

To Examine a Place in Time and Space: The Integrative Approach of Landscape Ecology

Robyn Myers

*National Aeronautics and Space Administration
Ames Research Center
Moffett Field, California*

WHAT IS LANDSCAPE ECOLOGY?

Landscape ecology is a new name for what, to many, is a familiar way of looking at Earth processes. Often, the first time someone hears the term "landscape ecology," it conjures up images of a planting design for your front yard, or of food chains and energy pyramids. In reality, landscape ecology is a way to study the biological, physical, and human elements of a geographic area emphasizing (1) the spatial relationships among landscape elements or ecosystems; (2) the flows of energy, mineral nutrients, and species among the elements; and (3) the ecological dynamics of the landscape mosaic through time (Forman 1984). Instead of the traditional separation and focus of scientific disciplines, landscape ecology provides a synthesized, interdisciplinary approach to environmental research. However, that means looking at the Earth with a new perspective.

Imagine, for a minute, watching the Earth rise slowly over the surface of the moon. You see the blue and white fullness of the Earth emerging from behind the grey lunar landscape. For thousands of years we have gazed at the heavens and wondered about the Earth. Our earth-bound perspective limited our views. Those first pictures of the Earth from space quietly enlightened its wholeness. Suddenly we realized that, instead of seven seas, there is only one ocean. The boundary lines so familiar on the globe did not exist as we saw the entire Earth for the first time. Great rivers and mountain ranges were seen for the first time in their entirety. Astronaut Sultan Bin Salman al-Saud of Saudi Arabia described experiencing this new perspective over time: "The first day or so we all pointed to our countries. The third or fourth day we were pointing to our continents. By the

fifth day we were aware of only one Earth" (Kelly 1988).

The development of science and technology provided us with this new picture of the Earth. The individual sciences, such as geology, wildlife biology, landscape design, physics, sociology, and geography, have each provided us with a per-

spective of different Earth systems. Looking across the boundaries and dimensions of time and space, landscape ecology focuses on the relationships between patterns and processes. It provides an integrative method of examining the whole along with the sum of its parts.

HISTORY AND PHILOSOPHY OF LANDSCAPE ECOLOGY

In 1939, the German geographer Karl Troll found that aerial photography provided a "new perspective" of the land. He noted that the photographs allowed observation of an area in sequential time. He is credited with having introduced the geographic discipline of landscape ecology. The concept developed across northern Europe, primarily evolving out of the need to plan urban areas. It evolved as an integrative device for the planner, taking information from scientists and integrating the information so planners could make sound decisions. As a result, landscape ecologists in Europe looked primarily at human-defined units rather than natural landscapes or ecological communities (Golley 1990).

The United States approach to landscape ecology has evolved more recently to examine natural landscapes, looking at ecological communities and systems, as well as natural boundaries within the overall landscape. Traditionally, environmental land areas are divided into study units. Landscape ecology takes an entire heterogeneous landscape area and looks at the relationships between and among homogeneous units. Landscapes can be defined operationally as a series of contiguous ecosystems, or as homogeneous pieces of a heterogeneous whole—it all depends on scale. Scales of time and space should be defined and organized to meet the objectives of the landscape being examined.

PLACE, TIME, AND SPACE

For example, let's look at a well-known and highly visited landscape: Great Smoky Mountains National Park. Spatially, at a *micro-scale* level, we could identify a particular watershed in the park to examine. Broadening our examination to a *meso-scale* would take in all of the Great Smoky Mountains, while a *macro-scale* would look at the entire Blue Ridge Mountain Range. Finally, the *mega-scale* would include all of North America. Temporally, we could examine any one of these

spatial areas in terms of *seconds to hours, days to seasons, decades to centuries, or thousands of years to millions of years.*

Once the scale of time and space have been defined, landscape ecology uses an ecosystem approach to look at the *inputs* and *outputs* of elements in the landscape such as energy, water, nutrients, vegetation, wildlife, and economic factors. Elements that are not traditional commodities can then be quantified. Landscape ecology is also a way of

looking at the causes of *patterns* within a landscape, such as environmental gradients that create patchiness, disturbances that create patterns, and the natural succession of communities as they change through time. It also provides a method for assessing the *effects of those patterns* and, recognizing humans as the primary manipulators of landscapes, serves as a basis for making sound choices and decisions.

The goals of landscape ecology are to: (1) quantify the *significance* of the

effects of landscape patterns; (2) observe *changes through time* at all stages within the entire landscape; (3) characterize landscapes with detailed *mapping*; (4) characterize landscapes with *patchiness of mosaic ratios*; and (5) *identify the effects* of the landscape mosaic on the spread of disturbance, maintenance of viable population sizes, recovery rate after disturbance, and resource quality (Knight 1990).

APPLICATIONS OF LANDSCAPE ECOLOGY IN RESOURCE MANAGEMENT

With the new trend toward management of multiple ecosystems within regional areas, rather than just individual specific resources, resource managers and scientists need integrated information to do their jobs. Both must know the resource systems in detail and be prepared to communicate and cooperate with other local agencies, the scientific community, and the public. Managers are also being asked to update or initiate baseline inventory data, as well as maintain a monitoring plan with fewer human and financial resources. The landscape ecology approach provides a method for accomplishing all these things.

Landscape ecology links the resource basic inventory, geographic information systems, current research activities, and past studies in an identified landscape area to present an overall picture of the landscape in its regional setting. Landscape ecology recognizes disturbance regimes, such as fire, as persistent and important processes. Disturbances drive the interactive dynamics of landscapes and create component patches. Landscape ecology integrates inter-

disciplinary and holistic perspectives and approaches with the specific disciplines of scientific research. It also infuses the human social element into resource management issues. Effective management of local ecosystems requires attention to individual detail as well as the entire landscape context in which they are located. Landscape ecology takes the sum of the parts of a place, and through the perspective of time and space presents a whole.

In the preface to their book *Landscape Ecology*, Richard Forman and Michel Godron describe the unique role landscape ecology plays in our lives:

When we focus on the heterogeneity in a landscape, we sense how intertwined its ecological systems are. An action here and now produces an effect there and then. Since the system is interlocking, it is critical to understand the spatial relationships among the landscape elements; the flows of species, energy, and materials; and the ecological dynamics of the landscape mosaic. Thus, an understanding of the whole—landscape ecology with its practical tools for scholars, citizens, and decision makers—emerges.

Since the beginning of time, humans have studied the Earth and its processes. We've taken it apart, assigned theories of explanation, examined the pieces, dissected the parts, and given them scientific names. It is only recently that we

have begun to realize and recognize the interconnected unity of our planet. As John Muir said decades ago: "When we try to pick out anything by itself, we find it hitched to everything else in the Universe."

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