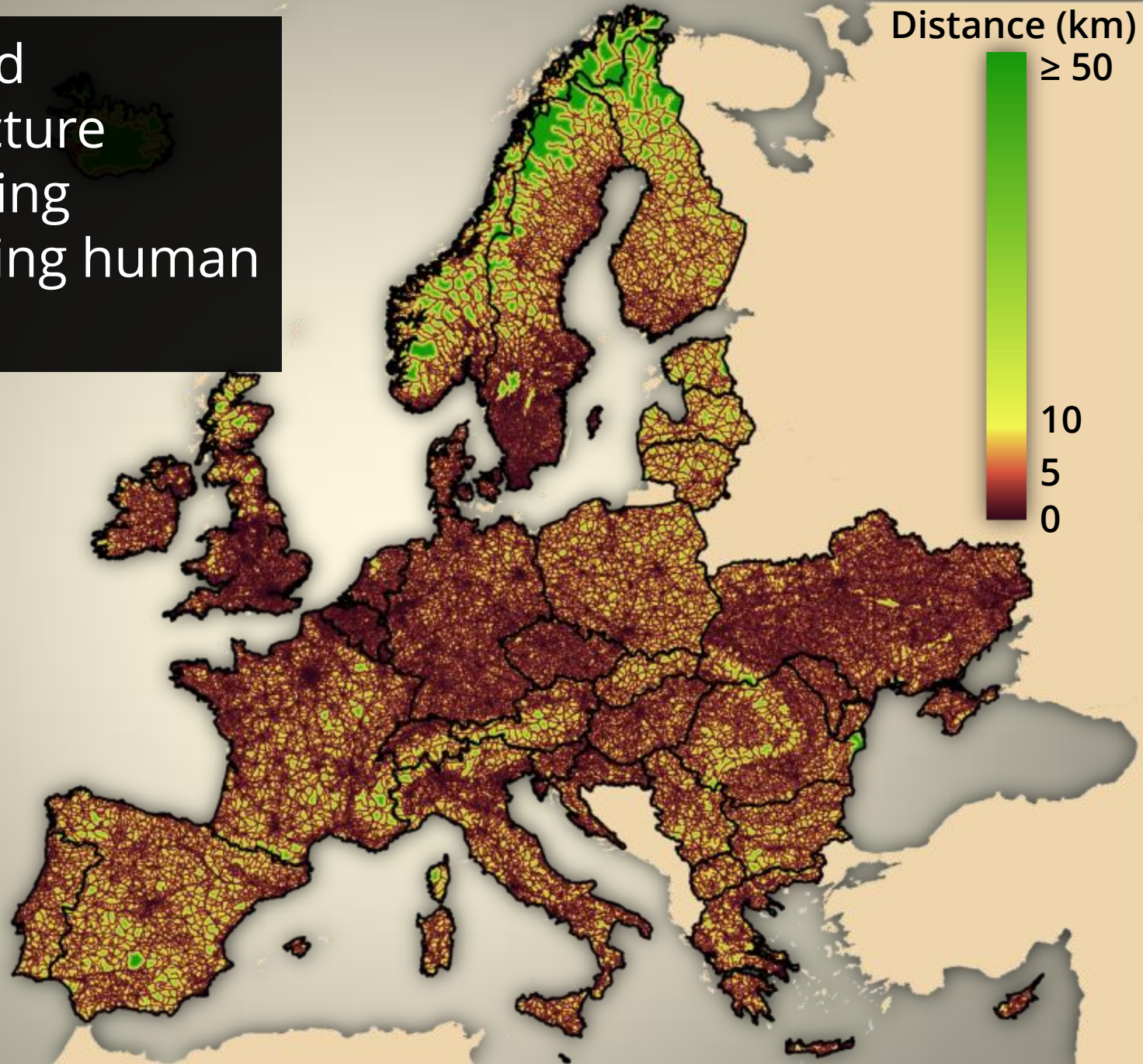
The case of sand

Aurora TORRES, Jodi BRANDT & Kristen LEAR





- Roads and infrastructure proliferating
- Accelerating human impacts



Effects of infrastructure on
wildlife, landscape...

**What about the resources
used for development?**





URBAN GROWTH & EXPANDING TRANSPORT INFRASTRUCTURE

Concrete, glass, asphalt



LAND SCARCITY

Land reclamation projects

An aerial photograph showing a beach nourishment operation. A large yellow bulldozer is pushing sand from a dune area onto the beach. Several people are visible on the beach, and a large pipe is laid out across the sand. The ocean waves are breaking in the background.

COASTAL EROSION

Beach nourishment



ENERGY PRODUCTION

Frack sand mining

Trade value
(\$US billion)

Net weight
(million Tones)



Challenges

- **Dispersed pieces of research** from different topics and disciplines
- **No synthesis of information**

TELECOUPLING FRAMEWORK

Overarching Objective:

Develop a comprehensive strategy for the **sustainable production** of the ever-increasing amounts of sand that our world requires

Specific research questions

1) Where are the **conflicts** among sand mining occurring?

2) What are the major **sending & receiving** systems of sand?

3) What are the main **components** of **telecoupled systems** involving **sand mining** and **trade**?

1) Conflict spots

(Raids, protests, gangs, and murders)



India



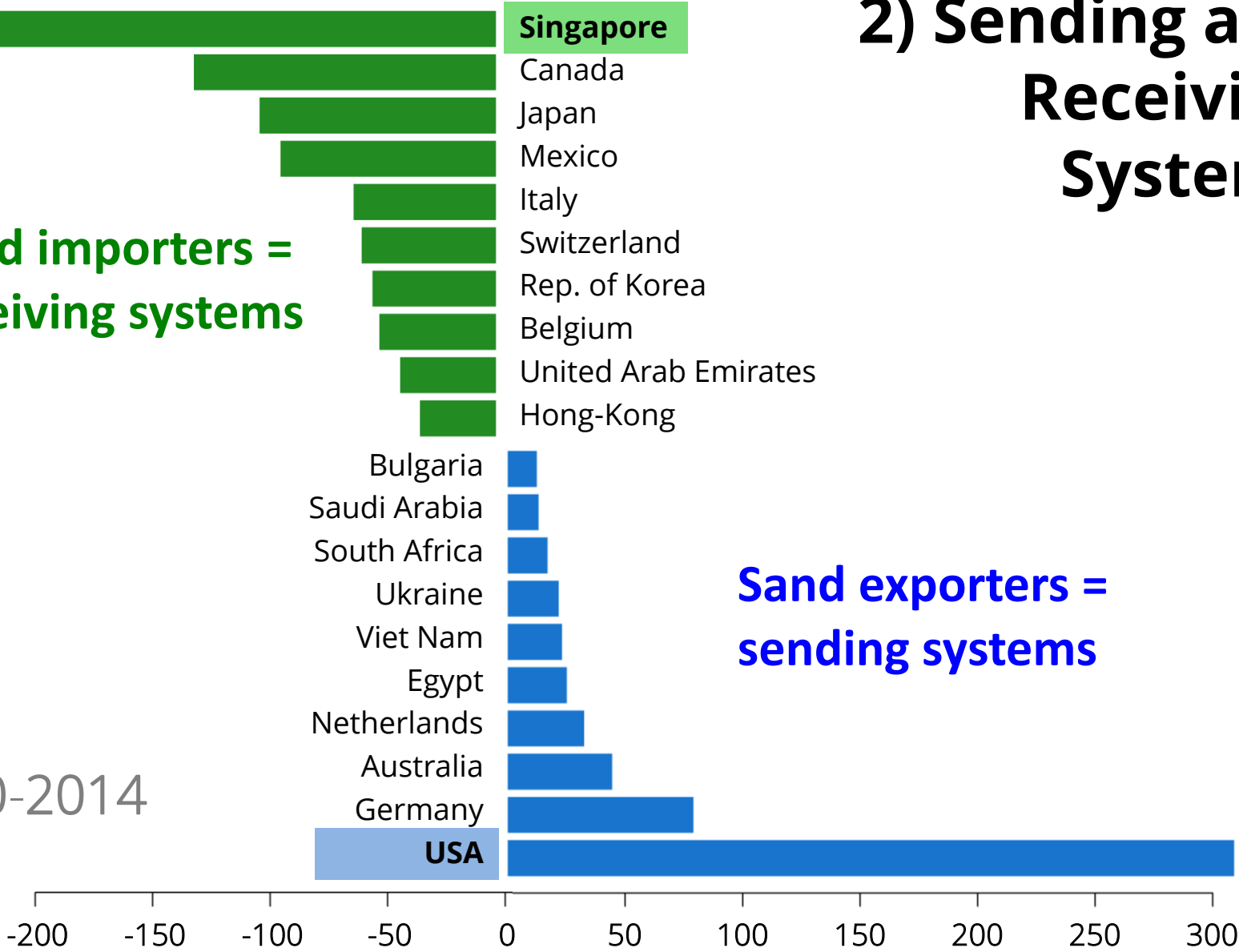
Adam Ferguson

2) Sending and Receiving Systems

Sand importers = receiving systems

Sand exporters = sending systems

2010-2014



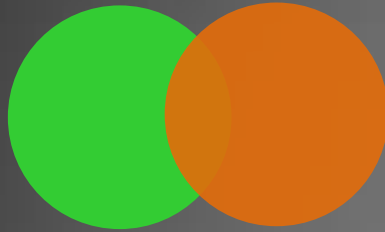
Net importers and exporters of sand (Million US\$)

From UN Comtrade database (SITC Rev. 3 2733 Natural sands of all kinds whether or not coloured)

3) Components

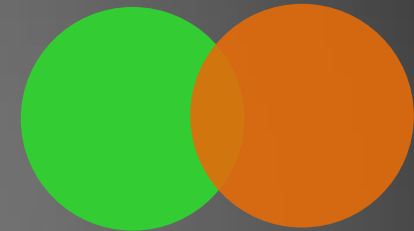
Sending system

natural system human system



Receiving system

natural system human system



\$\$\$





URBAN GROWTH & EXPANDING TRANSPORT INFRASTRUCTURE

Concrete, glass, asphalt



LAND SCARCITY

Land reclamation projects

DUBAI

The World



The Palm





Sending systems

Malaysia

Vietnam

Cambodia

Myanmar

Indonesia

Philippines



A map of Southeast Asia with a dark blue background and brown landmasses. A white circle marks the location of Singapore. Several red curved arrows point towards this circle from various directions: one from the north (Myanmar), one from the northeast (Philippines), one from the east (Indonesia), one from the south (Indonesia), one from the southwest (Indonesia), one from the west (Malaysia), and one from the northwest (Vietnam). The word 'SINGAPORE' is written in large white capital letters at the bottom left of the map.

SINGAPORE

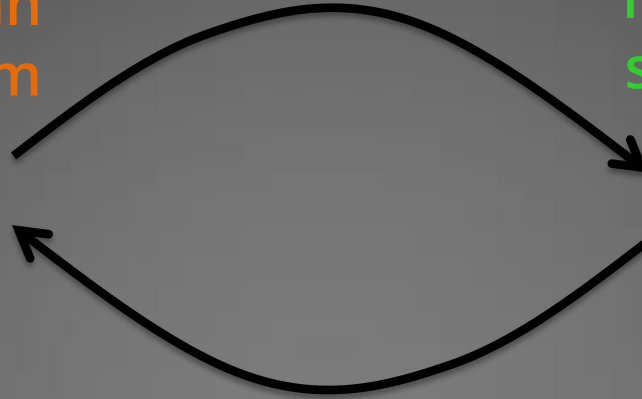
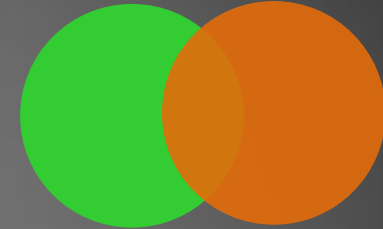
Sending system

natural system
human system



Receiving system

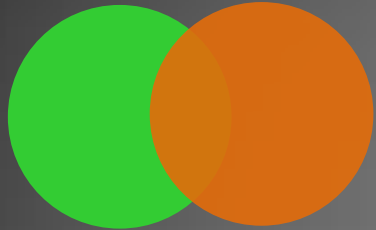
natural system
human system



- Decrease water quality & clarity
- Coastal or river bank erosion
- River and sea bed degradation

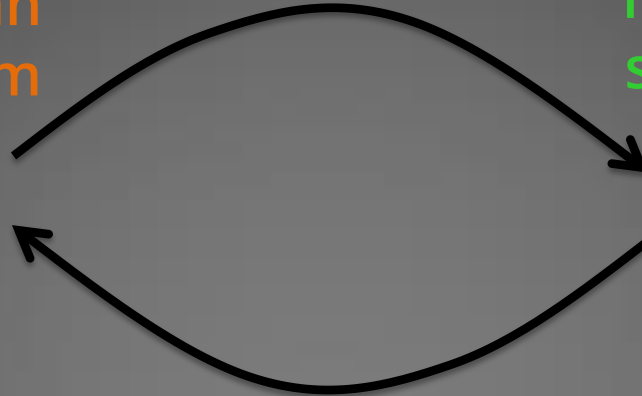
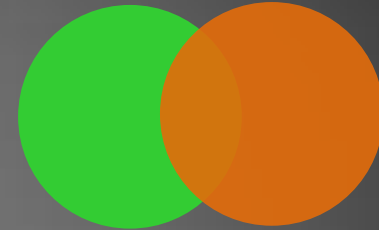
Sending system

natural system
human system



Receiving system

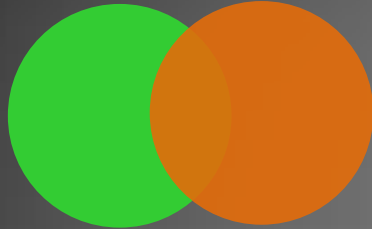
natural system
human system



- Water quality advisories
- Beach closings
- Negative impact on fishing
- Geopolitical conflicts

Sending system

natural system
human system



Receiving system

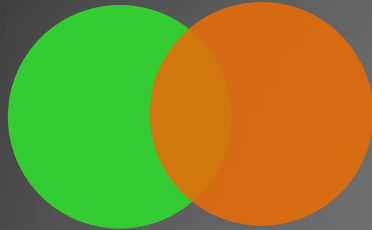
natural system
human system



- Reduce distribution of coral reefs and mudflats

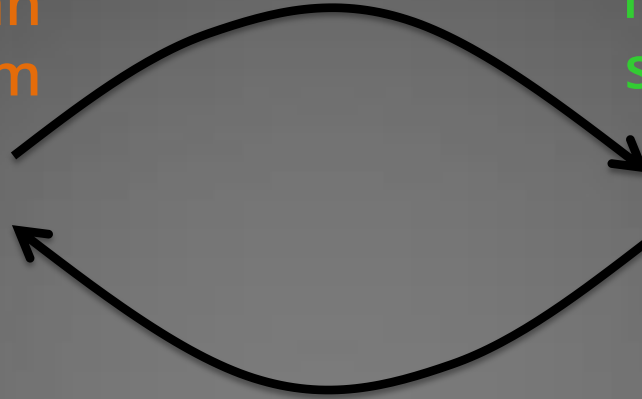
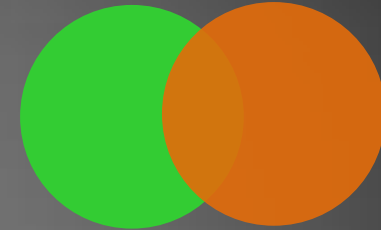
Sending system

natural system
human system



Receiving system

natural system
human system



- Geopolitical conflicts
- + Development projects
- + Increased number of jobs

SHANGHAI





**Banned local
sand mining**



December **1995**



December 2013

Image of the Day
March 17, 2016



10 km



Sand dredging

Gan River

Sand dredging

Sand dredging

Poyang Lake

- Largest freshwater body in China
- 98% of endangered Siberian Cranes and Oriental White Storks



Sending system

natural system

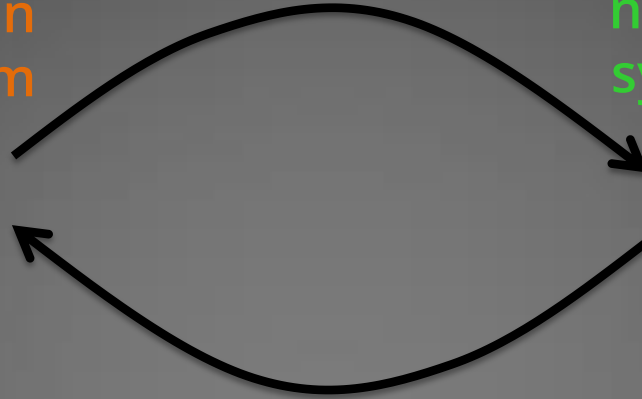
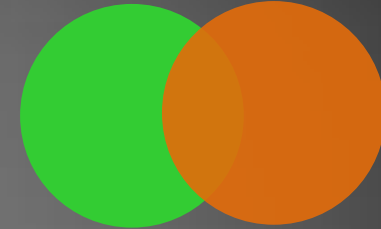
human system



Receiving system

natural system

human system



- Seasonal water fluctuations less predictable
- Damages to bridges from sand transportation + Economic prosperity
- Low water events
- Effects on endangered species



An aerial photograph showing a beach nourishment operation. A large yellow bulldozer is pushing sand from a dune area onto the beach. Several people are visible on the beach, and a large pipe is laid out across the sand. The ocean waves are breaking in the background.

COASTAL EROSION

Beach nourishment

CARIBBEAN ISLANDS





**Degrades beaches = bad
for tourism!**



Key Findings

○ Four **main causes** of sand telecouplings:

1. Urban growth
2. Land scarcity
3. Coastal erosion and tourism
4. Energy production

○ New telecouplings **created by**:

- Uneven distribution of appropriate types of sand
- Exhaustion of local sand resources
- Regulations/banning of sand mining in local areas

Moving Forward

- Quantify the extent to which the exportation of sand is a **driver of environmental degradation**
- Investigate **synergies with other sustainability challenges**
- Identify **tools & opportunities** to intervene in the systems in order to promote a **sustainable use of sand** and achieve conservation goals

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Kristen Lear

 @BatsForLife

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The increasing demand for sand will likely increase conflicts and potentially lead to a **“tragedy of the sand commons”**

