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Introduction to Ecosystems

(presentation by: Andrew Paterson)

How might 'ecologies' and 'ecosystems' apply to project design and management?

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Sir Arthur Tansley (1871-1955) was an english botantist, who in 1935, coined the term 'ecosystem' for the biotic and abiotic components that made a whole.

The key concept, in his own words, is

"the idea of progress towards equilibrium, which is never, perhaps, completely attained, but to which approximation is made whenever the factors at work are constant and stable for long enough period of time".

After his death this term came into general use, and now is part of everyday language, applied to many different contexts (technology, software)

Recent development of term … Ecosystem management: set up from trying to deal with the components seperately, to managing the system as a whole.

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Learning from Natural Science..

Odum, E. P. (1997), Ecology: A bridge between Science and Society. Sinauer Associates Publishers, Sunderland, Mass., USA.

The Ecological Hierarchy

Hierarchy is an arrangement into a graded series of compartments

Geological, biological and ecological hierarchies are **'nested'** in each level made up of lower-level units.

(In comparison human-organised hierarchies in governments, military, corporations, universities are 'non-nested': Sergeants, for example, are not composed of groups of privates).

In ecology the term **population**, originally coined to denote a group of people, is broadened to include groups of individuals of any species that live together in some designated area.

In the singular, a population is a group of organisms of the same, interbreeding species;
In the plural, populations may include groups of organisms of different species that are linked by common ancestry or common habitat (eg plants, birds, plankton populations)

Community, in ecology, is used in the sense of the biotic community, to include all of the populations living in a designated area.

The community (**biotic**) and the non-living environment (**abiotic**: stones, minerals) functioning together as an ecological system or ecosystem.

Groups of ecosystems along with human artifacts make up landscapes,

which in turn are part of large regional units (both geographical and natural regions) called

biomes (e.g. an ocean, a grassland region)

The major continents and oceans are the **biogeographic** regions, each with its own special flora and fauna.

The **Biosphere** (synonymous with ecosphere) is widely used to refer to all of Earth's ecosystems functioning together on a global environmental scale.

Ecosphere = all the life and interacting non-living materials (all the ecosystems).

Also lithosphere (rocks, sediments, mantle and core of earth), hydrosphere (surface and ground water) and atmosphere.

Each level in the hierarchy influences what goes on at adjacent levals.
Processes at lower levels are often constricted by those at a higher level.
In otherwords large ecosystems as a whole , such as oceans or large forests, are less variable over time than their individual components.

Applying Hierarchy Theory

The challenge is to recognise the unique characteristics of the level selected and devise appropriate methods of study and/or action.

Different tools are required for study at different levels.

To get useful answers we must ask the right questions.

Ref: Odum (1997) Chapter 2: Levels of Organisation

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About Models

A **model is a simplified formulation that mimics a real-world phenomenon so that complex situations can be comprehended and predictions made**.

In their simplest form, models maybe **verbal or graphic**.

In its formal version, a working model of an ecological situation would most likely have 5 components

1. **Properties** (P; state variables)

2. **Forces** (E; forcing functions) which are outside energy sources or casual forces that drive the system.

3. **Flow pathways** (F) showing where energy or material transfers connect properties with each other and other forces

4. **Interactions** (I; interaction functions) where forces and properties interact to modify and amplify or control flows

5. **Feedback loops** (L) where an output loops back to influence an 'upstream' component or flow

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LOOK AT BASIC INPUT-OUTPUT SYSTEMS

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Energy

Energy is a necessary input. The sun is the ultimate energy source for the biosphere and directly supports most natural ecosystems.

Other energy sources may be important for many ecosystems, for example, wind, rain, water flow, fuel.

Energy also flows out of the system in the form of heat and in other transformed or processed forms such as organic matter (for example food and waste products) and pollutants.

Energy Language Symbols

"Energy language symbols" developed by H. T Odum (1971) represent renewable energy sources:
Circle: Energy source

Downward arrow and earth: Heat sink: drains out degraded energy after its use in work

Rounded-rectangle: Producer: converts and concentrates solar energy; self-maintaining

Hexagon: Consumer: uses converted energy; self-maintaining)

Tri-circle: Storage

Chevron: Interaction: Two or more flows interact to produce a higher-quality energy

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Components entering and leaving the system

Water, air, and nutrients necessary for life, along with all kinds of other materials, constantly enter and leave the ecosystem.

And organisms and their popagules (seeds and reproductive stages) enter (immigrate) and leave (emigrate) the ecosystem.

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Ecosystems have 2 major biotic components.

Producers

Autotrophic: (self-norishing) component, able to fix light energy and manufacture food from simple inorganic substances (eg water, carbon-dioxide, nitrates) by the process of photosynthesis. Green plants on land, algae and water plants are these. "upper green belt"
These organisms may be thought of as producers.

Consumers

Heterotrophic: (other-nourishing) component which utilises, rearranges, and

decomposes the complex materials synthesised by the autotrophs. Fungi, non-photosynthetic bacteria, micro-organisms, animals , including humans, are these. “brown belt” of soil and sediment below the green canopy.
These organisms may be thought of as consumers, as they are unable to produce their own food and must be able to obtain it by consuming other organisms.
LOOK AT FOOD WEB

When Autotrophic and Heterotrophic organisms are linked together in a network of energy transfers, it is called a food web.

Herbivores (plant eaters), Carnevores (feed on other animals), Omnivores (feed on plants and animals) and Saprovores (feed on decaying organisms such as fungi and microrganisms)

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LOOK PERMACULTURE WEB

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Platform/project Ecologies

Choose a project to conceptually unpack

This is one which can be explored, unpacked, with the attempt to describe it as an ecosystem.

It can involve applying words and concepts from one context to another, and transforming meanings.

It can involve detailing all aspects of the project.

It can involve detailing the 'populations' in the project that make up the community.

It can involve detailing the community and 'non-living'/'other' environments working together (infomatic,financial,infrastructural,etc..)

It can involve detailing the project and the artifacts produced within it.

It can involve detailing the forces and energies applied between all of the above.

It can involve imagining where the project's 'landscape' and 'region' is.

It can involve imagining how the project might be developed or extended.

It can involve imagining its sustainability or life-span.

It can involve thinking about what might feedback in the process or recycled elsewhere.

It can involve thinking about what might be left behind and what use that might be.

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EXAMPLE OF TARANAKI PLATFORM ECOLOGIES

http://ecosys.wikidot.com/

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Jacobs, J. (2000), The Nature of Economies. Random House, New York, USA.

Jacobs (2000), Chapter 1: Damn, Another Ecologist

+++ Biomimicry

"Broadly speaking the aims are to make better materials than we manufacture now, but to make them, a life-friendly temperatures and without toxic ingredients, like the filaments spiders make or the shell material abalones construct, for instance.

Ideally by imitating the chemistry of nature, we should be able to make materials and products by methods that are benign and, at the end of their lives as products, return them to the earth or the sea to degrade benignly."

- "But it sounds like just another way for us to exploit nature – trying to get out of technological messes with more technological messes."

"No!.. Its learning from nature, with nature, with the object of undoing damage and getting along with nature more harmoniously."

"Biomimicry is a form of economic development. So caring about biomimicry requires caring about economic development – hoping that it continues vigourously. Otherwise, we can't hope for better products and safer methods. How else can we get them?

"Thinking about development has made me realise how similar economies and ecosystems are. Thats to say the principles at work in the two are identical.

I don't expect you to believe this just because I say so, but I'm convinced that universal natural principles limit what we can do economically and how we do it. Trying to override principles of development is economically futile. But those principles are solid foundations for economies... to learn economics from nature."

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Ecologists study:

1. structural, functional, and behavioral adaptations of organisms in relation to their environment (Chapter 3);
2. interrelationships between species and their populations, and populations in their communities (Chapter 4);
3. local and geographic distributions of organisms;
4. regional variations in organism abundances;
5. temporal changes in the distribution, abundance, and behaviors of organisms; and
6. evolution of the interrelationships described.

Ecologists regard ecosystems as basic structural units, implying that the biosphere is a collection or mosaic of definable ecosystems. However, an ecosystem is really more conceptual than actual. By this we mean that the definable boundaries of an ecosystem are more in the mind of the ecologist than geographical.

Gaia Theory: Consider that ecosystems are not, in most cases, isolated units, but parts of a larger functioning whole, at its broadest being the biosphere. Is it possible that biosphere—all life on earth and at least those physical things utilized and modified by life on earth—is one, large integrated system?

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The most basic interest of ecologists is how organisms interact with their environment. Inanimate objects do not normally "interact"—they are simply acted upon by forces in the

environment. Organisms, however, cannot be totally passive within a chain of events and still sustain life.

Living systems—organisms—respond in various ways to contacts with the physical forces of an ever-changing environment and interrelationships with other living organisms. The hereditary potentialities of an organism determine what it can do, but the environment determines what it actually does and to what degree (Greulach & Adams, 1962). This theme is important and you will see it repeated in the discussions that follow.

Organism responses can be described under four different categories:

* morphological,
* physiological,
* behavioural, and
* community relations.

Although these are more or less distinct categories and will be discussed in detail in this chapter, an organism's response to an environmental challenge seldom involves just one of these.

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A community is an assemblage of populations living in the same place at the same time, interacting with each other and their environment. There are various spatial scales used:

* 1. A forest - made up of trees, plants, and animals
* 2. A single tree - made up of a community of insects and flora
* 3. A termite gut - made up of a community of protozoa, bacteria, and archaea

http://en.wikipedia.org/wiki/Community_(ecology)

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Community stability

Community stability is the ability of a community to resist change or have the ability to rebound from change. There is a stability-diversity hypothesis that says that the more diverse a community is, the more stable and productive the community is. This is true because the more stable and productive communities can use the resources better and more efficiently than communities of less diversity.

There are a couple of arguments for and against this hypothesis. An argument for the hypothesis would be that pest outbreaks occur more often on cultivated (disturbed) land. The argument against this statement is that there is no co-evolutionary history with the pests that reside there.

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Ecology Richness/Diversity

http://en.wikibooks.org/wiki/Ecology/Species_Richness_and_Diversity

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Ecosystems

Living organisms and their nonliving (abiotic) environment are inseparably interrelated and interact upon each other. Any area of nature that includes living organisms and nonliving substances interacting to produce an exchange of materials between the living and nonliving

parts is an ecological system or ecosystem - E. P. Odum, 1959

An ecosystem is a biotic community with abiotic components consisting of plants, animals, and micro-organisms in an area functioning together with all the non-living physical factors of the environment. As previously mentioned, ecosystems contain bitoic factors and abiotic factors. The biotc factors are the living components of the environment. The abiotic factors are the non-living components of the environment.

The idea of the ecosystem relates to the idea that all organisms in the environment are engaged in relationships with every other aspect (like resources and other organisms) in that environment. Ecosystems deal with energy and nutrient flow through a system/community. For example, a household or a university could be described as an ecosystem, and a city or a state could be described as a larger ecosystem.

While ecosystems may be bound and individually discussed, they do not exist independently, but interact in a complex web. The ecological relationships connecting all ecosystems make up the biosphere. Because virtually no surface on the Earth is free of human contact, all ecosystems can be accurately classified as human ecosystems.

Ecosystems vary in diversity. Some ecosystems may be very diverse with many plants and animals; whereas other ecosytems may be less diverse with less animals and plants in the environment. For example, the tropical rain forests could be classified as an ecosytem that has a high diversity; whereas the temperate rain forests could be classified as an ecosystem that has a lower diversity than the tropical rain forest.

http://en.wikibooks.org/wiki/Ecology/Ecosystems

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Basic Ecology: A Free Online Textbook
http://en.wikibooks.org/wiki/Ecology/Contents

InContext: Permaculture: Design For Living
http://www.context.org/ICLIB/IC28/Mollison.htm

Cary Institute of Ecosystems Studies: Defining Ecology
http://ecostudies.org/definition_ecology.html

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Ecosystems in Information-Media context..

iPods, platforms and ecosystems
http://orweblog.oclc.org/archives/000770.html

Open source ecosystems as open-structure platforms
http://alexfletcher.typepad.com/all_bets_off/2007/09/open-source-eco.html

Emerging Ecosystems & Platforms
http://simeons.wordpress.com/2007/07/12/emerging-ecosystems-platforms/