Unit 2.4 Horizontal connections: How do linkages among places – e.g. pollution externalities, trade, and migration -- affect the pursuit of sustainability?

The course so far has emphasized two perspectives on sustainable development: one broadly global (e.g. the resource trends of Part I), the other focused on particular places (e.g. our teaching cases for London, Alaska and Appalachia). With this Unit we seek to bridge these two perspectives, acknowledging that local places are connected with one another on a global stage. Those connections are ubiquitous, involving flows of people, pollution, trade, finance, information, and other things we review in the readings. But they are also incomplete: the Anthropocene System remains heterogeneous in the face of connections rather than becoming homogenized: Vietnam and France, for example, remain distinct entities even though they are partially connected in many ways. Efforts to analyze the dynamics of nature-society systems therefore must take seriously both the persistent heterogeneity of different patches of the Anthropocene system and the partial connections among them.

What connections among places matter for sustainability? Some are clearly damaging to human well-being, inequitable in their consequences, or otherwise inconsistent with the goals of sustainable development, e.g. the spread of diseases from their points of origin into global pandemics; the enslavement of people from some places and their forceable removal to serve the interests of people in other places; the violent extraction of all manner of natural resources (fur, gold, cotton) from around the world by a handful of colonial actors; the unilateral export of pollution and other forms of waste from places that benefit from the production and consumption that generate the pollution to places that only experience its harms.

Other connections among places have arguably produced benefits to society as a whole, distributed them more equitably, or may be otherwise consistent with the pursuit of sustainability, e.g. the spread of "foreign" crops from their places of origin to become staples grown around the world (e.g. corn, wheat, potatoes, tomatoes); the migration of people from one place to another in search of a better life for themselves and their children can also benefit the places they immigrate to and (through remittances) the places they emigrated from; fair trade, allowing people in one place to take advantage of its comparative advantages in ways that benefit both local producers and consumers in places far away; knowledge produced in particular places that have invested in heavily in research promotes local benefits but also spills over to places that have done nothing to create it. Still other connections among places clearly play a role in the dynamics of the Anthropocene, but whether they support or impede sustainable development is unclear or depends on local context.

Analysts seeking to understand and promote sustainability need some organized way of sorting through the vast set of possible connections among places to focus on those most important for the pursuit of sustainability. We still lack (and may well never have) a grand theory of connections. But some progress is being made as is illustrated in the Readings listed below[*].

To prepare for this Unit, please:

a) **Read / review:** Matson, P. A., Clark, W. C., & Andersson, K. P. (2016). *Pursuing sustainability: A guide to the science and practice*. Princeton University Press. https://pursuing-sustainability.stanford.edu/**.** Read Ch. 3 "Dynamics of social-environmental systems," pp. 61-63

[*] Terminology Alert: The field of sustainability science is evolving rapidly, and we still struggle to find simple but meaningful terms for core ideas. For this course, "Connections" used in this class = "horizontal connections" from the syllabus and the Synthesis we provide in Unit 2.8. It means flows of materials, organisms or information from one place to another, and implies a global (or at least multi-place) perspective. "Invisibilities" is a term we used in the Matson et al. book to mean several things, one of which is a local perspective on the "connections" used here. "Vertical connections", a term used in the syllabus is something else altogether which we will explore in Unit 2.5. Just ignore it for now. Sorry.

("Invisibilities in space and time"). Review case study "London: The struggle for sustainable development in an urban environment," pp. 143-165.

b) **Read**: Hull, V., & Liu, J. (2018). Telecoupling: A new frontier for global sustainability. *Ecology and Society*, *23*(4), art11. https://doi.org/10.5751/ES-10494-230441 . Read the entire 7 pages of text and figures.

This paper discusses many of the kinds of horizontal connections that have turned out to matter for sustainable development. It is not comprehensive, lacking for example more than passing mention of the long range transport of air pollution. But you should extract from it and your own reflections a check list of what may be moving from one place to another.

c) **Read:** Harley, A. G. (2021). *Looking outward: Refocusing attention on London's hinterland (Addendum to London: A multi-century struggle for sustainable development in an urban environment)* (Course Library for Sustainable Development Course). Harvard University. (Available in Course Library).

This paper extends the London case study you read earlier to explore the city's "horizontal connections" with the rest of the world. It gives special attention to the resources that London, as capital of a colonialist empire, drew from around the world to support its growth and recovery from disaster.

d) **Review:** Thompson, M. (2021). The Alaskan Salmon Fishery: Managing Resources in a Globalizing World. Harvard University. (Available in Course Library pp. 1-25).

e) **Explore:** Clark, W. C., & Harley, A. G. (2025). NetLogo Guide for Sustainable Development Course. Harvard University. (Available in the Course Library). Review Section 1 "Basic access" and explore Section 4 "NetLogo fire with connections model" (Netlogo's title for this model is "Fire simple extension 3").

Study Questions to help you get the most out of the readings:

I. Use the "Netlogo fire with connections model" introduced in (d) to explore how connections change the system dynamics and thresholds that you encountered in the "Netlogo fire model" of the previous Unit. Note that simple fire model already involved some modest connections: the fire spread (connected) only to adjoining cells and only if those cells contained unburned forest. Low densities of forest increased the chances that the fire would have no unburned forest patches adjoining it, and would therefore die out. (Think of parallels with epidemics). The "Connections" variant of the simple model introduced in this Unit allows you to explore how various more complex connections of the system change its behavior. Start with an initial density of the forest close to what you identified in the previous unit as the threshold value that determined whether the fire would spread across the entire landscape and "homogenize" it. How does "wind speed" change the dynamics? "Wind direction?" Why? What are the implications for managing forests? What are analogs to wind speed and direction that might matter in other cases of connected dynamics, eg. migration, epidemics, 'viral' social media? How would they matter for management? The big change in this version of the fire model is what it calls "big jumps," i.e. the ability of fire to jump over the cells that contain no unburned forest and therefore would have stopped its spread in the simple model. What is the impact of turning on the "big jump" switch in the model? What are the implications for fire management? What could cause "big jumps" in real forest fire situations? What analogs to "big jumps" do you think can you think of as affecting the dynamics of other nature-society interactions? What are their implications for the pursuit of sustainability?

II. Connections with other places can have an important role in shaping the prospects for sustainability. How do the connections between in-shore and off-shore fisheries affect sustainability in Fishbanks?

III. For the London case review the original text but focus on the Addendum from the assigned readings for this Unit. When resources were low or depleted how did London rebuild its asset stocks? What role did connections play? What were the consequences for the places to which London connected?

IV. For the case study of the Alaska fishery introduced in Unit 1.1:
   a) Identify ONE connection that is highly relevant to the pursuit of sustainability between the place that is the focus of the teaching case and some other place(s) in the world. Describe the connection in terms of both the flows involved (what it is that is being moved from one place to the other, e.g. people, pollution, ideas, etc.) and the stocks that are thereby changed. Note that the impacts on stocks caused by the connection can be at either end of the flow, i.e. of the teaching case on somewhere else, or of somewhere else on the teaching case, or of both). Explain why you picked the connection you did, rather than one of the other possible connections identified in this note or in the readings.
   b) What is the system structure or process through which the connection you identified in (1a) occurs, e.g. migration, air movement, communication?
   c) What modification of the structures or processes you identified in (b) could best advance the pursuit of sustainability? Explain your answer.

Digging deeper (optional materials for further exploring frontiers in the pursuit of sustainability):

f) **Read:** Liu, J. (2023). Leveraging the metacoupling framework for sustainability science and global sustainable development. *National Science Review*, *10*(7), nwad090. https://doi.org/10.1093/nsr/nwad090

This paper provides an in-depth review of the multiple sorts of horizontal connections that affect development pathways and their prospects for sustainability.