

An Ecological Perspective on Supply Chains

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(Delivered via webcast. Highlighted phrases mark slide changes in accompanying PPT show.)

I'm Brent Ranalli, one of the editors of the anthology you are using as a textbook. I hope you're finding value in the book, and I'd be glad for any questions or feedback you might have about the book or any of the selections in it.

The premise of the anthology is that every discipline has something to contribute to an understanding of environmental issues. This is a particular instance of the general insight from the field of ecology that "everything is connected to everything else." In that same spirit of interconnectedness, I'd like to offer you today an ecological perspective on supply chains. Specifically, I'd like to argue that there are certain basic principles regarding supply chains, and that these apply at many scales, including:

- In ecosystems
- In human history
- In contemporary economic development, both in the first world and the third world, and
- In disaster management and disaster relief situations such as what is happening in Haiti—and I've tried to choose examples from Haiti to illustrate each of my points.

A little bit about myself: I'm an environmental policy professional with degrees in history and in environmental science and policy. I work for a company that does science and policy work for public sector clients, and I do a bit of scholarship on the side. Most of what I know about the topics I'll be talking about today comes from reading, but some of it, on sustainable development theory and practice, comes from personal experience and observations during time I spent in Eastern Europe in the late 1990s.

Some of what I have to say, I'm sure, will be on topics that many of you may have more expertise in than I myself, but I hope that this talk will offer some new and thought-provoking, possibly provocative, perspectives.

Defined broadly, **supply chains** are pathways by which one gets the things one needs. Supply chains are important when thinking about high-priority goals for human societies like stability, security, and sustainability, and I would argue that these terms of art from the diplomatic, military, and environmental communities have a lot of overlap.

Principle #1. When thinking about access to critical resources, *a shorter supply chain is better*, because there are fewer things that can go wrong.

Location, location

- So, for example: Alexander the Great founded almost two dozen towns during his campaigns, but he didn't put them just anywhere: the most suitable sites had a reliable supply of drinking water, arable land, a defensive position, and access to roads or rivers for communication and transportation. In many cases the sites he chose had already been occupied, since there are only a limited number of sites that meet all the criteria.
- As you've seen earlier this week in Kira Intrator's presentation, modern geographic systems and information technology can help locate suitable locations for temporary or permanent settlements in a place such as Haiti, based on factors including the proximity to coast and suitability of the terrain.

Simplify, simplify

- Today our supply chains are more numerous than they were in Alexander's day, and necessarily longer: telecommunications relying on satellites, motorized transport relying on oil pipelines half a world away, electric grids, drinking water treatment facilities, etc. Disruption of any one of those supply chains can cause major problems. So we have armies of plumbers and engineers and other specialized repair personnel, and we have literal armies and navies securing the long supply chain of our energy resources.
- This provokes a reaction—can't we make our supply chains fewer and shorter? There are many possible answers. A foundational thinker in this area is Henry David Thoreau, who made the first

modern “short supply chain” experiment at Walden, building his own house and raising his own food while living in proximity to civilization, and doing without a lot of luxuries that his contemporaries considered necessities, like running water or an oven or a stove. It would be in very poor taste to preach Thoreauvian austerity to a poor nation, but certainly aid agencies responding to a humanitarian crisis must wrestle with some of the same questions Thoreau did about what is truly a necessity when prioritizing limited resources.

Import Substitution

- One way of making supply chains shorter is known as “Import Substitution” or “Import Replacement”: The idea is to produce locally, for yourself, what you previously had to import from a long distance. It is an important principle in explaining the historical development of cities.
 - Ancient Sumarian city-states, for example, established tree plantations at the edge of local marshes so they wouldn’t have to import wood from the highlands (from the research of Guillermo Algaze)
 - And another example, this one from Jane Jacobs, who first identified the phenomenon: when Tokyo adopted the bicycles in the late 1800s, the city was purely a consumer of imported bicycles. But soon bicycle repair shops sprang up, using spare parts from scrapped bicycles—and then local artisans figured out how to produce the necessary parts for the repair shops, and Tokyo eventually became a bicycle manufacturer and exporter.
- In the mid-twentieth century Import substitution was adopted as government-subsidized strategy for economic growth in India and some Latin American countries. The result of this market intervention was generally *not* considered a resounding success, and this may have something to do with increasing globalization during that era—the ease of getting products from any part of the world to any other part in an era of cheap fossil fuels, which reduces the competitive advantage gained by producing things locally—and with confounding external factors, such as currency crises. (Good intro at http://rodrik.typepad.com/dani_rodriks_weblog/2007/08/does-import-sub.html; best analysis I’ve seen is http://faculty.nps.edu/relooney/Bruton_IS89.pdf.)
- But certainly, for Haiti, getting water purification stations up and running, and reducing dependence on bottled water imports, is a positive and economical step.

Principle #2. Stability requires *robustness*—a built-in redundancy, to mitigate damage when supply chain failure does occur

- The Internet and crowd-sourcing are good examples of this: the failure of any one part **does not cause a failure of the whole.**
- The selection in Chapter 7 of the anthology by Amory Lovins and L. Hunter Lovins, entitled “What is Real Security?,” makes a compelling case for distributed generation in the U.S. energy sector, to reduce our vulnerability both to terrorist attacks and to accidents. The same lesson and logic applies to the telecommunication sector, the transportation sector, and others. The more parallel systems you have in place, the less damage is caused when one system fails.
- We see examples of built-in redundancy in nature. One of nature’s most common strategies to ensure reproductive success is to produce an overabundance of seeds and nuts, and tadpoles, and kittens.
- This principle¹ has implications for nations that are developing or rebuilding, when considering whether to “leapfrog” past intermediate technologies to the most cutting-edge technologies in the telecom or energy or transportation sectors. It is important to consider the risks involved in putting all of one’s eggs in one high-tech basket: if a nation decides not to lay land lines for telephones, for example, but to rely primarily on cell phones, it gains in economy, but loses in robustness and security.

Principle #3 is that everything is connected, as I mentioned earlier, and one must take account of that interconnectedness and its implications

3a. First, there are virtuous connections, and one of the most important of these when thinking about supply chains is the idea that **waste is food** (or sooner or later will be food, because “everything has to go someplace”). This is an insight that has been developed at some length by American architect William McDonough.

¹ Here, during the presentation, the phone rang—I had left the phone line open just in case the audio of the webcast went bad and the class leaders needed another way to get in touch with me. This turned out to be a perfect illustration of the point under discussion.

- In nature, every living thing is literally food for some other living thing, whether predator, parasite, or decomposer, with the result that organic matter is continually reused and recycled, and none truly goes to waste.
- Industrial economies are becoming more like nature in this regard—recycling of paper and plastics and scrap metal, composting, and deriving methane from municipal waste are good examples of this, though we clearly still have a long way to go. Problems caused by *not* treating waste as food include such phenomena as:
 - The electronic waste from the U.S. that gets exported to China and ends up poisoning the Chinese countryside
 - The radioactive waste that goes into virtually permanent quarantine and becomes a permanent liability
 - The plastics that wind up in the ocean, where they get ground into fine particles that disrupt the diet of the smallest shrimp and the largest whale
- In this context, we may note that news reports from Haiti have identified waste disposal as a critical problem (<http://www.worldvision.org/news.nsf/news/haiti-water-sanitation-201006-eneews>), and that includes both human waste and trash:
 - In the case of plastics, especially plastic water bottles that arrived in response to the crisis, one aid agency says that Haiti has been left with "an overwhelming amount of plastics to throw away and no one seems to know what to do with them" (http://plasticsnews.com/blog/2010/03/haiti_seeks_help_recycling_pet.html). Before the earthquake Haiti once had one recycling facility for plastics, but at the time of that news report that infrastructure had not yet been reestablished.
 - Even more serious is the problem of human waste, which if left unsolved can spread disease, and has done so in Haiti. In at least one case, an aid agency has had success in turning the problem into an opportunity: organizing people to collect the waste and make fuel out of it, thus not only turning waste into fuel, but also providing employment and allegedly reducing crime (link above, also : http://www.undp.org/cpr/we_work/waste_management_haiti.shtml)

3b. Second, studying interconnections can lead to insights about pernicious connections, including areas where one is working **at cross purposes** with oneself

- Amory Lovins has pointed out that during the occupation of Iraq, the most important purpose of the convoys that were the target of roadside bombs was to transport fuel to remote outposts (up to 70% of total tonnage), and that most of that fuel was being used to provide air conditioning to tents. Partly at his suggestion, the military started insulating the tents and setting up local solar arrays, and realized enormous savings in fuel—and fewer convoys meant fewer lives lost as well. (from a presentation--some details are at <http://www.rmi.org/rmi/RMI+Helps+the+DoD+with+Energy+Policy> and <http://www.ndu.edu/press/lib/images/jfq-57/lovins.pdf>)
- Another example of a potentially pernicious connection is the water/energy nexus. Water production requires energy and energy production requires water. It is estimated that 2 gallons of fresh water are lost to evaporation in the production of every kWh of electricity in the U.S. (<http://www.nrel.gov/docs/fy04osti/33905.pdf>); and that at least in California the water sector “consumes about 19 percent of the state’s electricity, 32 percent of its natural gas, and 88 billion gallons of diesel fuel every year” (<http://www.energy.ca.gov/2007publications/CEC-999-2007-008/CEC-999-2007-008.PDF>).
 - In Haiti, water purification stations are generally diesel-powered, which means they are useless if fuel deliveries are not made regularly. One way to cut through this problem is with distributed solar energy, and there have been several solar success stories in the reporting from Haiti (<http://www.good.is/post/beacons-of-solar-light-in-haiti/>)
- Still another example has to do again with “location, location.” I have colleagues who do project assessments for development work in Africa, and they have found that many otherwise viable projects have been self-sabotaged by lack of appreciation of interconnections: for example, building the new medical clinic immediately downstream of the new village latrine (from presentations by Weston Fisher).

3c. A third area for consideration of interconnectedness is **local ecology** and human-environment interactions

- When thinking about Haiti’s ecology, the most salient factor is the dramatic deforestation, made all the more stark in satellite images by the **contrast with the Dominican Republic next door**.
 - The immediate effects of deforestation include soil erosion, loss of soil fertility, damage to infrastructure like roads and dams, loss of fresh water capacity, and disruption of marine ecosystems

- Second-order effects include making Haiti more vulnerable to natural disasters, and making it harder to recover and rebuild
- We can trace the causal chain in the other direction as well: Immediate causes of the deforestation are the high demand for wood to make charcoal for cooking fuel, and a whole raft of public policy failures—for example, lack of conservation and reforestation measures, failure to assign land titles, and inadequate investment in and promotion of alternative cooking fuels or cooking systems
- We can trace deeper causes as well behind policy failures and poverty, and among these the most salient is a matter of economic and military history, namely the crushing indemnity that France imposed on Haiti in 1825, paid out over a period of 120+ years, an indemnity that at times consumed as much as 80% of Haiti's national budget (http://www.timesonline.co.uk/tol/comment/columnists/ben_macintyre/article6995750.ece).
- When one has a grasp on the causes of an ecological failure, one can take steps to mitigate them: In the case of Haiti, there is interest in reforestation (<http://iapnews.wordpress.com/2010/02/01/in-haiti-reforestation-should-be-part-of-rebuilding-process/>), and a variety of international aid agencies are promoting alternative cooking fuels (for example, experimental briquettes made of local materials, developed by MIT's own D-lab), as well as alternative cooking systems (for example, solar systems) (<http://www.wehaitians.com/sept%202002%20science%20news%20this%20month%20.html>). Debt relief is also an obvious remedy, and the G7 nations, Venezuela, and the IMF have all stepped forward to cancel Haitian debt, to free the Haitian government's hand to provide services to its citizens (<http://news.bbc.co.uk/2/hi/8502567.stm>; <http://www.imf.org/external/np/sec/pr/2010/pr10299.htm>).
- Such considerations apply not only in the third world: there is in the United States, for example, the unsustainable use of water in West. Back in 1986, Marc Reisner documented the long-range problems with water use patterns in the Western states and the perverse subsidies behind them in his book *Cadillac Desert* (a selection of which is in the anthology). A recent report by the National Research Council indicates that many of the problems identified Reisner are still of concern, or getting worse: e.g., poor irrigation practices are sterilizing soil with salt, costing about \$2.5 billion in lost crop revenues, while due to perverse subsidies Western cities with the

most precarious water supplies have become the most profligate in per capita water use.

(<http://aquadoc.typepad.com/waterwired/2010/12/reclaiming-freshwater-sustainability-in-the-cadillac-desert.html>)

Principle #4. Complexity is a sign of health (whether or not one can fully comprehend, measure, or manage it)

- Consider two different bodies of water: on the one hand, a crystal-clear blue Caribbean sea, and on the other hand a muddy, slimy pond. I think we'd agree that we'd rather swim in the former (on the left in the slideshow), but it's worth remembering that the latter (on the right) is more valuable from an ecological point of view; the clear water is effectively an ecological desert.
- We have an aesthetic preference for what is clean, comprehensible, and manageable and against what is messy and unpredictable, and that aesthetic preference can lead us astray.
- As example of this is Germany's pioneering experiments in scientific forest management in the 19th century (a story told in James Scott's book *Seeing Like a State*). Scientific forest management meant regimented rows of trees, all the same height and the same age, with underbrush cleared away. It was aesthetically pleasing. It made it easy to see and study what was happening in the forest, to count, measure, and weigh, and to harvest the wood. But by eliminating the natural, messy complexity of the forest system (including rotting wood, many plants and most wildlife, as well as generational diversity among crop trees), the forest managers made it less robust and resilient, more prone to disease and vulnerable to storms, undermining the economic goals of scientific management.
- The same principle explains why well-planned organic agriculture is less vulnerable to pests and disease than conventional monoculture: diversity provides security and stability to the ecological community that would otherwise have to be imposed from without, with costs, by artificial fertilizers and pesticides.
- Those involved in development and disaster relief may be similarly averse to messy complexity: Leaders of a military relief operation, for example, like leaders of any military operation, may seek, unrealistically, full knowledge and full control of a situation, and military operations may focus on their primary mission with such efficiency that they don't realize they are creating other problems or missing other opportunities, as the example about the Iraqi convoys attests. And nonprofit aid organizations are often compelled to measure progress (to justify donor expenditures) in simplistic ways and on unrealistic timescales. (What I mean is that it is easier to

tell donors, “We delivered X thousand cases bottles of water,” than it is to say “We spent time talking to the locals and got conflicting ideas about what they think their needs are, and found out that three other agencies are also delivering bottled water and most of it is sitting on the dock unopened.”)

- It’s worth being on guard against this tendency to privilege the simple over the true. Some general strategies are:
 - to seek out local knowledge and encourage initiative among those who possess it;
 - to permit experimentation with multiple solutions to problems rather than imposing a one-size fits all solution, even in the name of “best practices”; and
 - to articulate multiple, flexible, inter-locking goals for a mission rather than just one or a handful.

I’d like to close by offering an applied example of many of these principles, and that example is the supply chain of *human resources*.

- The importance of a short supply chain implies that one should *make use of the local population* whenever possible.
 - Aid organizations often see it as part of their mission to provide employment to locals. But we can go deeper than that.
- The record of aid agencies in Haiti not stellar. News reports describe aid saturating the capital city while the countryside goes without, and stories of public service campaigns launched to encourage people to wash before eating at a time when no clean water is yet available (<http://canadahaitiaction.ca/content/harsh-words-haiti-aid-industry-doctors-without-borders>). One might think that such gaffes could be eliminated by increasing the level of coordination and communication. But the president of the International Council of Doctors Without Borders reports that attempts to coordinate the efforts of NGOs have not improved the efficiency of aid efforts, and have only created additional layers of bureaucracy (<http://canadahaitiaction.ca/content/harsh-words-haiti-aid-industry-doctors-without-borders>).
 - In some ways this gridlock is reminiscent of the maddening inefficiencies of the Eastern bloc countries in the Soviet era: for example, the notorious Polish hospital that stood empty for four years waiting for the production of equipment to fill it (R. J. Crampton’s *Eastern Europe in the Twentieth Century and After*, p. 250).

- The usual moral drawn from Eastern bloc inefficiency is one of public versus private institutions. The example of Iraq suggests that putting development and reconstruction in the hands of the private actors is no panacea
http://www.nytimes.com/2008/12/14/world/middleeast/14reconstruct.html?_r=1.
The analogy with aid agency inefficiency in Haiti suggests that a more fundamental concern than public versus private is remote control versus **local initiative**—an economy is dynamic when decision-making power is spread out in as many hands as possible, close to the needs to be filled, whether that means it is exercised by local businesses, local governments, or local cooperatives.
- For perspective, one might speculate about what would have happened in Haiti after the earthquake if there had been no organized foreign aid. Presumably the local population would have organized itself and rebuilt—probably more painfully at first, but probably also more purposefully than the present quagmire of thousands of aid organizations.
 - Ideally, aid organizations should be in a supporting role to an active local population, rather than merely supplying the needs of passive consumers of aid.
- That's not easy to put into practice, for several reasons. One is that however much we agree that in the long run it is better for the local population to determine its own destiny, it is not easy for an aid agency, or any other organization, to relinquish control, especially when lives are on the line and when the local population appears manifestly unprepared to assume control in the short run.
- Another obstacle to local initiative is structural: the fact that aid agencies in Haiti control the means of exchange. They and almost exclusively they have the power to hire people to get work done. The hard currency that aid agencies pump into the local economy leaves that local economy in a flash in exchange for necessities.
 - To get a local economy going you need a **means of exchange that will be circulated locally**. This will happen organically in any more-or-less stable community, even a refugee camp or a prison, as people do each other favors and owe each other favors.
 - A local currency would simply formalize that system of exchange—and it doesn't even have to be a physical currency, it could just be an accounting system, like "time-dollars": I'll spend an hour baby-sitting for you, and earn a credit I can use to get someone else to spend an hour tutoring me in English. Teenagers earn credits by organizing a talent show. People start to be engaged in the productive work that makes a community, in a

hundred ways that no aid agency or government bureaucracy would have the time to dream up or the resources to organize.

- A credit system would be capable of supporting not only English lessons and talent shows, but also essential services: things like hauling the garbage, and providing rides to the health clinic. Eventually, some of the local economic activity will spill over into production of goods and skills that are marketable outside the community and help move the community into equilibrium with the larger world, with production (exports) and consumption (imports) more or less in balance.

As a closing thought, I'd like to acknowledge that there is an important word I've used sparingly in this presentation. That word is *system*. There is fact a discipline called "systems theory" that offers many of the sorts of principles and insights I've been discussing today.

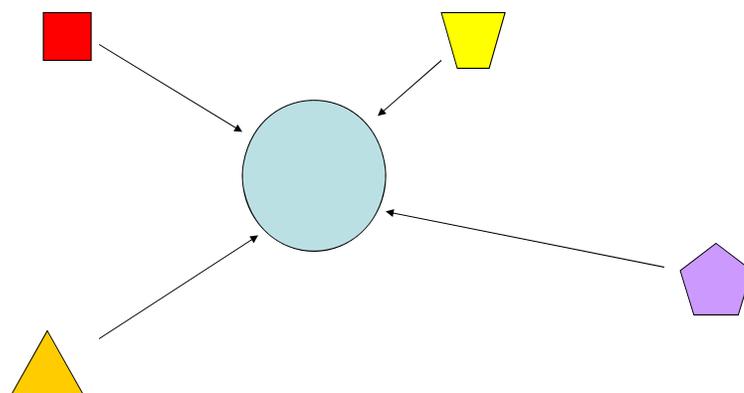
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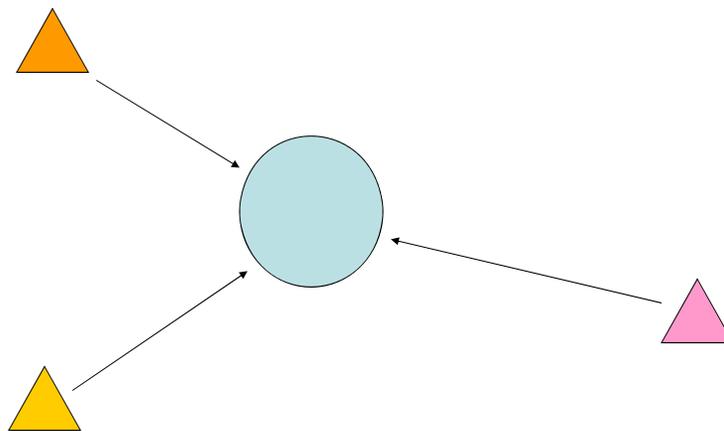
Supply chains



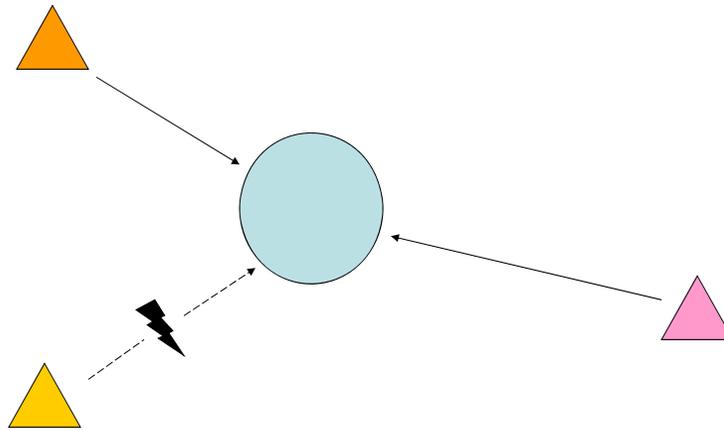
Principle #1: Keep supply chains short

- Location, location
- Simplify, simplify
- Import substitution

Principle #2: Build in redundancy, robustness



Principle #2:
Build in redundancy, robustness



Principle #3:
Remember that *everything is connected to everything else*

- Waste is food
- Identify areas where working at cross purposes
- Be aware of local ecological conditions and human-environment interactions

Deforestation in Haiti



"Haiti Deforestation Vulnerability" from OneResponse.info
 (<http://onerresponse.info/Disasters/Haiti/Environment/Environment/Forms/DispForm.aspx?ID=5>).
 Used by permission of Mr. Altan Butt, UNEP, Post-Conflict and Disaster Management Branch.

Principle #4: Remember that *complexity is a sign of health*



"Puro_island's_clear_water.jpg" by Evelyn Baylon.
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"Field_pond_Rushton_-_geograph.org.uk_-_178409.jpg"
 by Mike Harris, from geograph.org.uk. Found at Wikicommons, used per Creative Commons Attribution-ShareAlike 2.0 license

Applied Example: Human Resources

- Short supply chain: make use of local labor, skills
- Appreciate messy complexity: trust and take advantage of local knowledge, initiative
- Local means of exchange (currency/credit) fosters complexity, robustness in local economy