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INSTITUTE OF SCIENCE AND TECHNOLOGY
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SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

UNIT – I – LANDSCAPE ECOLOGY– SARA7331

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF ARCHITECTURE

COURSE MATERIAL

Subject Name: Sustainable Landscape Planning **UNIT I** **SUBJECT CODE: SARA7331**

Overview

Introduction to Landscape, Landscape Planning, Ecology and Landscape Ecology

There are several definitions of landscape from **different cultural and scientific approaches:**

"the total character of a region" (Von Humboldt);

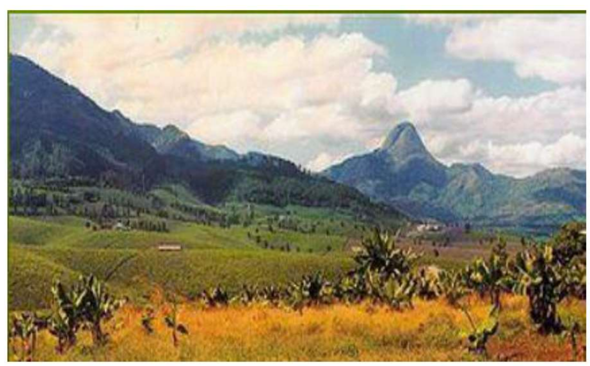
"A piece of land which we perceive comprehensively around us, without looking closely at single components, and which looks familiar to us" Haber (2004)".

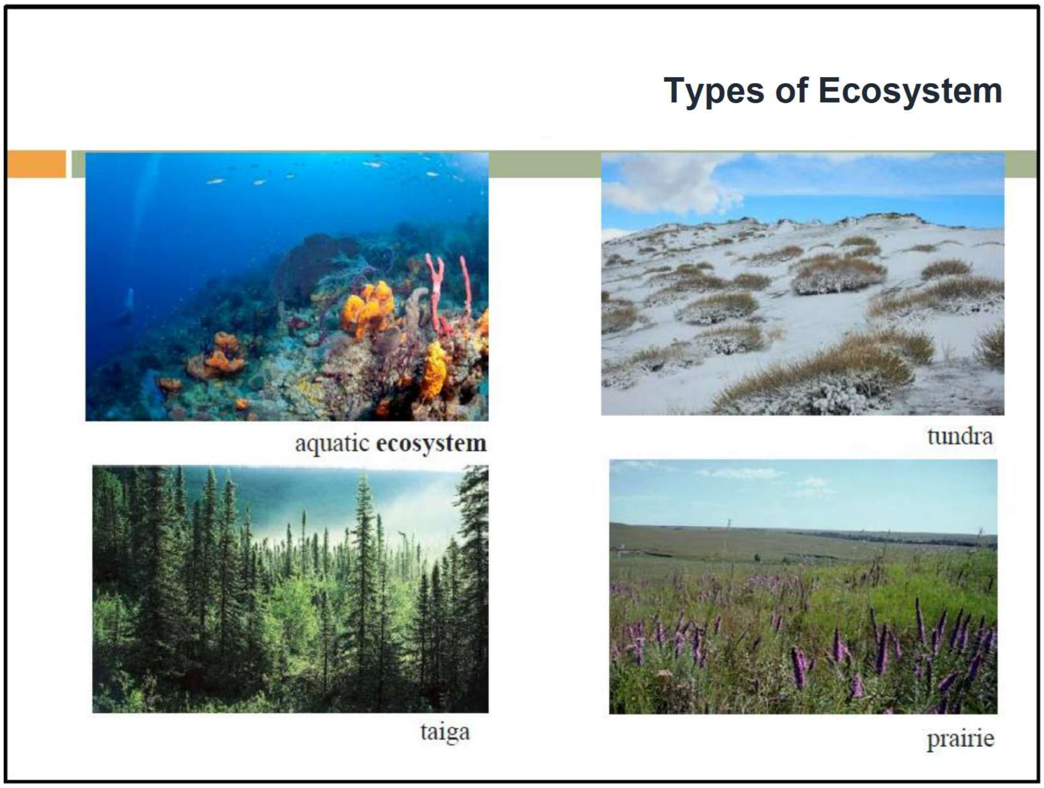
Terms Explanation:

"**Landscape** is a heterogeneous area composed of a cluster of interacting ecosystems (Forman&Godron,1986)

An ecosystem is a community of living organisms in conjunction with the non-living components of their environment ,interacting as a system. These biotic and abiotic components are linked together through nutrient cycles and energy flows.

Landscapes include physical, ecological and geographical entities, integrating all natural and human ("caused") patterns and processes (Naveh1987);





Major types of Ecosystem:

Human ecosystem, marine ecosystem, rainforest, savanna, steppe, urban ecosystem and others.

Landscape planning:

- Concerned with developing landscaping amongst competing land uses while protecting natural processes and significant cultural and natural resources.
- Park systems and greenways of the type designed by Frederick Law Olmsted are key examples of landscape planning.
- Landscape Planning is closely related with physical planning, which aims to optimize the distribution and allocation of land, often in a space-limited context *(Van Lier 1998; BotequilhaLeitão2001*).
- Prescribes alternative spatial configurations of land uses, which is widely understood as a key factor in planning for sustainability. (Jack Ahern, 2005).
- Successful planning needs to consider the following three elements:
  - (i) the structure and dynamics of landscapes and how these develop;
  - (ii) the values associated with landscapes and landscape developments; and
  - (iii) the governance structure for steering landscape developments.

- Landscape Planning is defined as an activity concerned with reconciling competing land uses while protecting natural processes and significant cultural and natural resources (ErvZube).
- Landscape planning is concerned with the macro environment of land use and planning activity dealing with landscape features, processes, and systems(Marsh, 1998).
- Landscape planning projects
  (i) are of broad geographical scope;
  (ii) concern many land uses or many clients;
  (iii) are implemented over a long period of time.

Pioneers in Landscape Planning briefly explained:
Ian McHarg

Ian McHarg (1920-2001) achieved numerous accomplishments in the field of landscape architecture and urban planning and was one of the true pioneers of the environmental movement

 Author of “*Design with nature”*

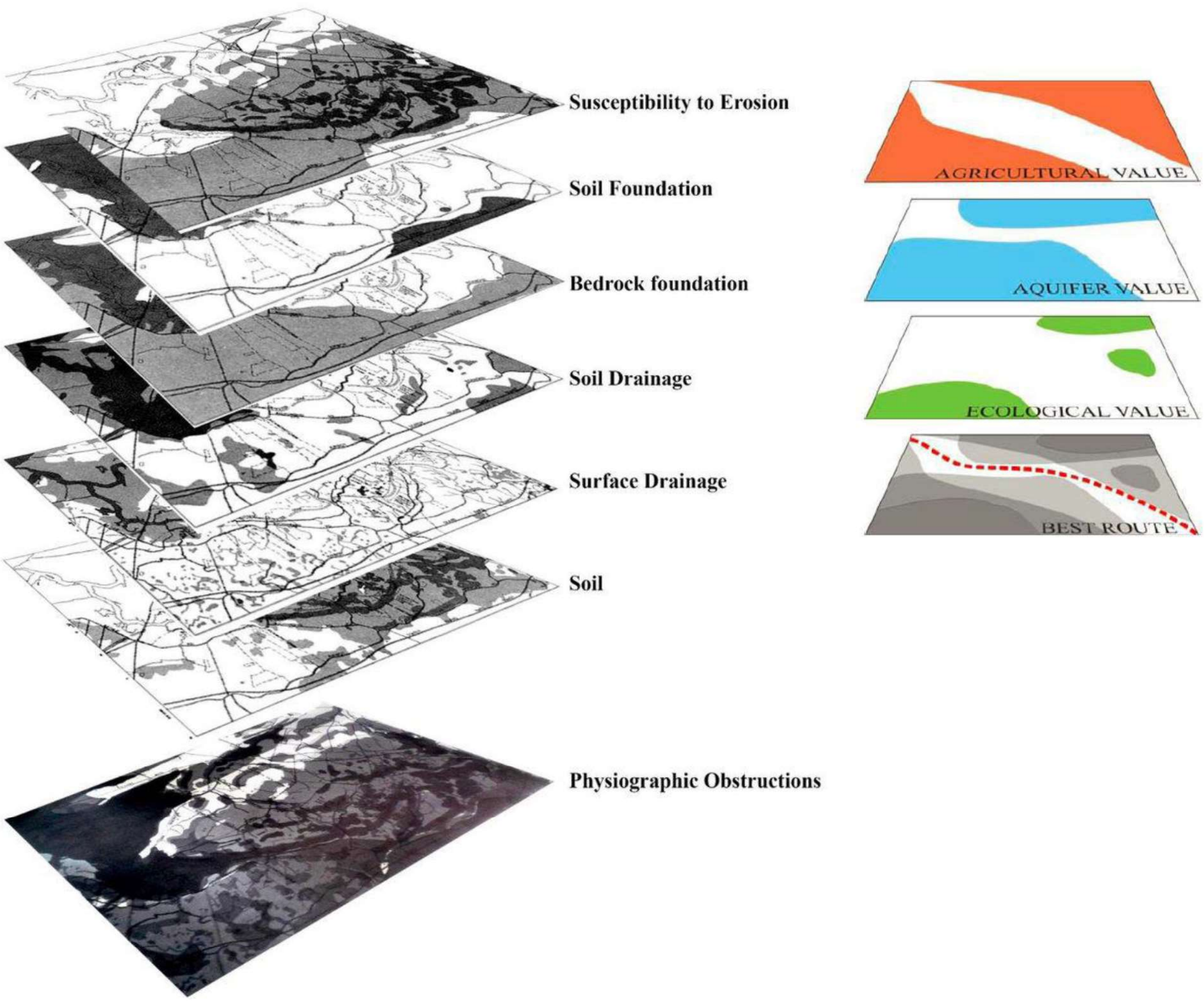
 Suitability Analysis

 Nature is process and value exhibiting both opportunities and constraints for human use.

McHarg’s firm was commissioned in 1968 by the New York City Parks Department to determine an alignment that would result in the “least social cost”. In order to determine an appropriate route, McHarg first considered a number of factors that would affect “social values”.
These factors included the following:
● Slope ● Surface drainage ● Soil drainage ● Bedrock foundation ● Soil foundation ● Erosion susceptibility ● Land values ● Tidal inundation ● Historic values ● Scenic values ● Forest values ● Water values (lakes, ponds, streams, etc.) ● Recreation values ● Wildlife values ● Residential values ● Institutional values
After these sixteen important factors were identified, McHarg developed an approach using map overlay analysis. Each characteristic was mapped on its own transparency and three different tones of shading were utilized, ranging from the darkest for the

greatest amount of value or cost to the lightest for least value or cost. Then by overlaying the transparencies into a single stack the optimal location for routing the parkway that would result in the least social cost was revealed. The results revealed that the current planned routing for the parkway in fact cut through some of the most valuable land from a social cost perspective and would destroy important scenic, recreational and wildlife resources on the island.
McHarg's solution was an alternative routing through an area to the west of the greenbelt, saving valuable forest and parkland.

Overlay Analysis:



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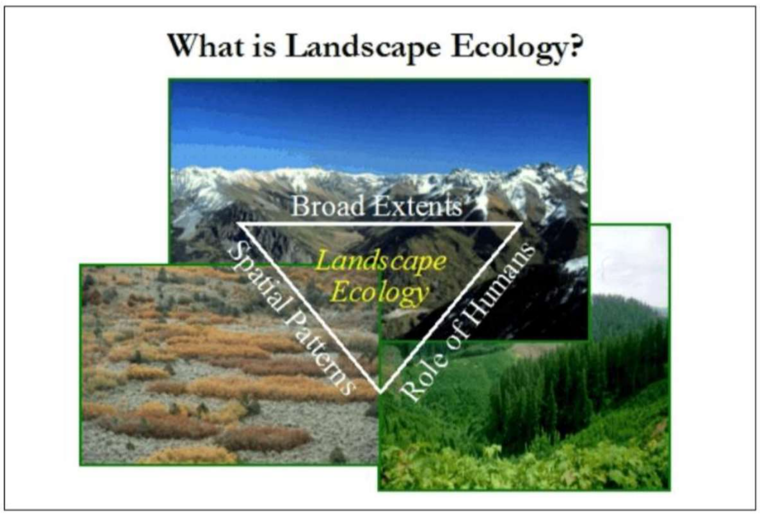
LANDSCAPE ECOLOGY:

Introduction to what is landscape ecology?



Landscape ecology, as the name implies, is the study of landscapes; specifically, the composition, structure and function of landscapes. But what's a 'landscape'? Although there are myriad ways to define 'landscape' depending on the phenomenon under consideration, suffice it to say that a landscape is not necessarily defined by its size; rather, it is defined by an interacting mosaic of elements (e.g., ecosystems) relevant to some phenomenon under consideration (at any scale). Thus, a landscape is simply an area of land (at any scale) containing an interesting pattern that affects and is affected by an ecological process of interest. Landscape ecology, then, involves the study of these landscape patterns, the interactions among the elements of this pattern, and how these patterns and interactions change over time. In addition, landscape ecology involves the application of these principles in the formulation and solving of real-world problems.

 Landscape ecology is the study of the causes and ecological consequences of **spatial pattern in landscapes.**

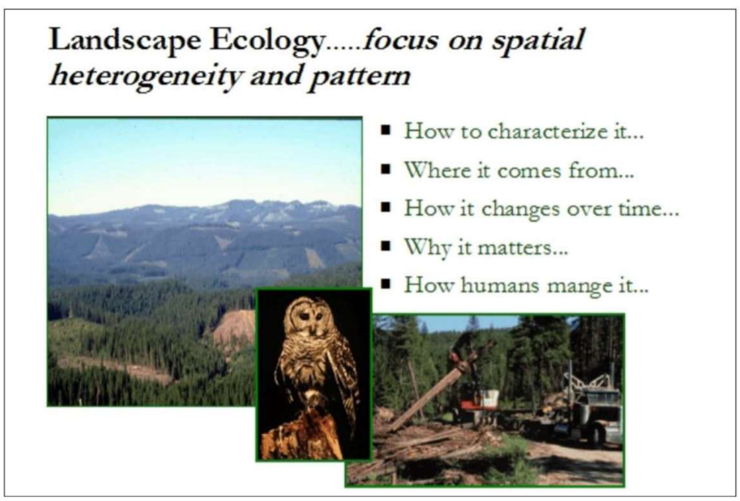
 Landscape ecology is the study of **structure, function, and change in a heterogeneous land area** composed of interacting ecosystems.

Landscape Ecology-Explanation further

Earl N. Troll (1939), a geologist, coined the term 'Landscape Ecology'

- A marriage of ecology and geography and study of how ecosystems are arranged spatially and how this arrangement affects biotic and abiotic components and processes
- Integrated discipline that incorporates the knowledge of ecological systems at all levels to address large-scale issues of ecology, and land use / land planning
- Landscape ecology can be portrayed by several of its core themes; **the spatial pattern or structure of landscape**s, ranging from wilderness to cities, **the relationship between pattern and process** in landscapes, the **relationship of human activity** to landscape pattern, process and change, the **effect of scale and disturbance** on the landscape.

The conceptual and theoretical core of landscape ecology links natural sciences with related human disciplines



Landscape ecology is perhaps best distinguished by its **focus on:**

1) spatial heterogeneity,

2) broader spatial extents than those traditionally studied in ecology, and

3) the role of humans in creating and affecting landscape patterns and process.

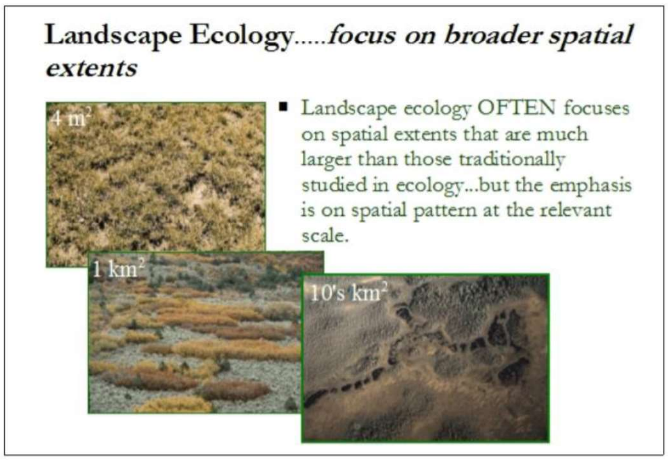
Spatial Heterogeneity:

Landscape ecology might be defined best by its focus on spatial heterogeneity and pattern: how to characterize it, where it comes from, how it changes through time, why it matters, and how humans manage it.

As such, landscape ecology has five central themes: • Detecting pattern and the scale at which it is expressed, and summarizing it quantitatively • Identifying and describing the agents of pattern formation, which include the physical abiotic template, demographic responses to this template, and disturbance regimes overlaid on these. • Characterizing the changes in pattern and process over space and time; that is, the dynamics of the landscape, and summarizing it quantitatively. An interest in landscape dynamics necessarily invokes models of some sort--because landscape is large and they change over time scales that are difficult to embrace empirically • Understanding the ecological implications of pattern; that is, why it matters to populations, communities, and ecosystems – and this is the stuff of conservation biology and ecosystem management. • Managing landscapes to achieve human objectives.

Broad Spatial Extents:

Landscape ecology is distinguished by its focus on broader spatial extents than those traditionally studied in ecology. This stems from the anthropocentric origins of the discipline (see below). Initial impetus for the discipline came from the geographers aerial view of the environment, for example, the patterns in the environment visible from an aerial photograph.



The focus on large geographic areas is consistent with how humans typically see the world– through a coarse lens. However, modern landscape ecology does not define, a priori, specific scales that may be universally applied; rather, the emphasis is to identify scales that best characterize relationships between spatial heterogeneity and the process of interest.

The Role of Humans

Landscape ecology is often defined by it focus on the role of humans in creating and affecting landscape patterns and process.

Indeed, landscape ecology is sometimes considered to be an interdisciplinary science dealing with the interrelation between human society and its living environment. Hence, a great deal of landscape ecology deals with 'built' environments, where humans are the dominant force of landscape change. However, modern landscape ecology, with 2 its emphasis on the interplay between spatial heterogeneity and ecological process, considers humans as one of many important agents affecting landscapes, and emphasizes both natural, semi-natural, and built landscapes.

The Emergence of Landscape Ecology:

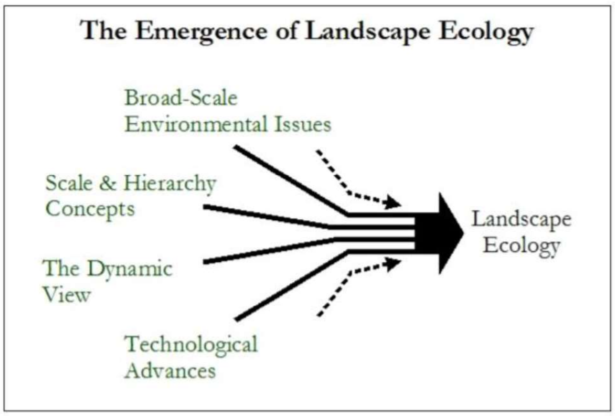
The emergence of landscape ecology as a prominent subdiscipline of ecology in the early 1980's can be traced to a number of factors:

1) growing awareness of broadscale environmental issues requiring a landscape perspective,

2) increasing recognition of the importance of scale in studying and managing pattern-process relationships,

3) emergence of the dynamic view of ecosystems/landscapes

4) technological advances in remote sensing, computer hardware and software



Broad-scale environmental issues

Unrelenting demand for more and more commodities and services from global ecosystems has led to numerous ecological crises. Staggering losses of topsoil each year from many of America's farmlands demonstrate that these ecosystems are being exploited. Failure of certain tropical humid forests to rebound after clearcutting dramatically illustrates their vulnerability to radical disturbance. Equally compelling evidence of ecosystem limits is seen in the altered flooding regimes, increased suspended loads, chemical contamination, and community structure changes in virtually every temperate river in the world. The degradation of Earth's ecosystems is further signaled by the unprecedented decline of thousands of species, many of which have become extinct. Many of these crises are the result of cumulative impacts of land use changes occurring over broad spatial scales (i.e., landscapes). Questions of how to manage populations of native plants and animals over large areas as land use or climate changes, how to mediate the effects of habitat fragmentation or loss, how to plan for human settlement in areas that experience a particular natural disturbance regime, and how to reduce the deleterious effects of nonpoint source pollution in aquatic ecosystems all demand basic understanding and management solutions at landscape scales.

Why do we need to study landscape Ecology?

Landscape ecology (or a landscape perspective) with its focus on spatial patterns is important, because:
1)ecosystem context matters,
2)ecosystem function depends on the interplay of pattern and process, and
3)because human activities can dramatically alter landscape context and the relationship between patterns and processes, planners and resource managers have a stewardship responsibility to understand and manage these impacts and to include a landscape perspective in resource management decisions.

Landscapes and regions are made up of groups of distinct terrestrial and aquatic ecosystems that interact with one another.

- The ecological dynamics between the different patches within these broad scales often are driven by geomorphology (landforms),climate, and changes in land use that surround and contain the area under investigation or separate one patch from another within it.
- At local scales, topographic, hydrologic, and soil patterns, as well as biological interactions (e.g., competition, predation, and grazing), become important causes and drivers of dynamics.

Why is landscape ecology important to resource managers?

Landscape ecology (or a landscape perspective) with its focus on spatial patterns is important to resource managers because:

1) ecosystem context matters,

2) ecosystem function depends on the interplay of pattern and process, and

3) because human activities can dramatically alter landscape context and the relationship between patterns and processes,

Resource managers have a stewardship responsibility to understand and manage these impacts – more pragmatically, resource managers have a policy and legal mandate to include a landscape perspective in resource management decisions. # Because ecosystem context matters Landscape ecology is founded on the principle that ecosystem composition, structure and function partially depend on the spatial (and temporal) context of the ecosystem (i.e., its landscape context); i.e., that what we observe ecologically at any particular location is affected by what is around that location. This shift in perspective from the site to the site embedded in a landscape context has profound implications for resource management. Let's consider a couple of examples:

• Metapopulations.–Metapopulation s depend on the number and spatial arrangement of habitat patches – where the probability of a habitat patch being occupied at any time is at least partially dependent on its proximity to other habitat patches. Focusing 6 management on the individual site, in this case, without consideration of its landscape context, can have disastrous consequences for the population.

• Forest succession.–Neighborhood effects can play an important role in determining the successional response following a disturbance. For example, edge effects that modify the distribution of energy and water and the plant species composition of the immediate neighborhood (which can influence the relative abundance of propagules) can exert a strong influence on succession in forest gaps and in larger openings, e.g., via wave-form succession. Ignoring these effects can lead to undesirable outcomes, including an unwanted shift in species composition or an inadequate recovery of vegetation altogether. # Because ecosystem function depends on the interplay of pattern and process Landscape ecology is also founded on the principle that spatial patterns affect ecological processes, which in turn affect spatial patterns. This interplay of spatial pattern and process is in fact the overarching focus of landscape ecology. While it can be argued that "ecology" has always sought to explain the relationship between pattern and process, it is safe to assert that "landscape" ecology has shifted the focus to pattern-process relationships over broad spatial extents and emphasized the role of humans in creating and affecting these relationships. This shift has profound implications for resource managers. Let's consider a couple of examples:

• Habitat fragmentation. –Disruption of habitat connectivity is a major impact of human activities on plant and animal populations and one of the leading causes of the biodiversity crisis. Anthropogenic landscape elements (e.g., roads, developed land, dams) can function as impediments to the movement of organisms across the landscape, and the cumulative impacts of these impediments over broad spatial extents can be devastating.

• Alteration of disturbance regimes.–Disruption of natural disturbance regimes has longlasting ecological and socioeconomic impacts. For example, disruption of fuel mass and continuity by human land use practices (e.g., livestock grazing) over broad spatial extents can dramatically alter fire regimes in fire-dependent ecosystems, leading to shifts species distributions and community structure and serious socio-economic consequences (e.g., catastrophic fires resulting in loss of life and property).

All federal land management agencies have formally adopted “ecosystem management” as the overarching resource management paradigm, and a landscape perspective (and all that it subsumes) is one of the pillars of the ecosystem management approach.

Landscape structure/ Pattern

Landscape structure is defined as a combination of elements, their location and mutual relations. Landscape structure expresses the spatial pattern of landscape elements and the connections between the different ecosystems or landscape elements.

The structure of a landscape is defined by the particular spatial pattern being represented, and it consists of two components:

(i) Composition

(ii) Configuration

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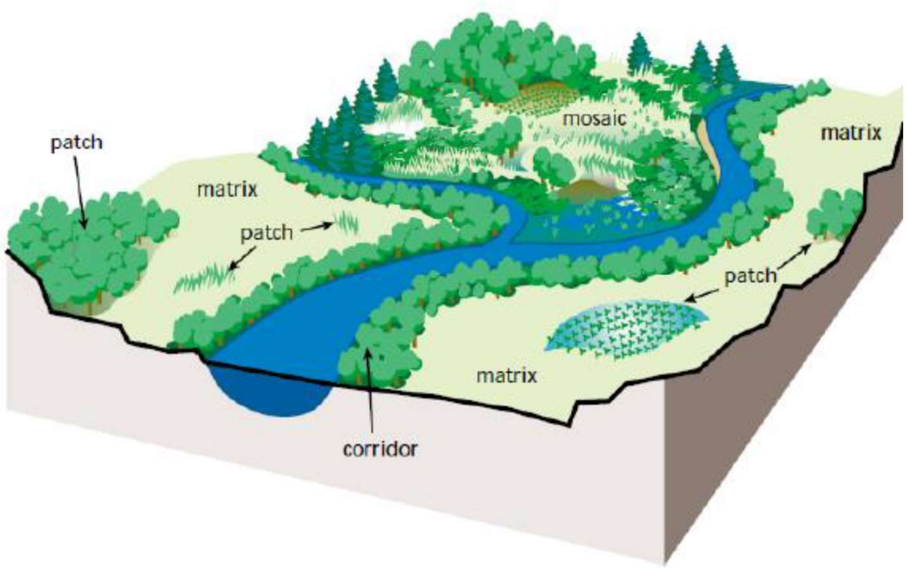
LANDSCAPE MOSAICS: PATCHES, CORRIDORS, AND CONNECTIVITY

Landscape Mosaics

Landscape mosaics are described by the landscape components of patches, corridors, and the surrounding matrix (Forman and Godron 1984, Turner et al 1987). Patches, corridors and matrix directly influence the spatial patterning and flows in a landscape. Spatial scale also greatly affects landscape structure, heterogeneity, and connectivity.

Landscape structure is determined by the flow of materials, animals, energy, and water through the landscape elements of patches, corridors, and matrix. Factors such as patch size and shape, corridor characteristics, and connectivity work together to determine the pattern and process of the landscape. The correlation between pattern and process results in an interdependency between landscape structure and function. Landscape patterns influence process, which in turn affect the patterns. The feedback between structure and function is evident in the landscape in the world around us (Forman 1995). For example, a vegetated patch may prevent soil erosion, which in turn allows vegetation to continue growing in that area.

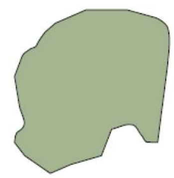


Patches

In landscape ecology, patches are spatial units at the landscape scale. Patches are areas surrounded by matrix, and may be connected by corridors. The geomorphology of the land interacting with climate factors, along with the other factors such as the establishment of flora and fauna, soil development, natural disturbances, and human influences work to determine patch size, shape, location, and orientation (Forman and Godron 1984). The size, shape, and nature of the edge are particularly important patch characteristics (Forman and Godron 1984).

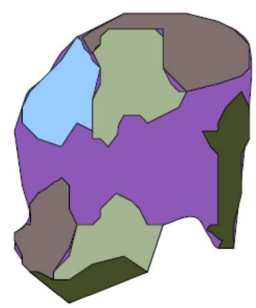
Some of the more common patches found in landscapes are fields, clearings, woods, and house clearings (Cantwell and Forman 1993). Most common configurations in landscapes are 1) a matrix or large landscape patch surrounding or adjacent to many patches; 2) a corridor bisecting the landscape; and, 3) the unit formed by a network of interacting corridors (Cantwell and Forman 1993).

Patch, a term fundamental to landscape ecology

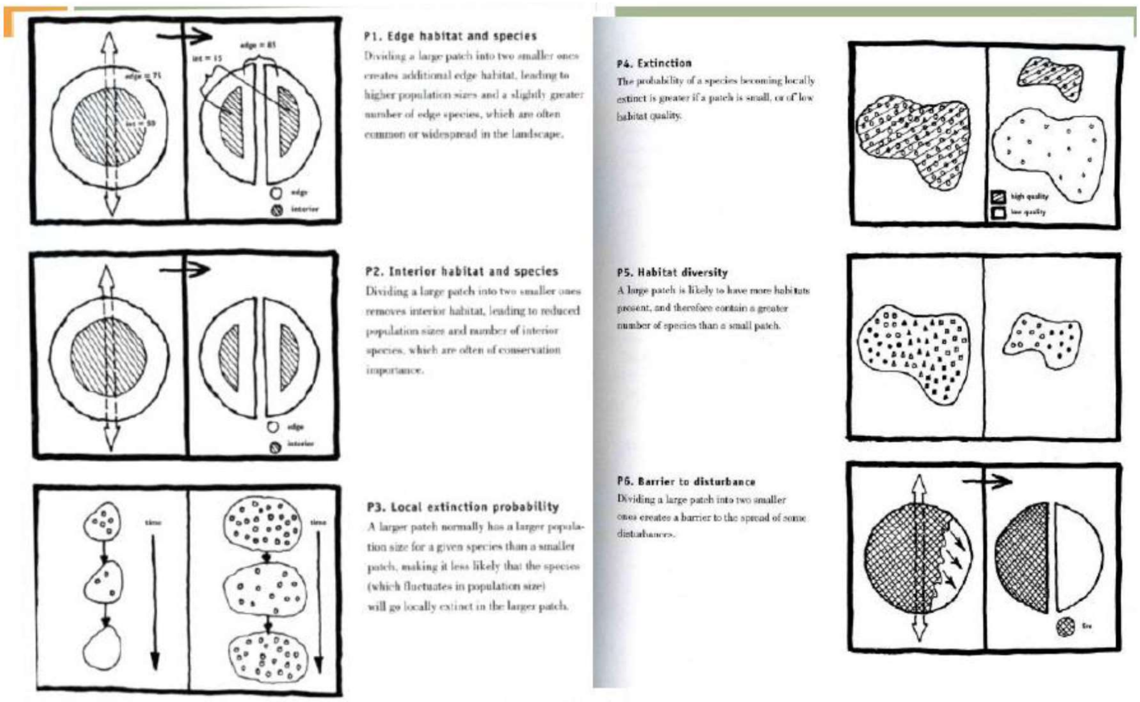


□Defined as a relatively homogeneous area that differs from its surroundings.

□Patches are the basic unit of the landscape that change and fluctuate, a process called *patch dynamics*.



□Patches have a definite shape and spatial configuration, and can be described compositionally by internal variables such as number of trees, number of tree species, height of trees, or other similar measurements.



P1. Edge habitat and species
Dividing a large patch into two smaller ones creates additional edge habitat, leading to higher population sizes and a slightly greater number of edge species, which are often common or widespread in the landscape.

P2. Interior habitat and species
Dividing a large patch into two smaller ones removes interior habitat, leading to reduced population sizes and number of interior species, which are often of conservation importance.

P3. Local extinction probability
A larger patch normally has a larger population size for a given species than a smaller patch, making it less likely that the species (which fluctuates in population size) will go locally extinct in the larger patch.

P4. Extinction
The probability of a species becoming locally extinct is greater if a patch is small, or of low habitat quality.

P5. Habitat diversity
A large patch is likely to have more habitats present, and therefore contain a greater number of species than a small patch.

P6. Barrier to disturbance
Dividing a large patch into two smaller ones creates a barrier to the spread of some disturbances.

Corridors

Corridors are elongated patches that connect other patches together. Many different kinds of corridors can be found in landscape. They can vary from wide to narrow, high to low connectivity, and meandering to straight (Forman 1995). These variables influence the role that corridors play in landscape patterns and processes. Corridors frequently form interconnected networks across the landscape, such as road systems and hedgerow networks (Cantwell and Forman 1993).

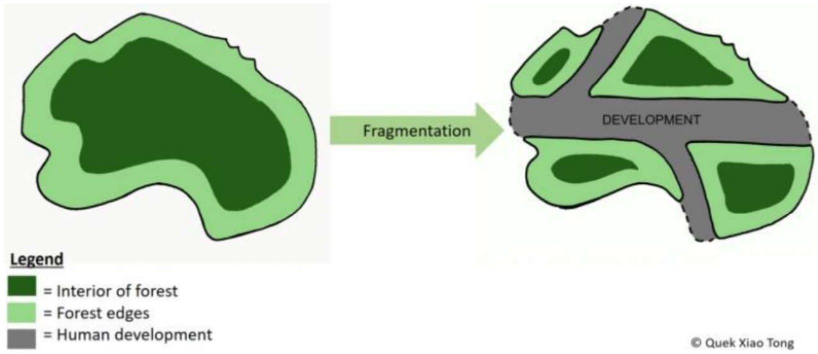
Elongated Patches that connect other patches together

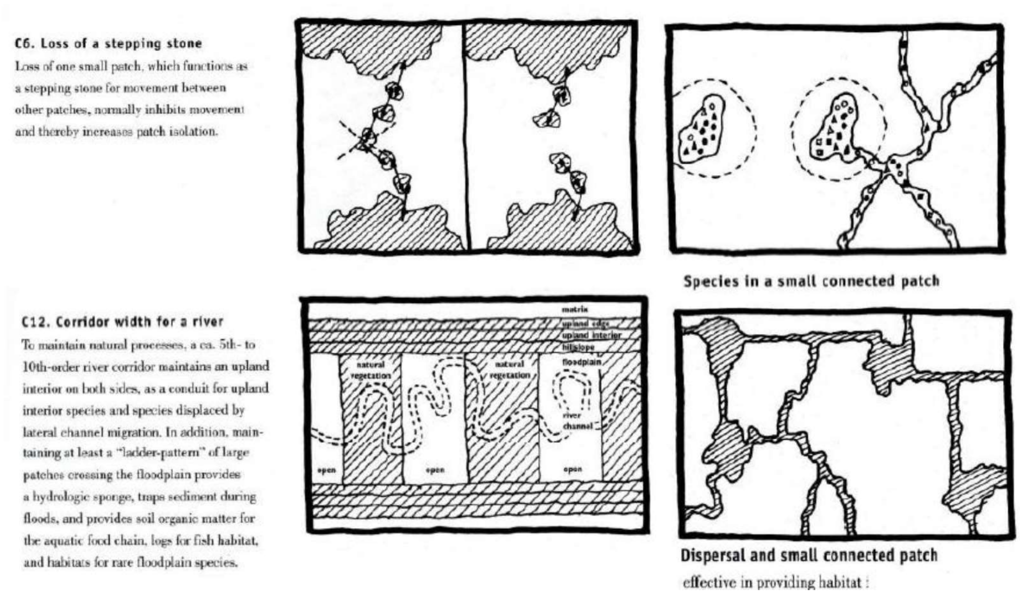
- **Corridors** frequently form **interconnected networks** across the landscape

- The loss and isolation of habitat is seemingly unstoppable process throughout the modern world.

- Key spatial processes that cause this;

- Fragmentation(breaking), dissection(splitting an intact habitat), perforation (creating holes), shrinkage (decrease in size) and attrition (disappearance)





Matrix

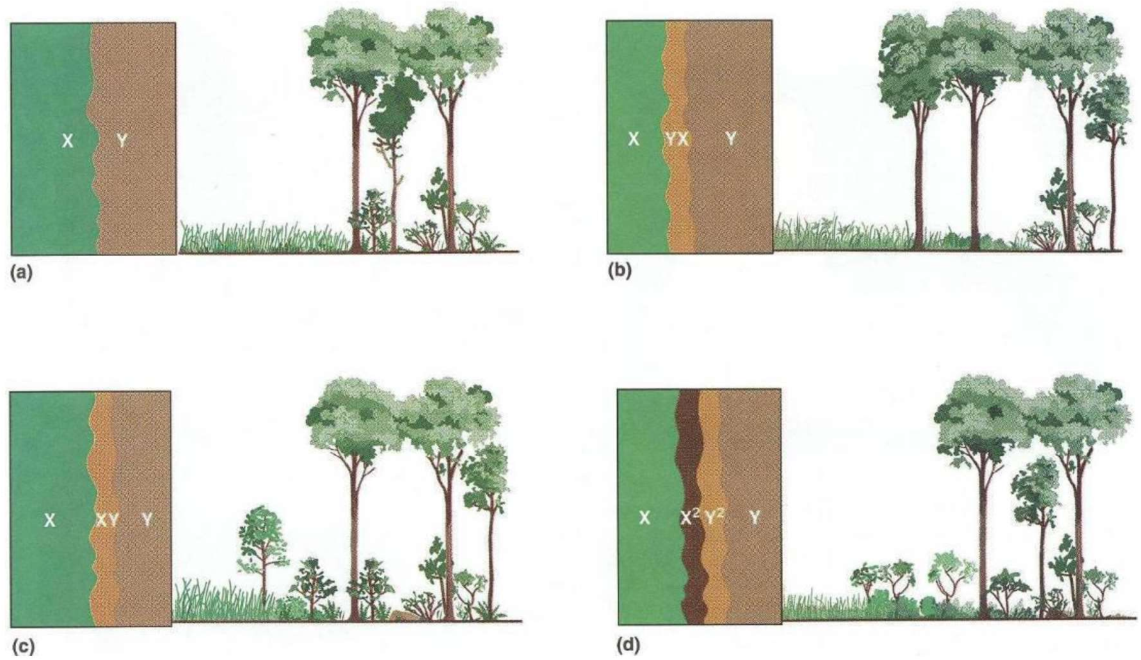
Patches and corridors are imbedded in the matrix, which is usually the most extensive and connected landscape element present. However, the matrix may play a dominant role in the functioning of the landscape without being the most extensive landscape element. Determining what is the matrix in a landscape depends on either connectivity, dominance, or function. Each landscape should be evaluated individually.

Edges

All patches have edges

□Edges have abiotic environments that are different from the interior of a patch
→differences in biota & processes

□The larger a patch, the more interior (core) it contains



The Importance of Scale

Landscapes are dynamic systems which occur in a spatiotemporal dimension. Issues of scale become important as we attempt to interpret the landscape. Ecological systems are scale dependent and understanding their spatial configurations is central to understanding the ecology of landscapes (Forman 1993).

How we view the heterogeneity of a landscape is often very different from how an organism utilizes mosaic of patches, corridors and matrices. The dynamics of a landscape is the flux of energy, materials, nutrients, and species among the components. Pattern, generated by processes at various scales creates the mosaic of a landscape (Urban et al 1987).

Heterogeneity

Landscapes vary greatly in their degree of heterogeneity. Factors which influence heterogeneity are aggregation, contrast and porosity. Aggregation is the degree to which patches are clumped together. Contrast refers to the diversity of patches, patch richness, number of patches, evenness (lack of dominance of one patch type.) Measures of heterogeneity must include the vertical and horizontal structure of landscapes. The degree of heterogeneity in a landscape plays a crucial role in determining the distribution and the habitat use by organism, as well as the abiotic functioning of the landscape.

Scale

The scale at which we view the system determines the degree of heterogeneity which we are able to see. Scale of landscapes can be defined in terms of grain and extent. The grain of the landscape is measured by the average diameter or area of all patches present (Forman and Godron 1986). Extent is the overall area encompassed by the observation.

Characteristics of small ecological systems differ a great deal from broad scaled systems. These differences affect how we perceive the system. Fine scale studies may reveal greater detail about processes which underlie the pattern, however the dynamics of a system are more likely to be revealed at broad scales (Wiens 1989). It is necessary therefore to take a multiscale perspective when observing a system.

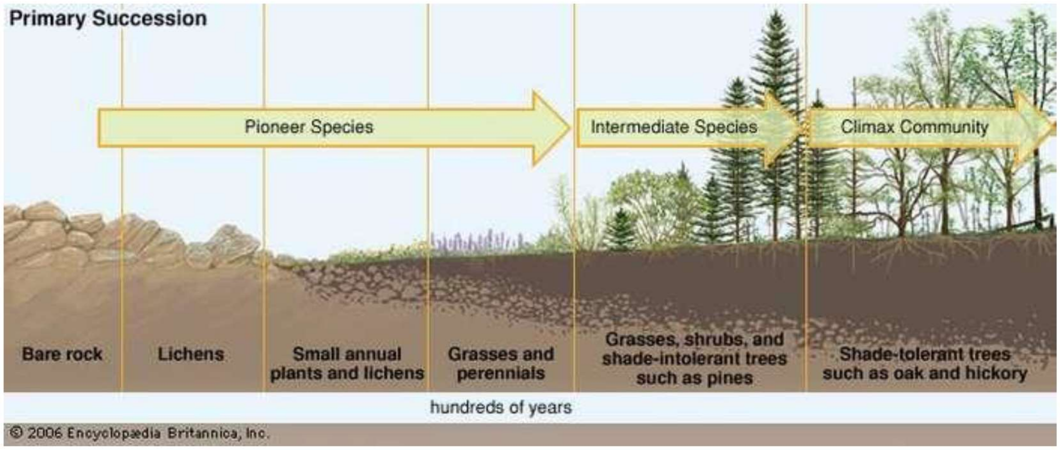
Observing at a small scale may excuse important patterns and processes which have important consequences on the dynamics of the system. Small scales of observations tend to have fast rate of processes or systems change. They have a high probability of system openness and there will be a large effect of individual movements on the patterns. The factors which influence species distribution are resource, habitat, distribution and physiological tolerances. There will be a high resolution of detail and a low potential for deriving generalizations. In contrast, broad scale observations involve much slower rates of process or system change. There is a low chance for system openness and individual movements will have a low effect on the patterns of the system. The factors which influence species distribution are barriers and dispersal. Broad scales have a low resolution of detail, but a much greater ability to derive generalizations.

Choosing the scale at which one should observe the landscape will depend on the question at hand. Landscape are dynamic mosaics that change over time. Seemingly chaotic processes at one scale may be evidence of process or pattern when viewed at a larger scale. How we view a system of patches and corridors may be very different from how an organism utilizes the patches and corridors within the landscape. Reconciling the differences in scale relationships is necessary in order to gain an understanding of the landscape dynamic. An exploration of several scales in which grain and extent are varied systematically and independent of each other provides an opportunity to resolve domains, patterns, and processes which interact to form the landscape.

Plant Succession

Succession is a directional non seasonal cumulative change in the types of **plant** species that occupy a given area through time.

It involves the processes of colonization, establishment, and extinction which action the participating **plant** species



Primary succession begins in barren areas, such as on bare rock exposed by a retreating glacier. The first inhabitants are lichens or plants—those that can survive in such an environment. Over hundreds of years these “pioneer species” convert the rock into soil that can support simple plants such as grasses. These grasses further modify the soil, which is then colonized by other types of plants. Each successive stage modifies the habitat by altering the amount of shade and the composition of the soil. The final stage of succession is a climax community, which is a very stable stage that can endure for hundreds of years.

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Landforms

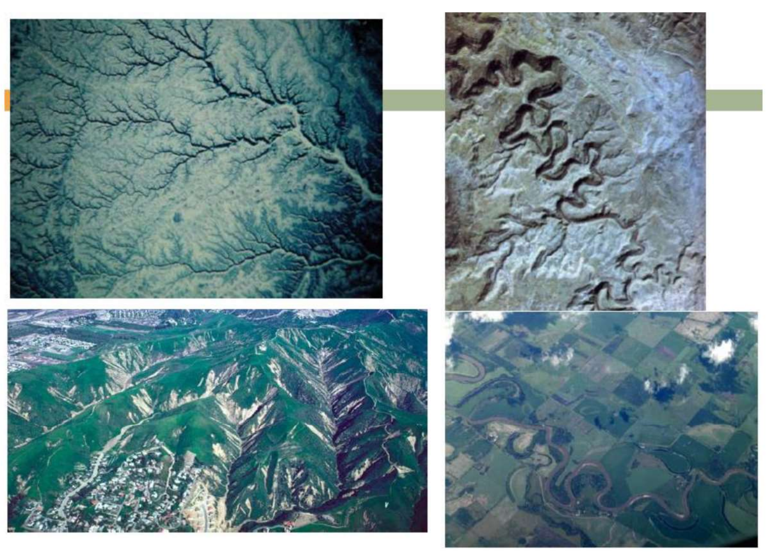
Landform gradient can deliver water to wildlife or act to constrain their mitigatory paths. A landform is a feature on the Earth's surface that is part of the terrain. Mountains, hills, plateaus, and plains are the four major types of landforms.

Minor landforms include buttes, canyons, valleys, and basins.

Appreciating the influence of landform and climate on soil, vegetation and wildlife is a path to gaining appreciation for landscape ecology

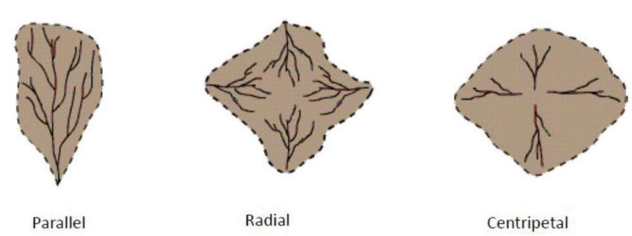
https://prezi.com/mqllxym4tqna/different-landforms-physical-processes/

The highest landform on Earth is a mountain: Mount Everest in Nepal. It measures 8,850 meters (29,035 feet) above sea level

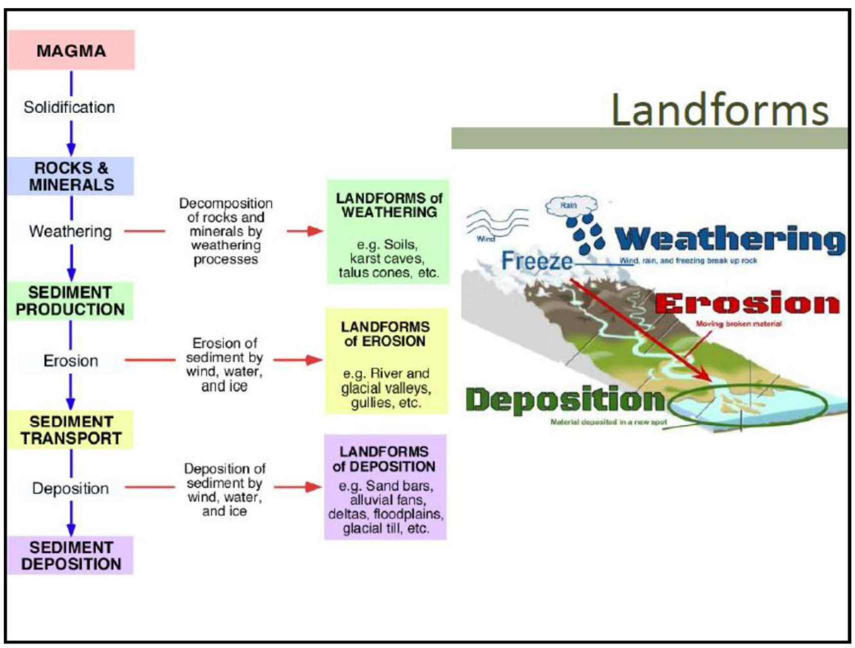


Drainage Pattern:

A **watershed** is the area of land where all of the water that is under it or drains off of it goes into the same place



The landforms that are found on the surface of the Earth can be grouped into 4 categories:
Structural Landforms-landforms that are created by massive earth movements due to plate tectonics. This includes landforms with some of the following geomorphic features: fold mountains, rift valleys, and volcanoes.
Weathering Landforms-landforms that are created by the physical or chemical decomposition of rock through weathering. Weathering produces landforms where rocks and sediments are decomposed and disintegrated. This includes landforms with some of the following geomorphic features: karst, patterned ground, and soil profiles.
Erosional Landforms-landforms formed from the removal of weathered and eroded surface materials by wind, water, glaciers, and gravity. This includes landforms with some of the following geomorphic features: river valleys, glacial valleys, and coastal cliffs.
Depositional Landforms-landforms formed from the deposition of weathered and eroded surface materials. On occasion, these deposits can be compressed, altered by pressure, heat and chemical processes to become sedimentary rocks. This includes landforms with some of the following geomorphic features: beaches, deltas, flood plains, and glacial moraines.
Many landforms show the influence of several of the above processes. We call these landforms polygenetic. Processes acting on landforms can also change over time, and a single landscape can undergo several cycles of development. We call this type landscape development polycyclic.



The lower spreading basin closest to the river are shown during both a dryer period on the left and following a heavy rainfall on the right illustrating the **site flexibility and multipurpose capacity**

Ecosystem services

The benefits people obtain from ecosystems include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth

The benefits people derive from ecosystems

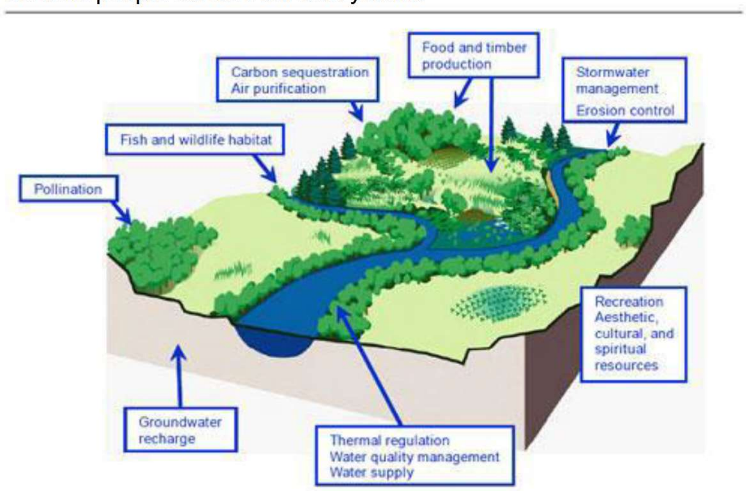


FIGURE 4-1
Examples of Ecosystem Services
City of Damascus Public Facilities Plan
CH2MHILL

http://ci.damascus.or.us/References/Misc/PFP%20Final.pdf

Provisioning Services

Products obtained from ecosystems

- Food
- Fresh water
- Fuelwood
- Fiber
- Biochemicals
- Genetic resources

Regulating Services

Benefits obtained from regulation of ecosystem processes

- Climate regulation
- Disease regulation
- Water regulation
- Water purification
- Pollination

Cultural Services

Nonmaterial benefits obtained from ecosystems

- Spiritual and religious
- Recreation and ecotourism
- Aesthetic
- Inspirational
- Educational
- Sense of place
- Cultural heritage

Supporting Services

Services necessary for the production of all other ecosystem services

- Soil formation
- Nutrient cycling
- Primary production

Provisioning services are: The products obtained from ecosystems, including, for example, genetic resources, food and fiber, and fresh water.

Regulating services are: The benefits obtained from the regulation of ecosystem processes, including, for example, the regulation of climate, water, and some human diseases.

Cultural services are: The non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience, including, e.g., knowledge systems, social relations, and aesthetic values.

Supporting services are: Ecosystem services that are necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.

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DEPARTMENT OF ARCHITECTURE

UNIT – II – LANDSCAPE PLANNING AND MANAGEMENT– SARA7331

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF ARCHITECTURE

COURSE MATERIAL

Subject Name: Sustainable Landscape Planning UNIT II SUBJECT CODE: SARA7331

Landscape Planning

Landscape planning is defined as an activity concerned with developing landscaping amongst competing landuses while protecting natural processes and significant cultural and natural resources.

American park system by Fredrick Law Olmstead

Main Scientific and Technical developments of Landscape design

Era	Science and Art	Technology	Tools
The analogue era (mid-19th century to mid-20th century)	• Frederick Law Olmsted Sr. (1822–1903): the father of American landscape architecture • Patrick Geddes (1854–1932): "survey-analysis-design" process • Warren Manning (1860–1938): map overlays method with light table • Frank Lloyd Wright (1867–1959): Fallingwater	• Large scope geological surveys • Remote sensing • Digital information and electronic computation	• Mainly by hand sketching • Map overlay method with light table
The poor data era (mid-20th century to 1970s)	• The awareness of environmental protection, e.g., Aldo Leopold, Rachel Carson, environmental laws and regulations • Ian McHarg's map-overly land suitability analysis	• The emergence of digital data and computer-based GIS	• Digital data and computed-based GIS were limitedly used due to a lack of digital data, low availability of mainframe computers
The small data era (1970s–2000)	• Ecological planning, Human ecological planning (Ian McHarg) • Ecological approach to landscape planning (Frederick Steiner) • Human ecosystematic design (John T. Lyle) • Landscape planning (Carl Steinitz)	• A variety of inventory and analysis techniques arose • Digital modeling and analysis methods were also advanced • Spatial operations allowed designers to **evaluate** land use suitability, landscape attractiveness, and vulnerability, **identify** land use conflicts, **forecast** population and urban growth, and **assess** the environmental and social impacts of proposed changes	• Data-driven analytical tools: GIS, remote sensing software • Idea-driven computer graphic tools: Auto-CAD, Photoshop, Illustrator, 3D Studio Max

Era	Science and Art	Technology	Tools
The big data era (2000 to present)	• Carl Steinitz's revised framework of landscape planning: three major iterations-understanding the study area-specifying methods-performing study • Sustainable landscape ecological planning, adaptive planning and design (Jack Ahern) • Land system architecture (B.L. Turner II) • Diagrammatic model to depict how to sustain ecosystem services for urban regions (Richard Forman and Jianguo Wu) • Pasteur's quadrant as an appealing ecophronetic alternative to the present research in ecosystem services (Weining Xiang)	• Information grow in volume, variety and velocity • Exponential growth in data requires novel approaches • Geospatial data has reached unprecedented resolution levels • Image processing methods have been advanced • Social networks and smart handheld devices equipped with GPS have been wide accepted	• Sub-meter level remote sensing scanners and cameras • Light Detection and Ranging (LiDAR) • Global Positioning System technologies • Idea-driven computer graphic tools: interactive drawing devices • Novel devices and modalities: additive manufacturing (3D-printers)

Ecological planning, landscape planning and sustainable landscape ecological planning all provided frameworks to help address the designing challenges to achieve the intended goals.
Among these design methods, sustainable landscape design is an adaptive process to understand flows of material, energy, and information through concerted ecological, economic, and social activities within and beyond the landscape scale
Source: Paper -Theories, methods and strategies for sustainable landscape planning, Jack Ahern

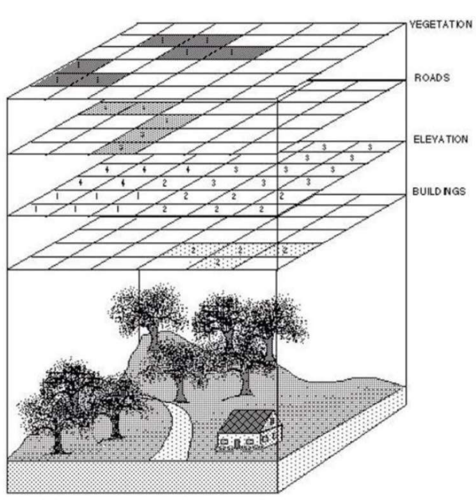
Ecological Planning Model
IAN MCHARG

Suitability Analysis(around1690) :Which used a transparent map overlay technique to find the most appropriate locations for human developments. This technique is the basis for much work in Environmental Planning today.

Superimposing layers of geographical data (e.g. environmental and social factors) so that their spatial intersection (relationships) can be used in making landuse decisions.

http://ratt.ced.berkeley.edu/tool_time/suitability_analysis/suitability_analysis.html

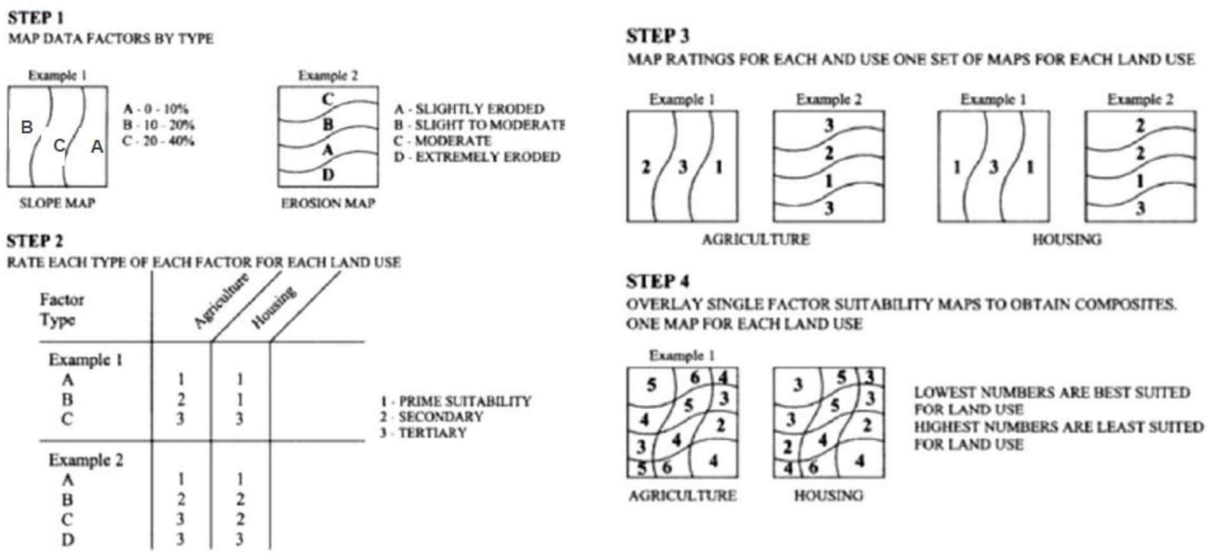
Suitability Model Logic & Suitability map and overlay



McHarg's method involved superimposing layers of geographical data (e.g. environmental and social factors) so that their spatial intersection (relationships) can be used in making land use decisions.

This core idea, McHarg's planning methodology, lead to the development of Geographic Information System (GIS) software tools. As a principal in a design firm (Wallace McHarg Roberts and Todd) his methods were oriented to landscape planning, design and development projects.

Procedure for Sutability Analysis



Ecological Planning Model

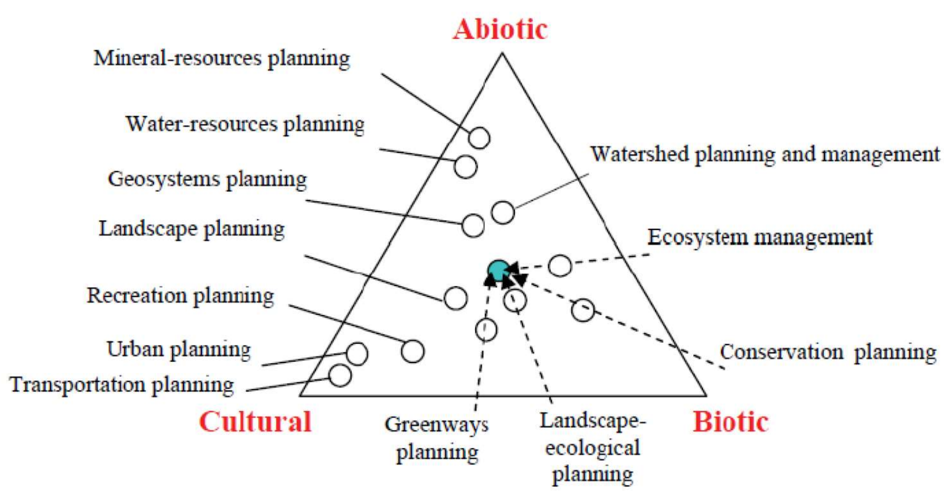
STEINER'S ECOLOGICAL PLANNING MODEL (1991;2000)

Multiple abiotic, biotic and cultural goals, with a focus on land-use allocation.

Studying the biophysical and socio-cultural systems of a place/ landscape to reveal where specific land-uses maybe be practiced.

It is based on IanMcHarg's Ecological Planning Method. The Ecological Planning Model includes an emphasis **on goal establishment, implementation, administration and public participation through systematic education and citizen involvement**. It can be considered transdisciplinary as it involves professionals, experts and citizens in a highly interactive process.

The framework is adaptable to multiple strategic contexts and it employs spatial concepts in the form of design explorations at a finer scale.



The challenge of sustainable development depends on a constant infusion of knowledge from scientific research and monitoring.
This expert knowledge is central to understanding the fundamental landscape pattern: process dynamic and must be integral to a landscape ecological planning process.
Scientists representing the abiotic, biotic, and cultural disciplines should be fully integrated with the planning method.

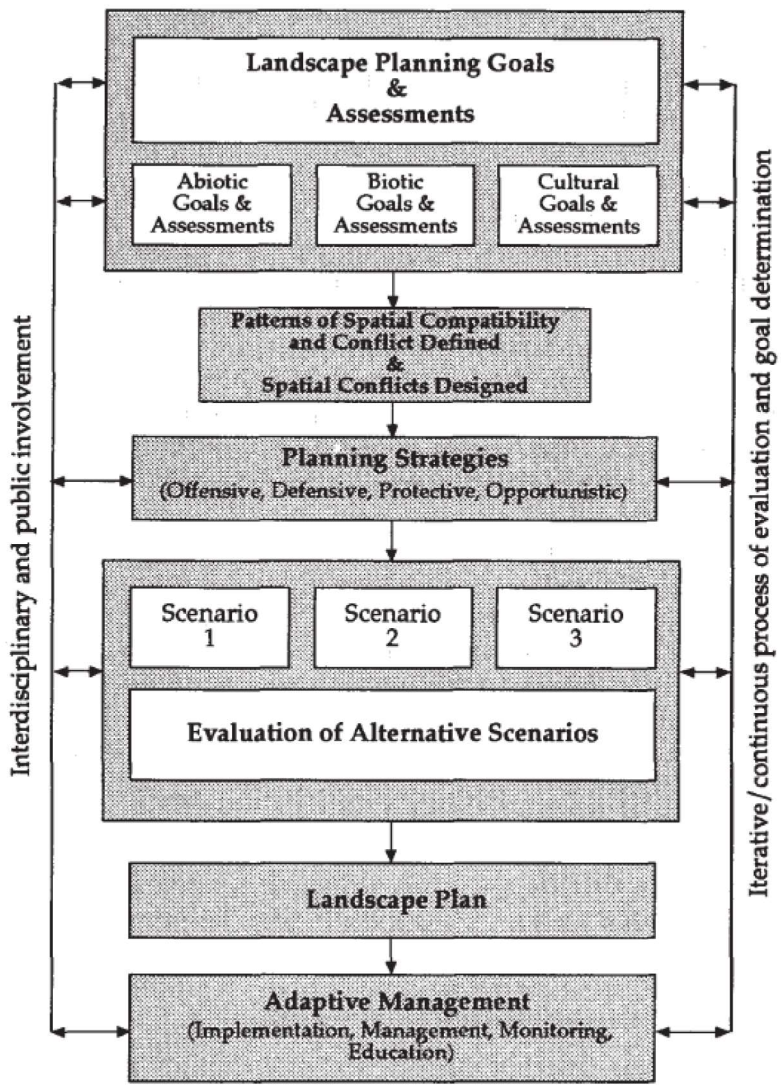
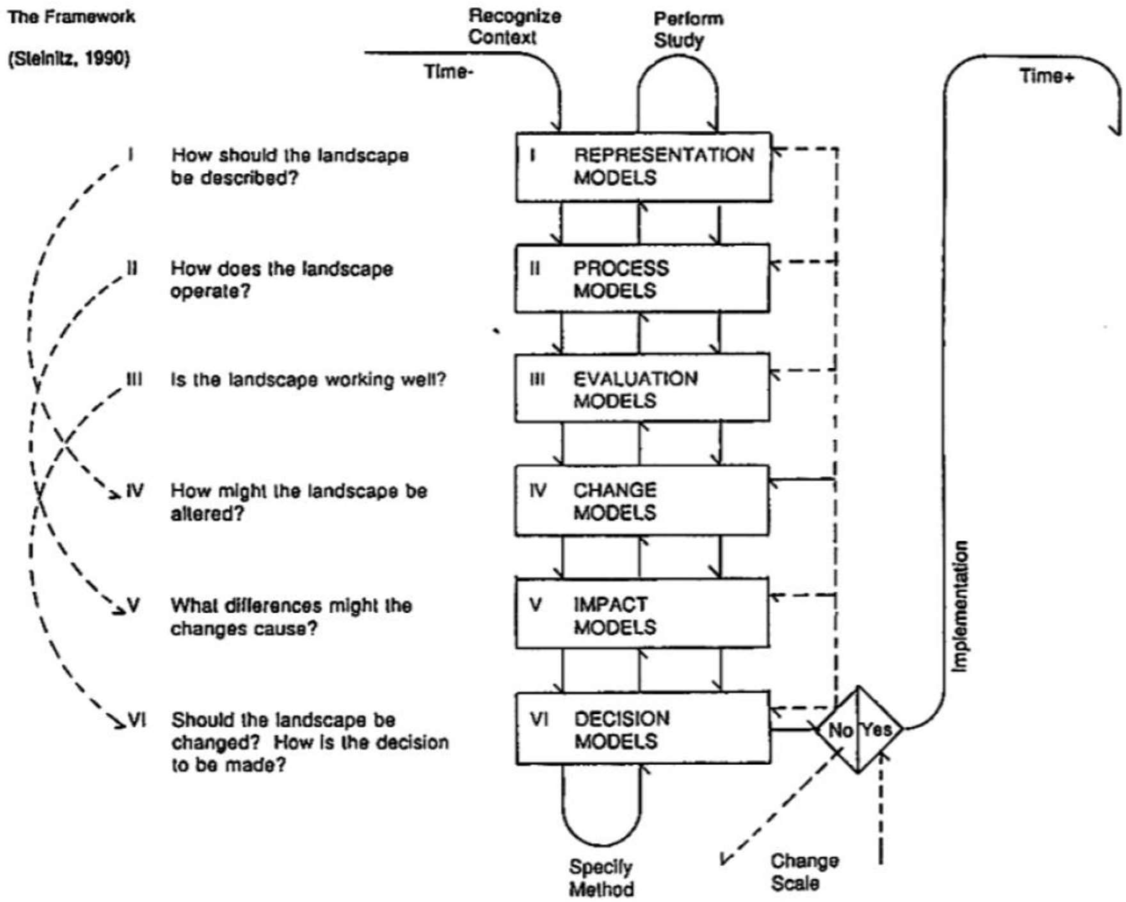


Figure shows: The frame-work method for landscape ecological planning a continuous, participatory and interdisciplinary process.

Frame-work method for Landscape planning by Stenitz



Landscape Planning Steinitz' Framework Method for Landscape Planning (1990; 1995) is presented as a series of six questions that are fundamental to landscape planning:

1.Representation: How should the state of the landscape be described in terms of content, boundaries, space and time?

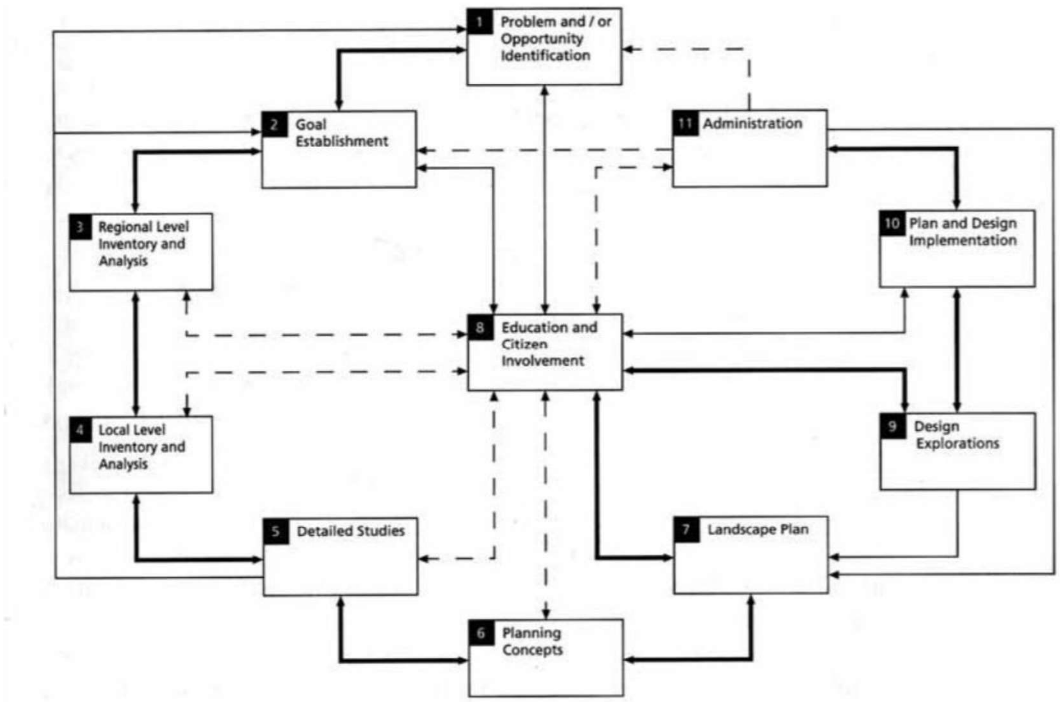
2.Process: How does the landscape work? What are the functional and structural relationships among its elements?

3.Evaluation: How does one judge whether the current state of the landscape is working well? The metrics of judgment include: beauty, habitat diversity, cost, nutrient flow, public health or user satisfaction.

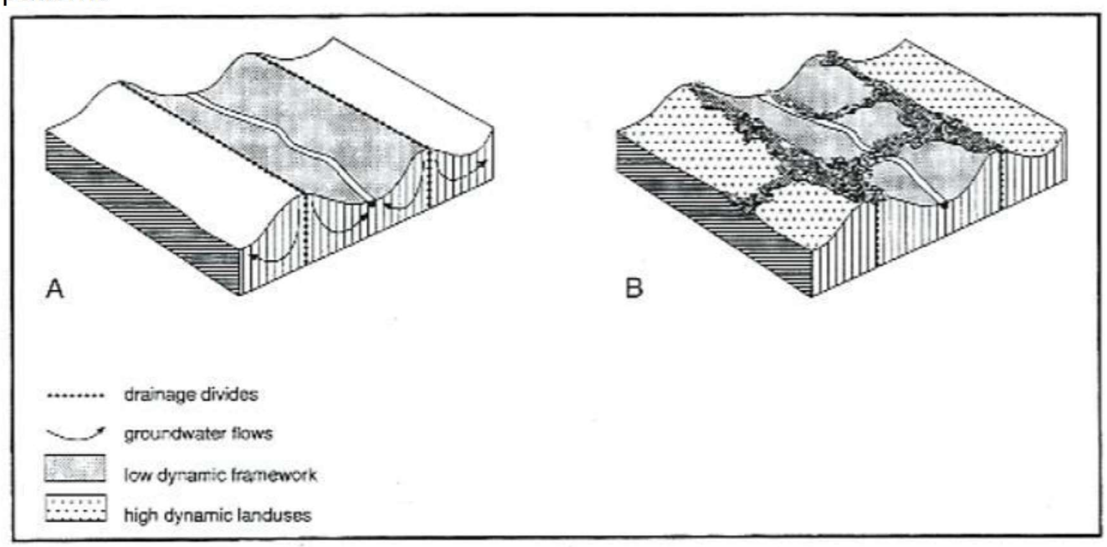
4.Change/Intervention: By what actions might the current representation of the landscape be altered (whether conserving or changing the landscape)?

5.Impact: What predictable differences might the changes cause (i.e., using process models to simulate change)?

6.Decision: How is the decision to change (or conserve) the landscape to be made? How is a comparative evaluation to be made among the alternative courses of action?



'Framework Concept' based principally on abiotic geo-hydrological landscape patterns



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COURSE MATERIAL

Subject Name: Sustainable Landscape Planning UNIT II SUBJECT CODE: SARA7331

Landscape Sustainability in Urban Context

Source: Claudia Dinep, Kristin Schwab -Sustainable Site Design_ Criteria, Process, and Case Studies for Integrating Site and Region in Landscape Design-Wiley (2009)

CASE STUDY— MENOMONEE VALLEY INDUSTRIAL CENTER

LOCATION: Milwaukee, Wisconsin, USA
SITE SIZE: 140 acres total (70 acres open space/70 acres development. The park discussed here is 20 acres.)
CLIENT: City of Milwaukee
DESIGNERS: Landscape Architect—Wenk Associates, Inc., Denver, Colorado
Ecological Consultant—Applied Ecological Services, Brodhead, Wisconsin
Engineers/Planners—HNTB, Milwaukee, Wisconsin
FORMER SITE USES: Industrial, then abandoned
LANDSCAPE BUDGET: $1.75 million
DATE OF COMPLETION: 2007

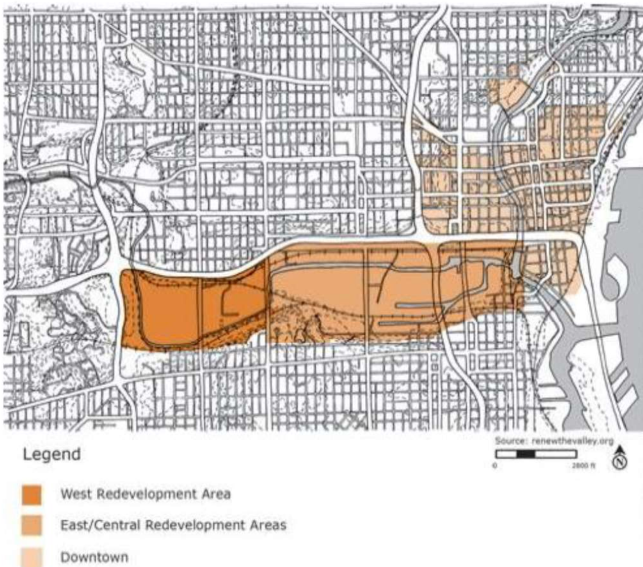
PROJECT INITIATIVES

This Brownfield development is an example of a sustainable design that developed from a spectrum of factors and needs—**environmental, social, and economic within the neighborhood, city, and region of Milwaukee, Wisconsin.**

The Winning architecture firm , the landscape architects developed that vision further into **an uncommon use of storm water basins, not as elements to be hidden, but as the primary form-making features of what was to become a public park.**

The adjacent, **densely developed industrial complex has its storm water piped to this 20 acre park into successively larger and deeper basins that lead to the river**.

This project, however, combined these seemingly incompatible uses to **provide open space and access to the river to the surrounding neighborhoods and greater region of Milwaukee.**



The **area's heavy industrial history left it contaminated with a variety of materials and compounds that rendered it a brown field site** following its large-scale abandonment in the 1980s.

The site was **unusable for any redevelopment program without a plan for environmental remediation that would isolate or remove the contamination, protect the groundwater and human inhabitants from potential exposure, and restore ecological health** to the site.

Later after many years the site was put in the focus for redevelopment for community needs. The basic components of the redevelopment were new parcels and infrastructure for light industrial use that would provide desired economic impacts, and open space that would provide environmental improvement and community connections **(Sixteenth Street Community Health Center 2004).**

DESIGN CONCEPT

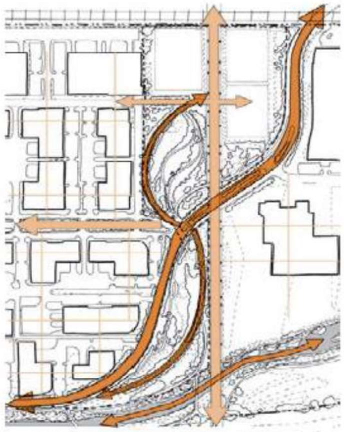
The Deign conceived to focus on Storm water park becomes a **civic recreational and ecological centerpiece** for industrial development sites that are raised out of the floodplain. Chimney Park and River Lawn portions as the main body of the park that has been built to date and where the majority of the intensive program is carried out.

These **two park areas** cover **approximately 40 acres**, while the A**irline Yards area and other planned segments** are about **30 acres**, for a total of **70 acres of open space**.

SITE ORGANIZATION DERIVATIONS

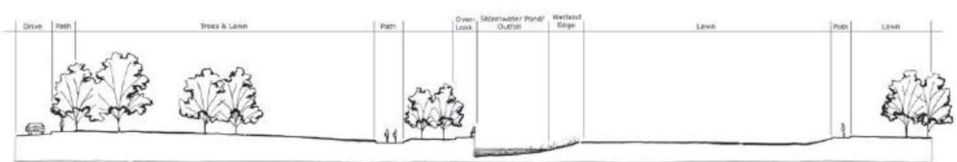
In total there are 70 acres for development, with 20 to 30 acres of allowable building coverage. The grid of the development extends into the park at its northern end with the placement of the playing fields, the planned park building, and the Wheelhouse Road walkway extension.

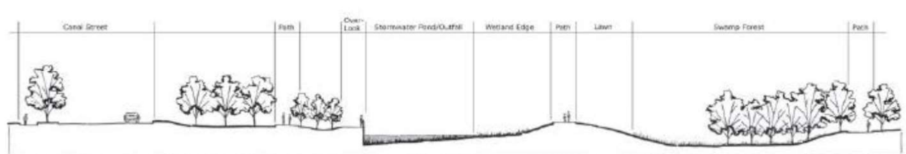
The park forms a linear open space spine that is perpendicular to the river, connecting the north and south sides of the city to the valley, through a sequence of areas that transition from more active human use in the northern Chimney Park section, to more passive uses in the southern River Lawn section and the Airline Yards riverfront area. These areas use planting density, vegetative surface variation, and landform to define this transition.

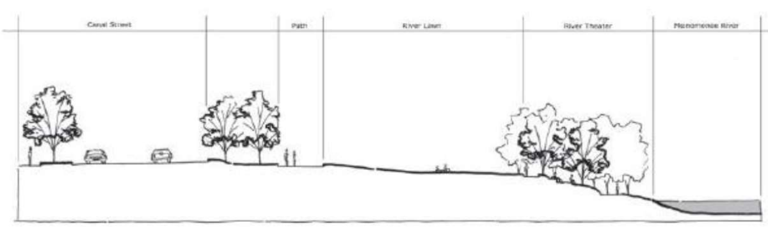


The lower spreading basins closest to the river are shown during both a dryer period on left and following a heavy rainfall on right, illustrating the site's flexibility and multipurpose capacity.

Section drawings of the park illustrate the progression of water treatment and the integrated relationship of pedestrian and vehicular circulation to the park's storm water functions.







Materials: The site is primarily vegetated with small isolated paved nodes for gathering. The constructed materials consist of:

• Concrete paving at the storm water outfall nodes with metal railings inset with glass interpretive panels. These have a modern industrial feel.

- Limestone block terraces are placed in arched alignments along the riverfront to provide shore stabilization and a node for congregation and access.

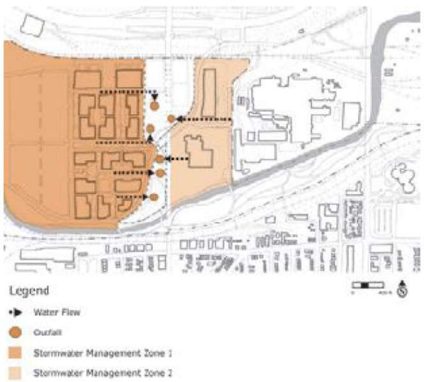
Materials used include granular surfacing concrete for curved seat walls that mimic pathway alignments and enclose the space, and elliptical pipe for benches.

The site design and engineering allows for a series of Storm water events to distribute runoff to park areas that provide bio-treatment and detention while still allowing access and use of the park.

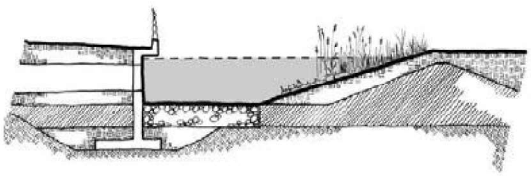
• large, locally obtained rough-cut stone terracing at the river amphitheater that gives rustic structure at the natural river edge.
•. Granular surfacing, curved linear concrete seat walls, and elliptical pipe benches at the Chimney common area shown in the figures.

Much of the site's intensive construction is invisible—making use of highway rubble for the subsurface constructed soil system created to satisfy fertility, filtration, and drainage needs for the extensive storm water basin planting scheme.

	INITIAL PROGRAM GOALS	SITE CHARACTER	CONTEXT CHARACTER
ENVIRONMENTAL	Contaminated land remediation	Blank, flat, sterile surface	Riparian corridors have long history of degradation related to industrial use
	Biological stormwater treatment for industrial development pads	Debris fill to depth of 21' in some areas, contamination with arsenic and petroleum	
	Habitat creation	Degraded Menomonee River edge	Floodplain has been filled to accommodate development and inhibit flood control, water quality, and habitat capacity
CULTURAL	Site and neighborhood industrial history acknowledgment	Historic industrial chimneys from Milwaukee Road rail yard	Historic industrial architecture and rail form remnants, influences
	Aesthetic, spatial considerations to improve character and define public/private use	Historic use of site for largest rail yard in United States	Native American influences
SOCIAL	Neighborhood connection/ revitalization	Site inaccessible to public and separates neighborhoods	Current problems with crime and unemployment
	Local light industrial businesses and jobs	Centrally located site lies fallow and unusable	"Dead" area sandwiched between lakefront downtown and stadium
	Public recreational open space		Culturally diverse historic working-class neighborhoods



Storm water basins are fed from the two developed sides of the site.



Layered components include the subgrade cap (bottom), drainage infiltration gallery (middle), and growing medium for plants that provide biological treatment (top).

The park has been capped due to brownfield contamination, these areas provide detention and water quality treatment, but do not allow for infiltration of the stormwater. They are designed to remove 80 percent of the total suspended solids (TSS) contained in stormwater runoff (Wenk Associates).

The SMAs and the Swamp Forest treat water in three steps:

1. Stormwater is collected and piped from the industrial redevelopment areas and Canal Street to the storm outfalls located in the park. Here large particulates settle in small pools.

2. Storm flows spread out across broad shallow wetland meadows. The subgrade layer, called an "infiltration gallery," consists of coarse-textured, crushed concrete that allows stormwater to infiltrate below the surface, above the capped soils.

3. Infiltrated storm flows will be collected and transpired through the plant material at the Swamp Forest as shown in Figures. The system both removes particulates and pollutants, and detains the 100-year storm, eliminating the need for traditional detention basins within the industrial development parcels themselves.

Site Design Engagements – Human systems : Community involvement

Biking and kayaking are among the active recreational uses of the park, while educational programming on the site's cultural and natural dimensions are provided on an ongoing basis.

Community involvement in planting and maintenance is critical to the ongoing improvement and management of the park, as well as the sense of community ownership and stewardship of the open space.

This project exhibits two types of ecological engagements: regeneration through large scale storm water treatment basins and the creation of a new vegetation matrix.

Elliptical Pipe Bench.

Interpretive Signage.

Special elements, nodes, and views encourage user experience and understanding of the park's sustainable design on both conscious and subconscious levels.

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DEPARTMENT OF ARCHITECTURE

COURSE MATERIAL

Subject Name: Sustainable Landscape Planning UNIT II SUBJECT CODE: SARA7331

Guiding Principles of Sustainable Design

Five Criteria to focus on when beginning a design: Connectivity**,** Purpose**,** Meaning Efficiency**,** Stewardship

Recognition of context: No site can be understood and evaluated without looking outward to the site context. Before planning and designing a project, fundamental questions must be asked in light of its impact on the larger community.

Treatment of landscapes as interdependent and interconnected: Conventional development often increases fragmentation of the landscape. The small remaining islands of natural landscape are typically surrounded by a fabric of development that diminishes their ability to support a variety of plant communities and habitats. This situation must be reversed. Larger whole systems must be created by reconnecting fragmented landscapes and establishing contiguous networks with other natural systems both within a site and beyond its boundaries.

Integration of the native landscape with development: Even the most developed landscapes, where every trace of nature seems to have been obliterated, are not self-contained. These areas should be redesigned to support some component of the natural landscape to provide critical connections to adjacent habitats.

Promotion of biodiversity: The environment is experiencing extinction of both plant and animal species. Sustaining even a fraction of the diversity known today will be very difficult. Development itself affords a tremendous opportunity to emphasize the establishment of biodiversity on a site. Site design must be directed to protect local plant and animal communities, and new landscape plantings must deliberately re-establish diverse natural habitats in organic patterns that reflect the processes of the site.

Reuse of already disturbed areas: Despite the declining availability of relatively unspoiled land and the wasteful way sites are conventionally developed, existing built areas are being abandoned and new development located on remaining rural and natural areas. This cycle must be reversed. Previously disturbed areas must be re-inhabited and restored, especially urban landscapes.

Making a habit of restoration: Where the landscape fabric is damaged, it must be repaired and/or restored. As most of the ecosystems are increasingly disturbed, every development project should have a restoration component. When site disturbance is uncontrolled, ecological deterioration accelerates, and natural systems diminish in diversity and complexity. Effective restoration requires recognition of the interdependence of all site factors and must include repair of all site systems—soil, water, vegetation, and wildlife.

Topological and Chorological approach in Landscape planning:

Stenitz, Van Buuren and Kerstra introduced several landscape planning methods that incorporate interdisciplinary approach and address landscape pattern, process at multiple scales and they include a human ecological component in this process. One distinction between landscape ecology and earlier approaches to landscape planning is the integration of topological and chorological perspectives.

Topological analysis is a parametric approach which describes and analyzes the "vertical" relationships between many factors that occur at the given location, be it a patch of wetland, a forest edge or a residential neighbourhood.The Topological approach was popularized by Mc Harg(1969).

Buildiinga "layer cake" of factors which collectively describe a place or places.

Factors considered often start at the bottom with bedrock geology and followed by surficial geology, soils, subsurface and surficial hydrology, vegetation, wildlife and climate. The topological approach is complemented by a **Chorological approach** which describes and analyzes horizontal relationships and flows (Zonneveld 1995). It can describe dynamic spatial processes and particularly horizontal relationships such as hydrological dynamics between land uses, nutrient flows, metapopulation dynamics in fragmented landscapes, and human transportation.

What is an Externality?

An externality is a cost or benefit of an economic activity experienced by an unrelated third party. The external cost or benefit is not reflected in the final cost or benefit of a good or service.

The primary cause of externalities is poorly defined property rights. The ambiguous ownership of certain things may create a situation when some market agents start to consume or produce more while the part of the cost or benefit is covered or received by an unrelated party.

Environmental items, including air, water, and wildlife, are the most common examples of things with poorly defined property rights.

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UNIT – III – ENERGY EFFICIENT SITE PLANNING WITH LANDSCAPE– SARA7331

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DEPARTMENT OF ARCHITECTURE

COURSE MATERIAL

Subject Name: Sustainable Landscape Planning **UNIT III** **SUBJECT CODE: SARA7331**

Process in Landscape Planning:

The planning problems we are facing today are many and complex, and not all, of course, are tied directly to the landscape. For those that are, most seem to result from mismatches between land use and environment. The mismatches stem from five main origins:

1. *Initially poor land use decisions* because of ignorance or misconceptions about the environment, as exemplified by the person who unwittingly builds a house on an active fault or ignores warnings about hurricane -prone shore property.

2. *Environmental change* after a land use has been established, as illustrated by the property owner who comes to be plagued by flooding or polluted water because of new upstream development or by the coastal properties flooded and eroded because of a sea level rise related to global warming.

3. *Social change*, including technological change, after a land use has been established and represented, for example, by the resident who lives along a street initially designed for horse -drawn wagons but now used by automobiles and trucks and plagued by noise, air pollution, and safety problems.

4. *Poor planning and design*, as in the case of the road redesigned for greater efficiency and safety which instead induces more accidents among cars, bicycles, and pedestrians than the roadway it replaced.

5. *Violations of human values* concerning the mistreatment of the environment, such as the eradication of species, the degradation of streams, and the alteration of historically valued landscapes

Procedures to be covered under landscape planning process

Four Stages in the process

1. Survey and Analysis
2. Evaluation/ Assessment
3. Policy or Design Solutions
4. Implementation

The scope of modern landscape planning is surprisingly broad and encompasses a great many areas of professional activity. Some activities with environmental inventories and impact assessments, as suggested, are common to most land use projects in both rural and urban settings. Others, such as risk management planning and restoration planning, deal with particular problems and settings. Yet others are broadly based and oriented more toward community and regional land use planning.

The following paragraphs describe a number of these activities.

Environmental Inventory. One of the best -known activities in landscape planning and design is the so -called **environmental inventory**, an activity designed to provide a catalog and description of the features and resources of a study area. The basic idea behind the inventory is that we must know what exists in an area before we can formulate planning alternatives and design schemes for it. Among the features consistently called for in environmental inventories are water features, slopes, microclimates, floodplains, soil types, vegetation associations, and land use, as well as archaeological sites, wetlands, valued habitats, and rare and endangered species. Environmental inventories are a major part of environmental impact statements, in which the inventory must also include an evaluation of the recorded phenomena based on criteria such as relative abundance, environmental function, and local significance. This is supposed to indicate the comparative importance or value of a feature or resource

Site Analysis and Evaluation. A second type of planning activity is aimed at the discovery of **opportunities and constraints**. This activity is often undertaken after a land use program has been proposed for an area but the density, layout, and appropriate design of the land use program are still undetermined. The study involves searching the environment for features and situations that would (1) facilitate a proposed land use and those that would (2) deter or threaten a proposed land use. Basically, the objective is to find the potential matches and mismatches between land use and environment and to recommend the most appropriate relationship between the two. This may involve a wide range of considerations including off -site ones where the site is affected by systems and actions beyond its borders, such as stormwater runoff and air pollution from development upstream and upwind, as well as phenomena covered by public policies, such as protected species, floodplains, and wetlands.

Documenting opportunities and constraints is often included in **site assessments**. These are pre-purchase or preplanning environmental profiles of sites highlighting whatever conditions might be germane to land value, purchase agreements, and program planning. A central part of modern site assessments, particularly on the urban/suburban fringe, are inspections for hazardous wastes such as buried storage tanks and possible safety problems such as shallow mine shafts, contaminated groundwater, potentially contentious border conditions, risky flood plains, and unsafe soils and slopes.

All of the above are commonly part of **site analysis**, an activity that investigates the makeup and operation of a site vis -à-vis a proposed use program. The program serves as an initial problem statement or a testable proposition. The analysis is tailored to the particular requirements of the program; to the character of the site itself; to the site's relationship to surrounding lands, waters, and facilities; to community concerns; to policy issues; and to other factors. Site analysis may also include several of the remaining areas of activity as well.

Land Capability Assessment. Studies designed to determine the types of use and how much use the land can accommodate without degradation are referred to as **capability** or **suitability assessments**. For sites or study areas composed of different land types, the objective is to differentiate buildable from nonbuildable land and to define the development capacity, or **carrying capacity**, of different land units or subareas. Capability studies may also be performed to determine best use, such as open space, agricultural, or residential, for different types of land over broad areas. Capability and capacity studies are fundamental to **sustainability planning**, in which the overriding objective is to build land use systems that are environmentally enduring and balanced for both humans and other organisms over the long term. The concept of sustainability in development planning has become more or less interchangeable with the “green” facilities theme, most notably advanced by architects in their building standards called LEEDS (Leadership in Energy and Environmental Design).

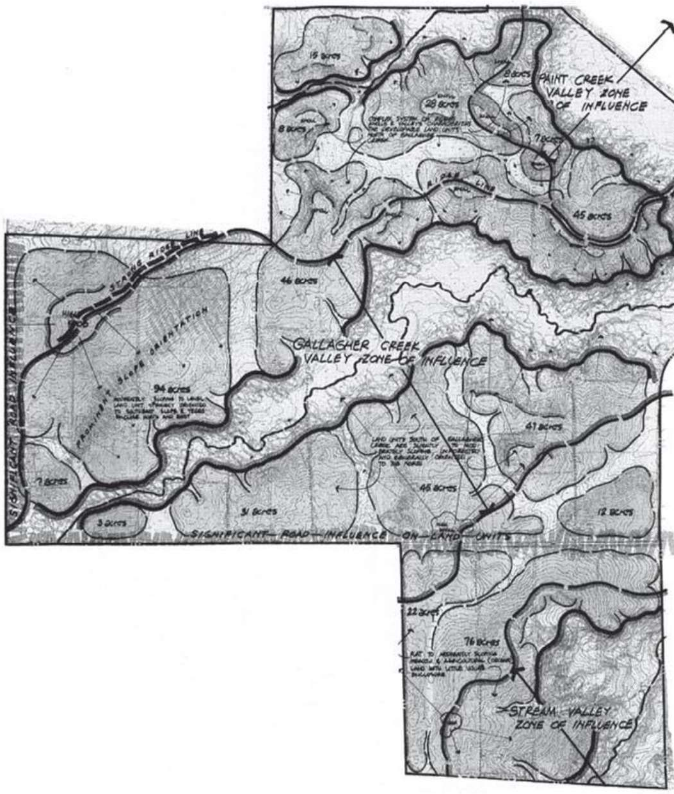
Hazard Assessment and Risk Management. The objective in **hazard assessments**, which are a specialized type of constraint study, is to identify dangerous zones in the environment where a use is or would be put in jeopardy of damage or destruction. Hazard research has been concerned both with the nature of threatening environmental phenomena (floods, earthquakes, and storms) and with the nature of human responses to these phenomena. Zoning and disaster relief planning for hurricane and flood -prone areas, for example, have benefi ted from hazard assessment at the national, state, and local levels. Another benefit is the emergence of **risk management planning** as a part of development programs, which involves building strategies and contingency plans for coping with hazards and providing emergency relief services. Both hazard assessment and risk management planning are gaining serious national attention in the United States in response to recent disasters such as the 1993 Mississippi flood, the 1994 Northridge earthquake near Los Angeles, the North Dakota flood of 1997, the 2004 rash of hurricanes in Florida, and the Katrina and Ike disasters in Louisiana and Texas.

Impact Forecasting. Hazard assessment, environmental impact assessment, opportunity/constraint studies, and site assessments all depend on another activity: **forecasting impacts**. This activity involves the identification of the changes that a proposed action calls for or implies, followed by an evaluation of the type and magnitude of the environmental impact. The process is tough because of the difficulty in deriving accurate forecasts by analytical means. As a result, forecasts of impacts are usually best estimates, and the significance assigned to them seems to be as much a matter of perspective (such as an engineer ’s versus an environmentalist ’s) as anything else. Nevertheless, the *process* is an important one because it often leads to clarification of complex issues and their environmental implications, to modification of a proposed action to lessen its impact, or to the abandonment of a proposed project.

Special Settings. Delineation, analysis, and evaluation of **special environments**, such as wetlands, unique habitats, and archaeological sites, is a rapidly rising area of planning activity. Though logically a part of impact assessment, capability studies, and most other planning activities, special environments have gained increased attention with the enforcement of wetland protection laws, rare and endangered species laws, and similar ordinances relating to prized environmental resources. The focus of activity to date is overwhelmingly empirical, dealing mainly with the field identification and mapping of the feature or organism in question. The results usually center on the question of the presence or absence of, for example, a threatened species or a valued habitat, as the basis for deciding whether a proposed land use can or cannot take place in or near the area under consideration.

Other kinds of special environments are those in need of some kind of restorative action.

Restoration planning addresses environments such as wetlands, wildfl ower habitats, stream channels, and shorelines that have been degraded by land use activities. Perhaps the most common restoration planning activity is associated with damaged wetlands, degraded streams, and waste disposal sites. Wetland mitigation includes both the restoration of damaged wetlands and the construction of essentially new wetlands.



Land capability map for a modern residential development in which buildable land units are differentiated from nonbuildable areas, such as stream corridors.

Areas of Activity

- Inventory
- Site Analysis and Evaluation
- Land Capability Assessment
- Hazard Assessment and Risk Management
- Impact Forecasting
- Restoration Planning
- Feasibility Studies

The Information required to begin the Landscape Planning Project is as below;

- Socio-economic and Cultural Factors
- Landscape-Ecological Factors
- Visual Appearance (represents the interaction of 1 and 2)

Landscape Assessments

1.**Area-based assessments**

2.**Proposal-driven assessments**

Area-based Landscape Assessments

- Landscape Description/Inventory
- Landscape Characterisation
- Landscape Evaluation

Landscape description / Inventory: a process of data compilation during which the layers or components that make up the landscape are identified.

Landscape Characterisation

- Landscape characterisation: The process of identifying, mapping and describing landscape character areas.
- Landscape character is derived from a combination of landscape components (i.e. landform, land cover and land use) that distinguishes one area from another.
- Scale: Different scales from the national to local levels, assessment at each level adds more detail to the one above.

The processes of change and specific threats to landscape character can also be identified as part of the landscape characterisation process.
Landscape evaluation (i.e. assigning value) should identify important landscapes and natural features.
Defining values, assigning rankings and prioritising management.

'Proposal-driven' Assessments

Submitted with development proposals

- Purpose is to identify the effects of a proposal on landscape values.
- Scale ranges from small subdivisions to large infrastructure developments such as wind-farms, transmission lines and roads.

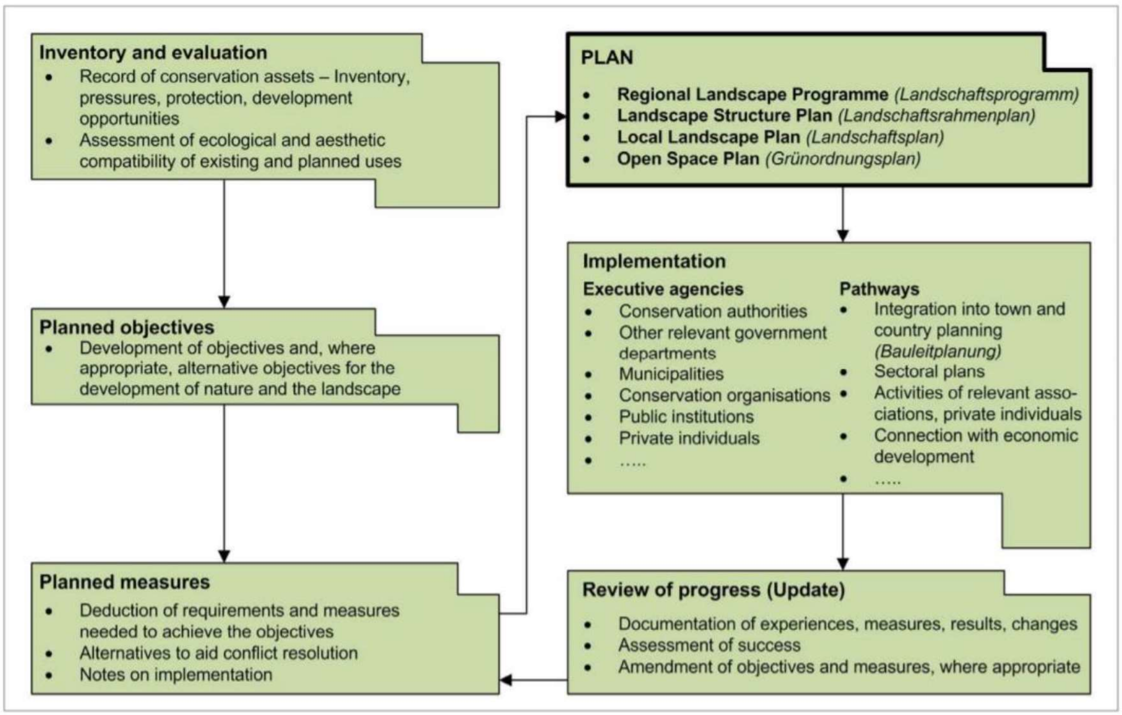
The types of effects considered:
Landscape effects: derive from changes in the physical landscape, which may give rise to changes in its character and how this is experienced.
Visual effects: relate to the changes that arise in the composition of available views as a result of changes to the landscape, to people's responses to the changes, and to the overall effects with respect to visual amenity.

'Proposal-driven' landscape assessments will typically contain: A detailed assessment of the physical changes to the landscape that will result from the proposal; A description and analysis of the impact that physical changes will have on identified landscape values, visual impacts from key locations and cumulative effect of the proposed activity; A detailed assessment of the extent to which the changes will affect the existing landscape character and the way in which affected parties' perception and experience of the landscape including visual amenity values is likely to be affected; An evaluation of the significance of natural character, landscape, visual and amenity effects in relation to statutory requirements; and Identification of landscape mitigation measures, including enhancement or rehabilitation and assessment of the effectiveness of such measures.

Visual absorptive capacity

Visual absorption is the capacity of the landscape to accommodate manmade elements without being seriously altered in character by them

Tasks and contents of landscape planning in logical sequence of work steps



Single-purpose planning

Modern planning tended towards the creation of similar places all over the world.

The land use came as near to being a single-purpose activity as possible
Single-purpose results in roads planned only for motor vehicles, forests for timber production, farms for food, rivers for flood water, bus stops for standing in queues, parks for recreation, stations for getting off trains and buildings for sleeping or working. If students are isolated on a campus, they lack shops, entertainment, part-time jobs and a variety of accommodation. If places to work are isolated from places to live, everyone must commute. If housing is isolated from reservoirs, parks and natural areas, people cannot choose to live in contact with nature. If rivers are planned as industrial corridors, they cannot fulfil their potential as wild life habitats or public open spaces.
Great harm was done to the environment by single-use planning

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF ARCHITECTURE

COURSE MATERIAL

Subject Name: Sustainable Landscape Planning **UNIT III** **SUBJECT CODE: SARA7331**

Waterfront Development

Urban waterfronts can be thought of as geographical territories with their particular ecologies, economic systems and identities

•Urban waterfronts are places where material components of nature such as large bodies of water and land formations, and ecosystems such as woodlands and marshes, intersect with each other with great fluidity.

•The human manipulations of these material forms of nature have not left urban waterfronts as pristine natural places, but, indeed, have heavily influenced their transformation over time.

•The historical development of urban waterfronts has shown the intricacies of the inter-relationship between society and nature, but more importantly, how material forms of nature are constantly re-produced through social processes.

Problems and Opportunities associated with urban waterfronts

•Flood Risk

•Water quality

•Soil Erosion

•Offer unique opportunities for providing cultural and recreational public amenities to urban life

Process

1.Establishing partnerships

- seek out stakeholders who can make the vision for the future of the waterfront a reality.
- a vision that captures the ideas and interests of a broad constituency of those concerned with the future of the waterfront can be created.
- A partnership is an agreement between two or more entities to work together for a particular purpose

2.Defining the waterfront study area boundaries

3.Assessing the waterfront

Look at the waterfront from four perspectives: the developed waterfront, the natural waterfront, the public waterfront, and the working waterfront

4.Developing a vision and strategy

5.Project planning, financing, and implementation

http://www.dos.ny.gov/opd/programs/pdfs/LWRP_guidebook.pdf

Guidelines:

•Preserve the existing waterbody and Protect the health of the waterbody

•Control the use of adjacent lands

•Consider the floods

•Plan in harmony with the waterways

•Engage the community

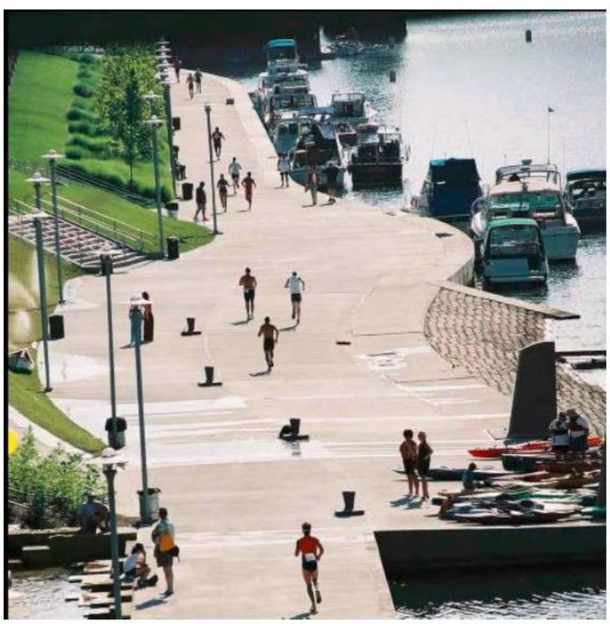
•Create a shared community vision

To make the best possible use of water and its shoreline, plan the traffic movement and patterns of land use in advance

•Align the traffic ways beside the stream

•Plan streets and rivers parallel with the water course

•Balance environmental benefits with human needs



Sidewalks, public streets, pathways, and promenades provide safe and engaging passages and reinforce the riverfronts as the public realm.

Perpendicular connections bring people to the waterfront

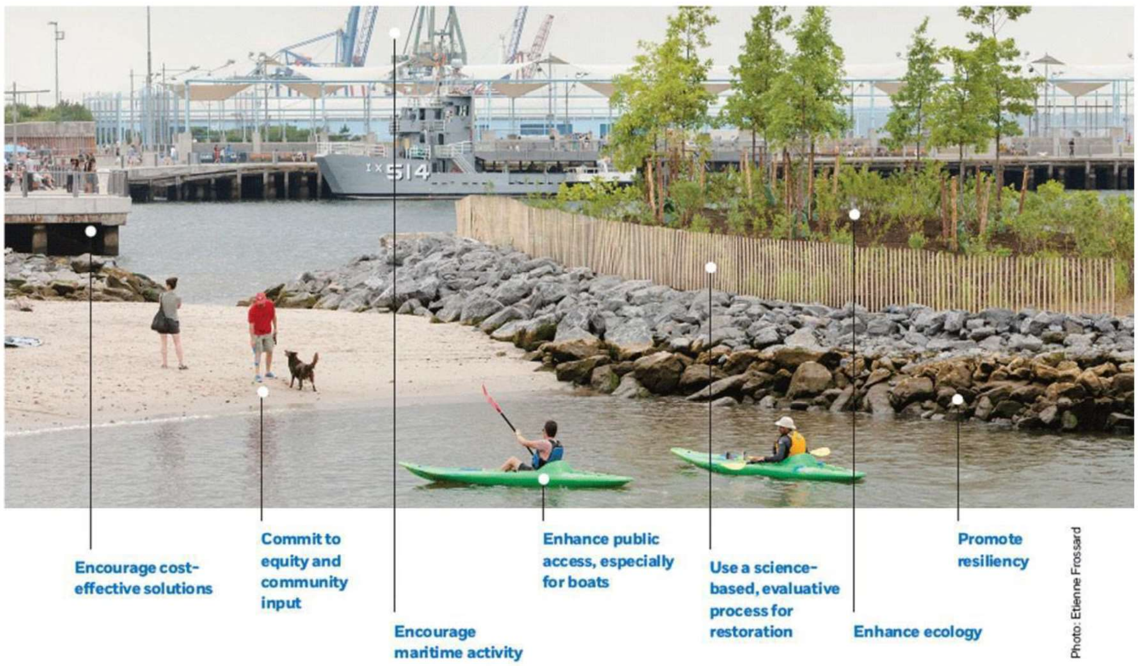
Along the waterways, there are many opportunities for integrated regenerative design, storm water management, habitat restoration, public access, stewardship, and redevelopment.

TREATMENT OF WATER EDGES

The edge conformation and structures have a direct effect on the hydrodynamics of the water courses, affecting the water currents, sedimentation, wave action, and water quality.

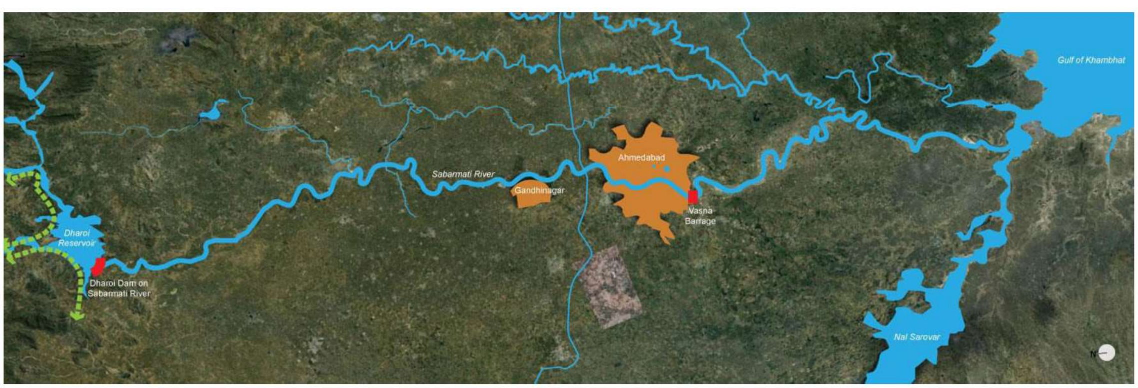
Where plant growth is to be encouraged, design the section to permit full sun penetration at the edge.

Waterfront Edge Design Guidelines (WEDG)



The goal of this incentive-based ratings system is to make our waterfronts more resilient, environmentally healthy, accessible, and equitable for all

Case Study –Sabarmati Riverfront



•The Sabarmati River is a monsoon-fed river that flows north-south through Ahmedabad, bisecting the city into its western and eastern halves.

•It has been an integral aspect of Ahmedabad city since its foundation.

•Initially, the river was the city's prime source of water. Today, water is supplied from many distant sources.

Issues

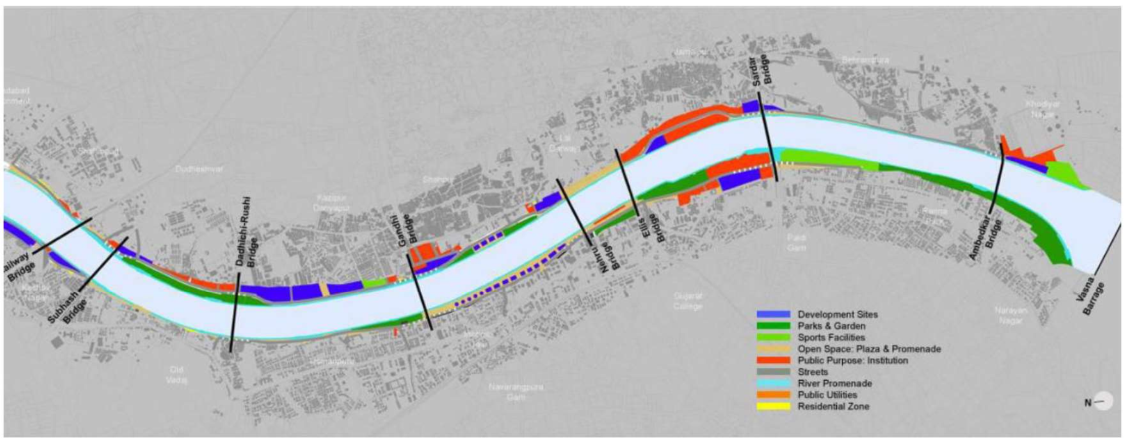
•**Declining ecological health**

•**Access to the river**

The river became inaccessible to the majority of the city's residents. Owing to private ownership of most riverside land and the informal settlements, there were very few public access points to the river. By the 1970s, the bridges were the only places from where citizens could enjoy the expanse of the river running through the heart of the city.

Sabarmati River becoming polluted, abused and neglected. The riverfront became characterized by unimaginative and unplanned development

MASTER PLAN –Land Use Map



A public edge along the river on the eastern and western bank

By channeling the river to a constant width of 263m, riverbed land of 202.79 hectares has been reclaimed.

Sabarmati Riverfront Development

•The main considerations in allocating land uses for the reclaimed portions have been:

•existing land uses along the river;

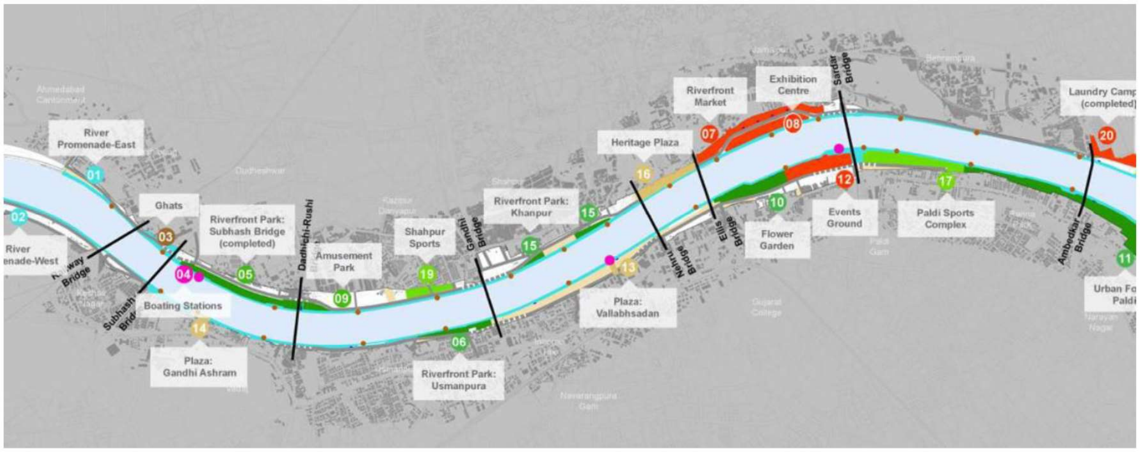
•extent, location and configuration of reclaimed land available;

•potential for development;

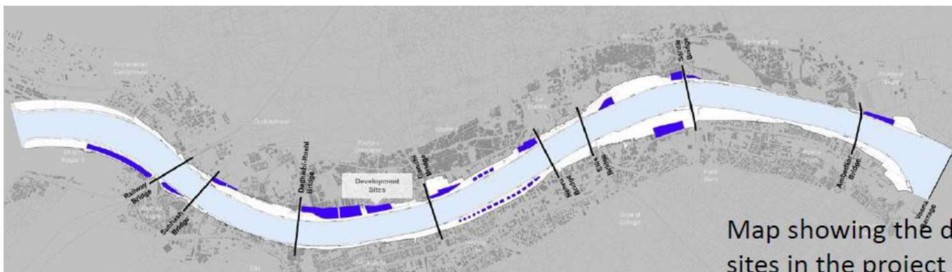
•the structural road network and form of the city;

•bridges proposed in the Ahmedabad Development Plan;

•the possibility of providing adequate infrastructure in the new development.

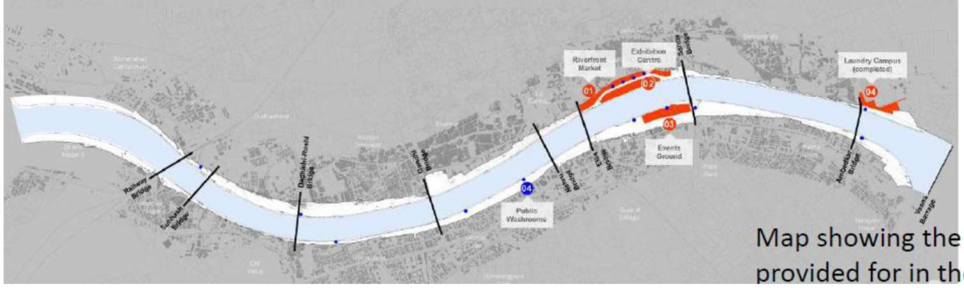


Recreational facilities highlighted in the map



Map showing the development sites in the project area

Street Network



Map showing the amenities provided for in the project

View of the proposed street along western bank

Lower Promenade

Kite Festival- January 2012

Criticism

•Universal “Promenade Approach”

•Pinching the river -controlling the river system -based on hydrological principles

•River ecology is equated to the “hose piped water” and non-perennial ecological dynamics are not recognised

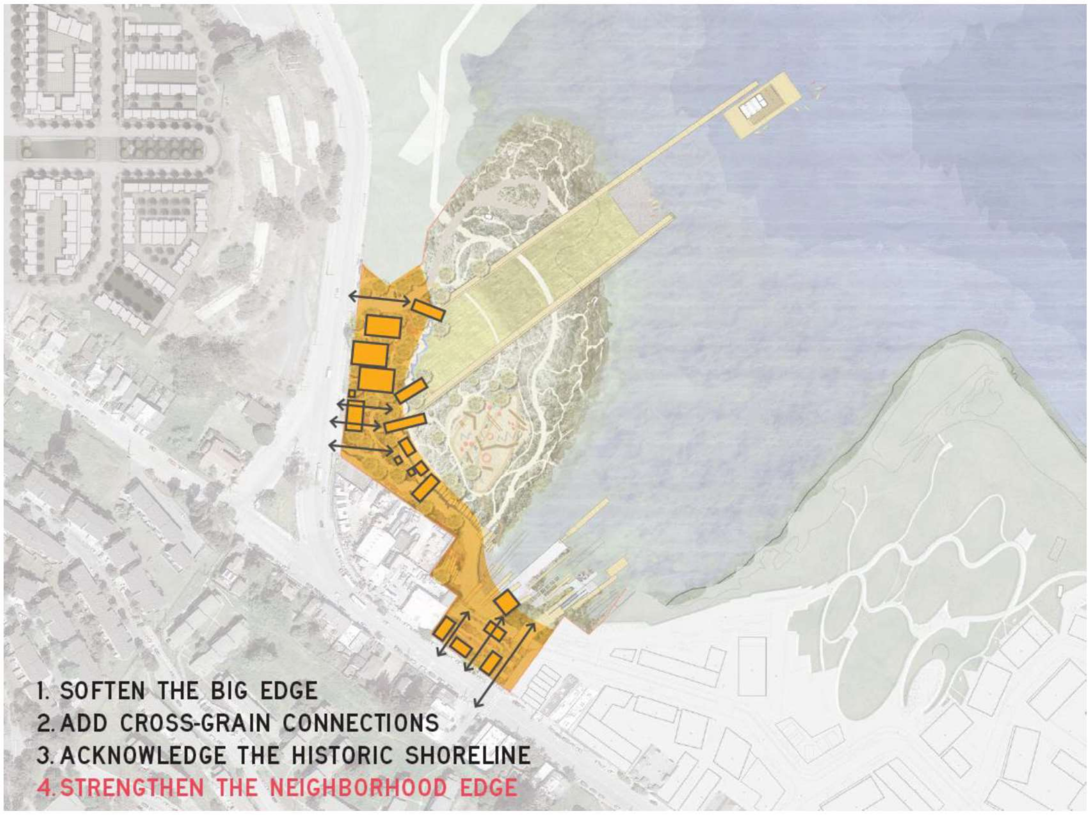
•Riverfront is treated merely as an aesthetically pleasing water features to benefit human pleasure

Could have incorporated

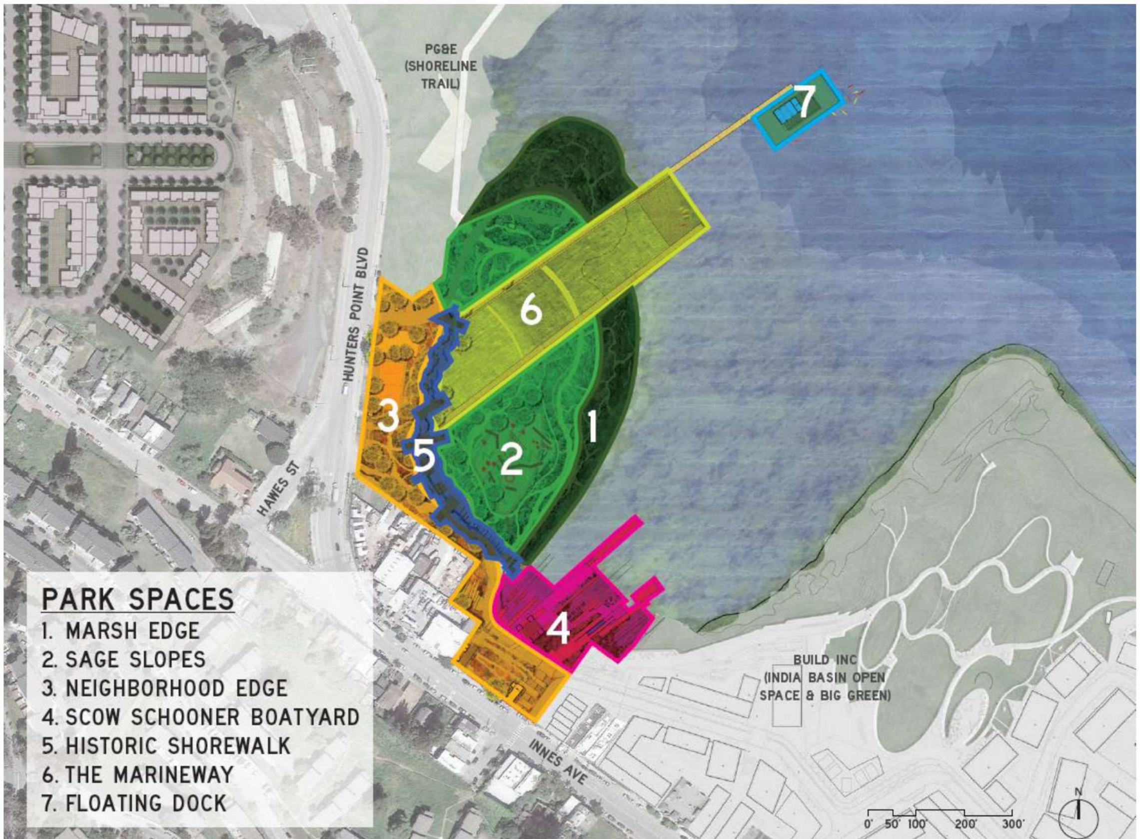
- Alternate water management techniques
- Redefine the edges
- Dynamic landscape –a hard and softscapes which at times could be flooded and some parts retained –reveal the dynamic phenomenon

•http://www.studio360.org/story/250967-after-sandy-redesigning-waterfront/

CASE STUDY
FOUR BIG MOVES

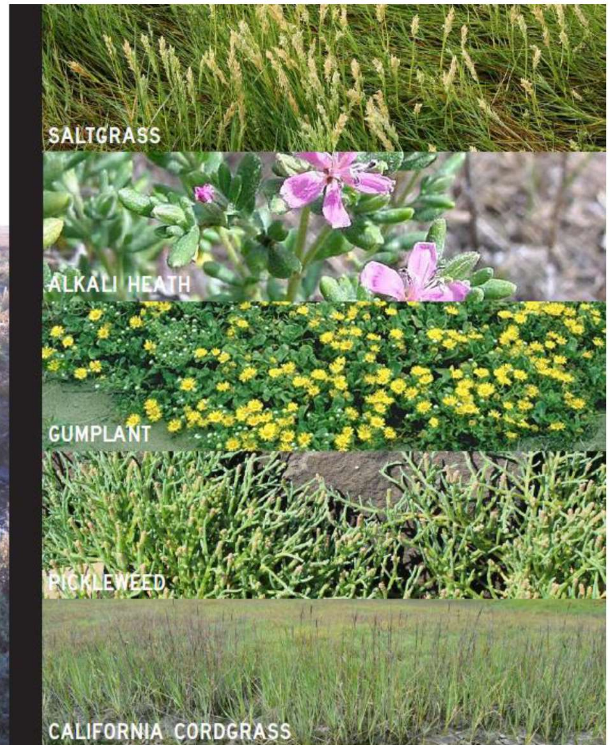

1. SOFTEN THE BIG EDGE
2. ADD CROSS-GRAIN CONNECTIONS
3. ACKNOWLEDGE THE HISTORIC SHORELINE
4. STRENGTHEN THE NEIGHBORHOOD EDGE


PG&E (SHORELINE TRAIL)
HUNTERS POINT BLVD
HAWES ST
INNES AVE
BUILD INC (INDIA BASIN OPEN SPACE & BIG GREEN)
0' 50' 100' 200' 300'
N


PG&E
(SHORELINE
TRAIL)
HUNTERS POINT BLVD
HAWES ST
INNES AVE
BUILD INC
(INDIA BASIN OPEN
SPACE & BIG GREEN)
1
2
3
4
5
6
7
PARK SPACES
1. MARSH EDGE
2. SAGE SLOPES
3. NEIGHBORHOOD EDGE
4. SCOW SCHOONER BOATYARD
5. HISTORIC SHOREWALK
6. THE MARINEWAY
7. FLOATING DOCK
0' 50' 100' 200' 300'
N

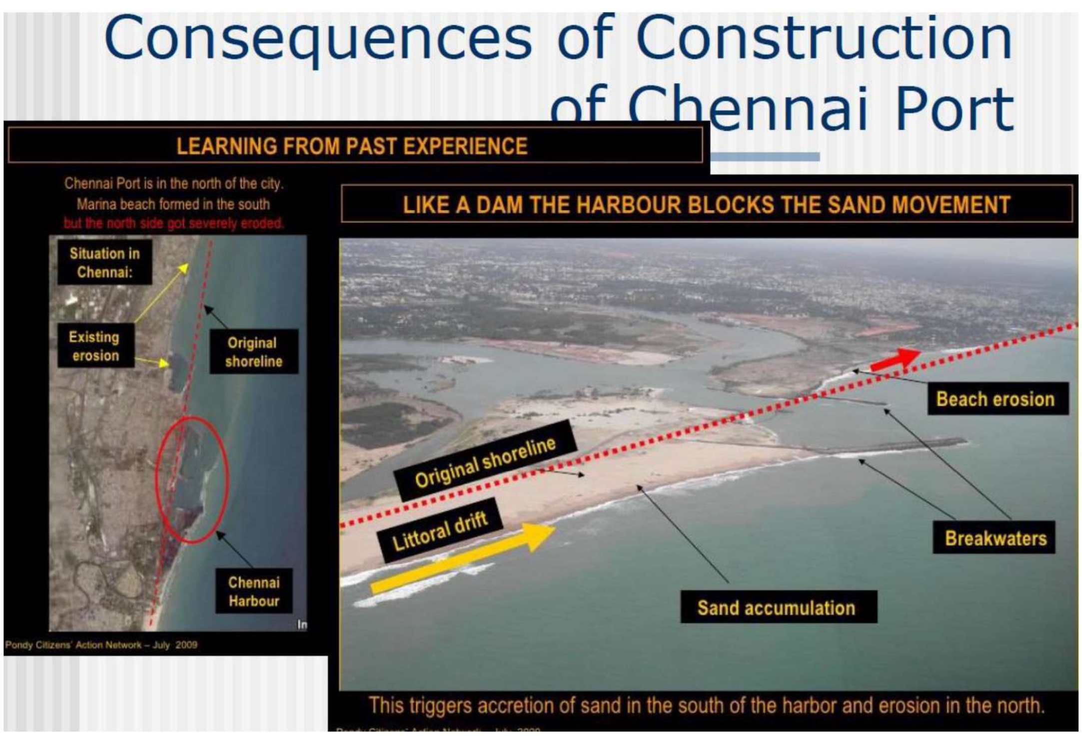
MARSH EDGE


HERON'S HEAD PARK


SALTGRASS
ALKALI HEATH
GUMPLANT
PICKLEWEED
CALIFORNIA CORDGRASS


RESTROOM
INFORMAL TRAILS
SKATE EDGES
BAY TRAIL / BLUE GREENWAY
RECREATION LOOP
RESTROOM
INFORMAL TRAILS
ADVENTURE PLAY AREA
FITNESS AREAS

Chennai Coast–Erosion and Accretion – To study by students in detail



Buildings that are carefully designed using passive strategies for natural ventilation and day lighting reduces our dependency on electrical energy meanwhile ensuring thermal comfort inside the building. Similarly, carefully planned vegetation around the building helps in reducing the urban heat island effect and electricity consumption. Methodology adopted for presenting this study as book chapter, first by understanding the concept of landscape with respect to typologies and components.

Secondly discussing the physical parameters in terms of temperature, precipitations and humidity of varied prevailing climatic conditions and varied methods adopted through landscape interventions and techniques to overcome the extreme conditions throughout the year, which in turn helps in reducing the consumption of energy. Source - Rao, Prashanti, and Janmejoy Gupta. "Energy-Efficient Landscape Design." *Architectural Design–Progress Towards Sustainable Construction*. IntechOpen, 2020.

Landscape is specifically the amount of land, either countryside or cityscape, that can be seen at once in a glance by the eye in a single frame. Landscape can also be referred to as an area of either land or water, taken in aggregate. According to Norman T Newton in the forward to his “Design on the Land: The Development of Landscape Architecture” book, stated landscape architecture as “the art or the science if preferred of arranging land, together with the spaces and objects upon it, for safe, efficient, healthful, pleasant human use.” Landscape elements include parks, turfs, golf courses, managed bio reserves, soil systems, water systems, street-furniture, outdoor spaces, side-walks, lighting features, railings, and of course, vegetation.

Landscape is a common element in most architectural works. It has many functional values even though it is largely used for its aesthetic properties. It can be shading devices & evaporative coolers during the summer period, windbreaks during the winter period, and light filters throughout the year. Environmental quality within a building can be improved significantly by plants. Urban heat island is one of the most discussed phenomena in the present world. It is more evident in dense urban forms. It affects human beings as well as the environment by having both physical and physiological impacts. Some of the causes for this phenomenon are inappropriate material selection for building envelopes, improper land use, transportation & traffic, impermeable surfaces, etc. However, the landscape can improve this situation at different levels. Urban heat island can be reduced by proper planning of vegetation around the dwellings at micro and macro levels.

1.1 Components of landscape

Hard-scape & soft-scape are the two constituents of landscape design. Both differ in their characteristics; Hard-scape has a solid character while soft-scape is more fluid in nature. Hard-scape remains unchanged throughout time but soft-scape changes with time as they mature. Soft-scape acts as a breathing animated component of the landscape (**Figures 1–3**).

Hard-scape elements – walkways, driveways, rocks, paver patios, etc.

Soft-scape elements - flowers, trees, turf, plants, vines, shrubs, etc.

Some of the key advantages of landscaping are as follows:

- Reducing energy consumption, CO_2 impact & heat island effect.
- Treating nitrogen pollution in rain.
- To negate acid rain effect.
- Aesthetical value

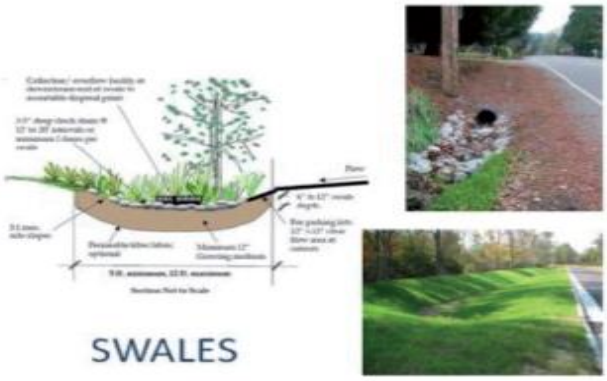


Figure 1.
Softscape (vegetated swales). Source: Co-author.

Figure 2.
Hardscape (hard paving).

Some of the major concerns that landscape deal with are:

- Improving both outdoor & indoor environmental quality.
- Integrating man-made structures such as agriculture, forests, transport, settlements, industry etc. to the natural world.
- Composing land, water & vegetation with built elements & paving.
- Designing land, together with spaces & objects upon it, to develop a public realm.

2. Types of vegetation and its landscape-oriented benefits

Growth habits define the shape or form of the plants and play a key role in both their esthetic character and their function in the landscape. Based on growth habit, plants can be classified as trees, shrubs, groundcovers, or vines. The boundaries between these growth habit types are not always distinct, nor consistent. A plant species may fall into several categories depending upon the conditions of a particular site or its maintenance regime. Despite the shortcomings of this classification system, it is widely used in landscape design.

Herbaceous & woody plants are the main two kinds of landscape plants. Both kinds of plants differ in their characteristics. Plants that do not produce woody stems are known as herbaceous plants. They are known botanically as herbs. They can grow either in an upright, prostate, or creeper manner. Trees, shrubs, or woody vines are different types of woody plants. It is usually difficult to find out a clear distinction between trees and shrubs. Woody plants can be further divided into evergreen & deciduous plants. Deciduous trees usually shed their leaves in autumn while evergreen trees keep their leaves. Trees are relatively larger than shrubs. Shrubs are usually taller than 0.5 m and less than 3 m in height. Plants that grow over and cover ground areas are known as ground covers. They act as the bottom layer in a planting design. Groundcover has various advantages and can be used for different purposes. It can protect from drought & soil erosion. It is also used to improve the aesthetical value of a landscape as it fills the area between trees & large plants. Vines are climbing plants that can spread in different directions. Vines can be used to control erosion as well as for protecting horizontal & vertical planes from the summer sun (**Figures 4** and 5).

Plants can also be classified according to their lifespan. Ecological origin, growth habit & seasonal pattern of plants are important factors that have to be considered in a landscape design. Region or place from which a plant species originated is considered as its ecological origin. Therefore, plants can be either native or non- native. Native plants usually have an integrated growth habit & pattern with its native ecology. Native plants can provide food to native insects and birds, developing an

Figure 4.
Trees with different foliage columnar, oval, weeping, conical and round-spread out. Source: Authors.

Figure 5.
Typical broad-leaved-evergreen tree with large canopy.Source: Authors.

Sr. no.	Name	Physical characteristics	Function/benefits
1.	Ground cover	Typically grow to less 0.5 m tall or are maintained at that height. In general, they reach 15–30 cm high.	A groundcover is utilized to provide protection from erosion and drought, and to improve the esthetic appearance of a landscape by filling areas between large plants and trees.
2.	Shrubs	It can be defined as being larger than 0.5 m, but less than 3 m in height.	Used for Esthetic purpose, Buffer and fencing also sometimes
3.	Vines/Climbers	Vines are climbing & rambling plants.	They are used on man-made structures such as a trellis, a pergola, a balcony to protect from summer sun the horizontal and vertical planes. Various vines can also be used for an effective erosion control.
4.	Trees	Trees measuring 3 to 6 m is height can be classified as `small trees`, trees 6 to 9 m can be considered as `medium trees`, and trees taller than 9 m can be considered as `large trees`.	Form and Foliage persistence of the tree perform various function, in terms of shading, wind breakers, cooling, buffering and also add Esthetic value.
4a.	Deciduous	Deciduous plants are those which completely or significantly, shed their foliage during the winter or dry season. and remain bare for a period of time, followed by the growth of new leaves in the next growing season, typically spring.	These trees are helpful for shading during the w Summer season and Allowing Sun light and warmth during the winter season.
4b.	Evergreen	Evergreen plants retain foliage throughout the year.	All of these plants have special leaves that are resistant to cold and/or moisture loss. Evergreens may continue to photosynthesize during the winter or dry period.

Source: Authors

3. Energy-efficiency through landscaping: Interventions

3.1 Introduction

Energy consumption can be reduced to a greater extent by proper utilization of landscape elements such as trees, shrubs, ground covers, or vines in strategic locations and proper quantity. Such kind of landscape systems can convert solar heat energy into moderate thermal loads. Thus, the need for mechanical cooling is reduced. Proper planning and management of landscapes help us to achieve a higher comfort level within the buildings. Landscape elements can be used to alter the microclimate around a building to regulate the heat gain in summer & heat loss in winter.

Heat exchange within a building occurs through three different processes – air infiltration, heat conduction & transmission of solar radiation. Outside air can infiltrate into the buildings through its openings in the ceilings or walls. Passage of air is also possible through cracks around doors & windows. This is the first heat exchange process. Air infiltration results in heat gain in summer and heat loss in winter. Surfaces that face wind subject to comparatively higher air pressure as the wind velocity increases and thus air enters through the openings or cracks in these surfaces. Proper planting of plants can reduce the wind velocity and thus reducing the air infiltration. Heat conduction is the second process. Heat can conduct through materials used for constructing the building. The Rate of heat conductions depends upon the insulating properties of these materials. Landscape can also reduce the heat conduction by regulating the difference between the inner & outer surfaces of the building. Landscape elements such as trees & shrubs also regulate the solar radiation receiving on the outer surfaces. Solar radiation can reduce heat loss in the winter period by increasing the temperature of outside surfaces. The Landscape system can block cold winds during the winter period to reduce conductive heat loss. Transmission of solar radiation via windows is the third process. South facing and east or west -facing glass allows an undesirable amount of solar radiation during the summer period. Glass can also heat a building in the winter period. Proper planning & planting of vegetation helps to regulate the transmission of solar radiation in different seasons. Thus landscaping & orientation on the site are two important factors that can affect the heating, cooling & lighting of a building.

- Landscape reduces air infiltration & creates air spaces adjacent to buildings. These air spaces act as insulation.

- Landscape elements can be shading devices that can reduce the total thermal heat loads on a building, especially during the summer period. Trees are better than man-made structures to provide canopy as trees do not heat up & reradiate down.

- Vegetation cools the air in contact with it by transpiration of water from the leaves and thus reducing the cooling load on buildings. It is better for the building to be surrounded by trees, rather than concrete walls.

- The advantage of using native plant species is that they are more adaptable to the local soil, climate & pathogens.

- Longwave radiations are reduced by the trees and thus regulating the natural cooling at night. Radiant cooling will be more in an open field than in a canopy.

- Vegetation can improve the quality of daylight passing through the windows and it can also moderate the light intensity & glare from the bright sky.

- Vegetated green walls are more efficient in reducing the cooling load as compared to green roofs.

Strategic designing of the landscape is required in achieving these advantages. For example, plants are more effective when they are planted adjacent to the east & west walls, as those sides are more exposed to the summer sun. The north side requires comparatively lesser shading. The selection of plant species for shading the southern windows is difficult for a building that requires winter heat.

Figure 6.
Shaded alleys under canopy cover. Source: Co-author.

3.2 Shading through vegetation

Proper shading of building surfaces is an effective method to reduce the undesirable thermal load, especially during periods of high-intensity solar radiation, such as the summer period of the year. The effectiveness of shade is largely dependent on canopy spread, the height of the trees, and the location of trees & shrubs within the site. One of the best methods to reduce the air temperature is by providing shade to the building roof, south-west &west facing walls & windows. This also helps in hastening early evening cooling. South-facing roof & wall surfaces have to be shaded as these surfaces receive the majority of direct sunlight when the sun is higher in the sky. Proper plants have to be provided for shading the east or west-facing surfaces as these surfaces receive direct sunlight in the morning & afternoon. Deciduous trees can be used to block the sunlight during the summer period. Sun crosses the sky at a lower angle during the winter period but proper planting of tall trees or trimming up the branches helps to achieve desirable winter sunlight. The ambient temperature around the structure as well as the indoor temperature can be reduced to some degree by shading other parts of the building & its adjacent site. The landscape design of the site is also an important tool to reduce the reflected light towards a building from surrounding surfaces (**Figure 6**).

Vine covered frames or pergolas & high bushes can also be used for shading the surfaces. One main advantage of a newly planted vine is that it can provide shade much earlier than a newly planted tree. It is an effective method to cover east and west-facing surfaces by vertical vine-covered trellis while horizontal trellis can be used on any orientation. Bushes can be used on north-facing surfaces to block the low sun (**Figure 7**).

3.3 Directing wind

Evergreen plants can be used in landscape designing to protect the cold winter winds. These plants can be used on the north, east & west sides of a building. Both evergreen trees and shrubs are used for continuous shading or to block heavy winds. Trees and shrubs with low crowns are used as an effective windbreak system that can block wind, close to the ground. Key locations, a well-designed landscape system & proper selection of plants help to reduce the total expenses for winter heating & summer cooling of a building. It can be reduced as much as twenty-five percent.

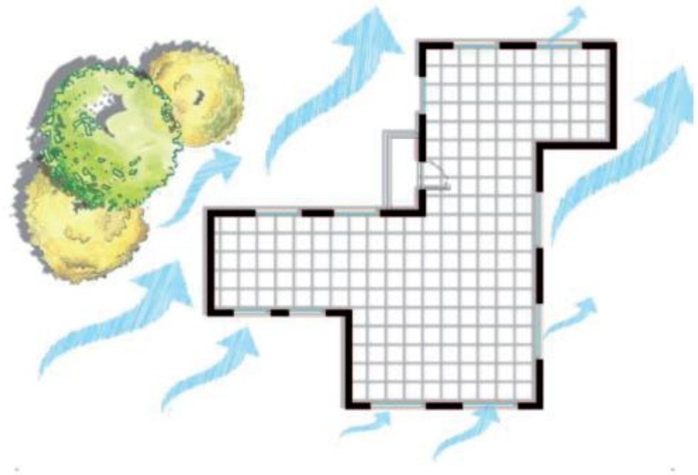


Figure 7.
Shading of west walls through landscaping. Source: Authors.

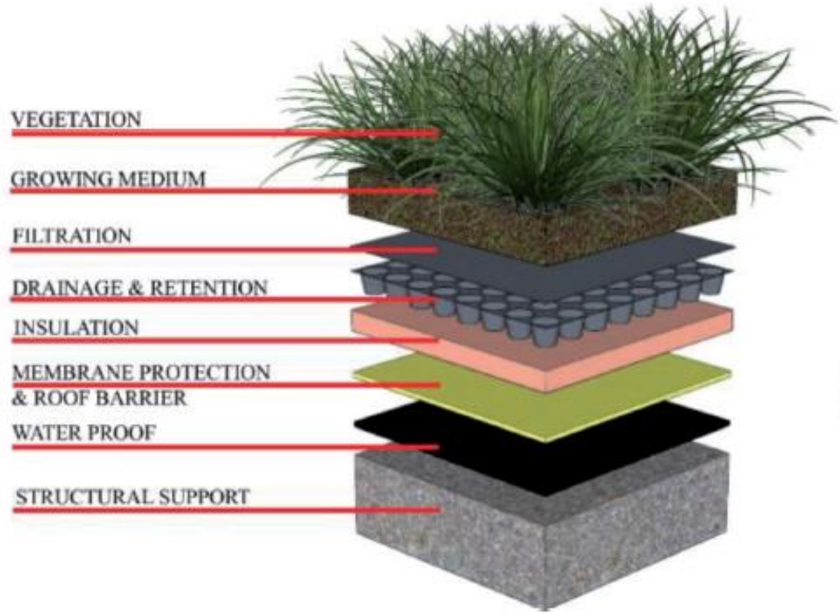


Figure 13.
Schematic cross section of a green roof. Source: Redrawn by Co-author, reference from American Wick Drain: https://www.awd-usa.com/drainage-applications/green-roof.

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SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

UNIT – IV – PLANTS AND SUSTAINABILITY– SARA7331

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF ARCHITECTURE

COURSE MATERIAL

Subject Name: Sustainable Landscape Planning UNIT IV SUBJECT CODE: SARA7331

LANDSCAPE MANGEMENT

Sustainable Landscape Planting

- A sustainable landscape is a healthy and resilient landscape that will endure over the long term without the need for high input of scarce resources such as water.
- A sustainable landscape is in harmony with local environmental conditions, including climate, topography, soil and water.
- Far from being environmentally friendly, parks and gardens, both public and private, are all too often consumers and contaminators

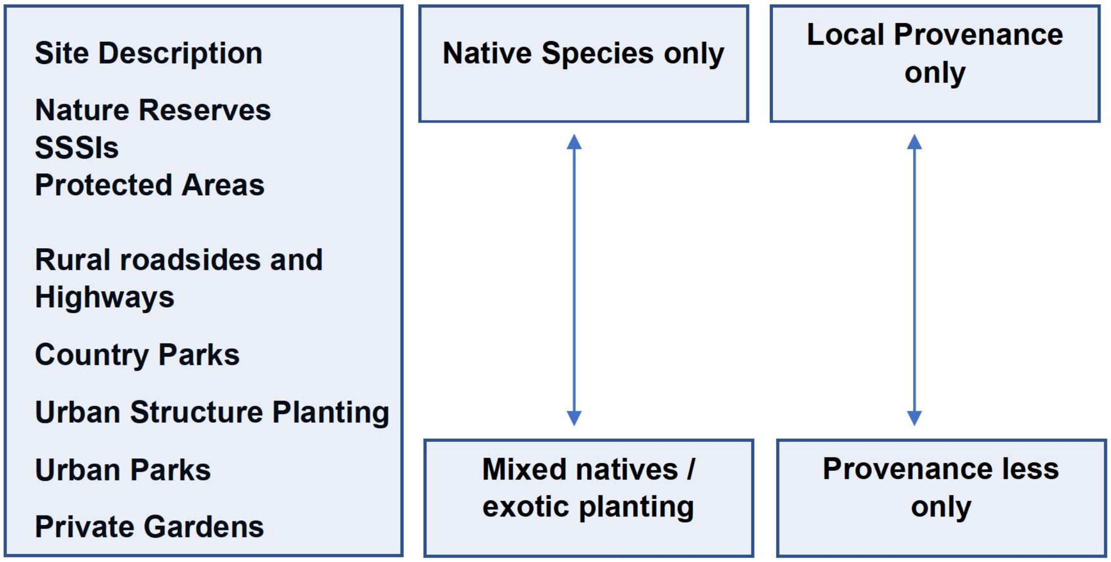
Selection Process:

The selection of plant material and the way that vegetation used onsite can have a profound influence on the sustainability of any designed or planned landscape.

- Current mainstream or standard landscape planting is characterized by the widespread use of relatively few species.
- Horticultural practices have relied on relatively high fertility organic matter and water availability for their success.
- The basis of a sustainable approach to landscape planting □Choose species that are suitable to the site
- Sustainable plant choices must be those that will best establish and succeed under given site conditions

Environmental Impact of mainstream landscape planting

Stage	*Possible environmental issues*
Plant production	Pollution, energy consumption, loss of finite resources and ecosystem function (e.g. horticultural peat), ecosystem depletion through habitat stripping
Distribution	Energy consumption, air and water pollution, use of finite resources in packaging
Site treatment	Energy consumption, ecosystem loss, hydrological effects, air, water and soil pollution
Plant establishment	Energy consumption (planting vs. succession/regeneration), air, water and soil pollution.
Design in use	Ecosystem disruption (native vs. non-native, local genotypes, habitat quality etc.), energy consumption, recycling of organic materials
Long-term functioning	Energy consumption, replacement needs (clearance and replanting, or dynamic succession)



The eight sustainability principles applicable to all urban landscapes, public and private, include:

1.Design for local environmental conditions

2.Plant selections that require little supplementary water

3.Non-invasive plant selections

4.Minimal chemical use

5.Provision of habitat for local native fauna

6.Water conservation measures

7.Minimal non-renewable energy consumption

8.Use of sustainably and locally sourced products and materials.

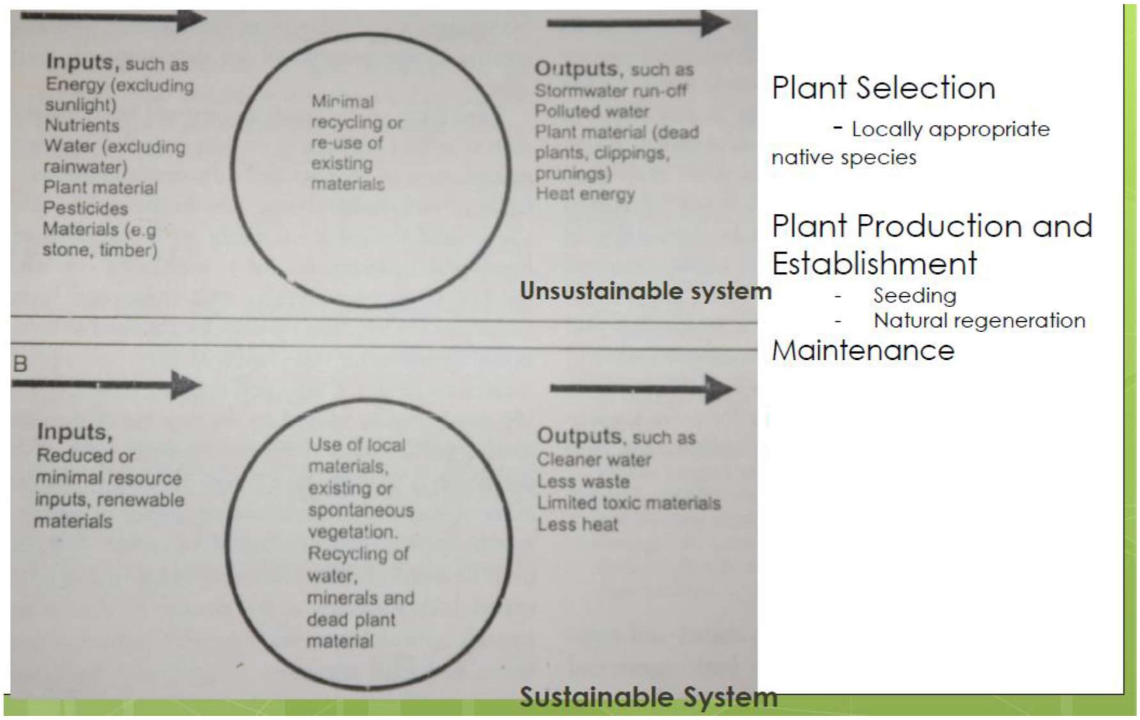
Horticultural Practices

- Diminishing resources, climate change, and invasive species challenge our ability to grow plants.

- Sustainable horticultural practices are necessary in order to conserve natural resources, enhance our environment, provide economic opportunities, and meet our nutritional needs.

- Increasingly research on this topic is occurring in urban and peri-urban settings, and encompassing social programs to promote health and improve the quality of life for local communities

Sustainable horticultural practices



New urban horticultural systems

New horticultural practices have been developed to maximise the use of space, to optimise the use of inputs and to minimise impacts of horticulture on human and environmental health.

Some of the new techniques are:

- growing horticultural crops on urban built-up land with various types of urban substrates (e.g. on roof tops, organic farming and hydroponic production)

The purpose is to

- save water in highly populated areas,
- produce pesticide-free vegetables year-round with a low content of heavy metals and human pathogens, and
- control wastage and leaching (fertilisers, pesticides, organic matter, water) into the urban environment.

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INSTITUTE OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF ARCHITECTURE

COURSE MATERIAL

Subject Name: Sustainable Landscape Planning UNIT IV **SUBJECT CODE: SARA7331**

Derelict Landscapes

The term "derelict land" is commonly used to describe land which is uncared for or which has been damaged by some use or process and then neglected. From a landscape stand point the term is applied to land which has become derelict and unsightly through human activities and industrial operations.

The surface can be fairly level but barren of vegetation or it may be pitted with deep furrows and excavations or disfigured with spoil heaps, ridges and mounds like a lunar landscape. The surface covering can vary from coarse grass or rough scrub to bare rock, slag, chemical wastes or just infertile subsoil or the land may be covered with water or it may be subjected flooding or liable to subsidence.

Definition:

- *Land which has been damaged by extractive or other industrial processes, which in its existing state unsightly and incapable of reasonably beneficial use and which is likely to remain so, unless subjected special reclamation treatment*
- *Land so damaged by industrial or other development that is incapable of beneficial use without treatment*
- *Land that is not in a stable or productive condition*

Types of Dereliction:

- Deep Mining
- Surface Mining
- Industry
- Transport System – Disused railway lines, bridges
- Waste Piles, Dumps, Sanitary Fills
- Borrow Pits
-

Deep Mining : These operations usually produce soil heaps, derelict buildings and equipment, and subsidence on the surface.

Surface Mining: Surface mining always result in a hole in the ground, which may either be a single large excavation or a series ridges and hollows known as " hill and dale" landscapes.

The land is scalped, top soil is buried, debris is scattered, erosion started and streams and lakes polluted with silts and other wastes. Noise, mud, dust , truck traffic and unsightly workings are typical features.

Industry: Types of dereliction left behind by industry are varied. Areas occupied by chemical and some of the ore smelting, industries have problems of toxicity and fusion of materials in waste heaps.

Transport System – Disused railway lines, bridges: For disused railway line, dereliction is seen in the cinder foundation of the tracks, derelict stations and other buildings, bridges gradually becoming dangerous.

For roads, lack of use and maintenance soon leads to the gradual development of vegetation cover and hedgerow vegetation.

In canals, the water sometimes becomes impassable with weed growth or it drains out leaving a muddy exposed bottom.

The common feature of derelict railway lines, roads and canals is their linear character.

Waste Piles, Dumps, and Sanitary Fills: Theses vary from excavations filled with town refuse to the dumping of metal wastes. These tend to spread and disfigure the complexion of regional landscape and to poison the ecosystem.

RECLAMATION OF DERELICT LAND

AIM:

The most frequent aim of reclamation is to return to some useful function land which is unsightly and neglected and cannot be put to use in its derelict condition.

However, the emphasis need not be on putting land to good use. But more on ensuing the healthy state of land balanced ecosystem and also to establish a landscape pattern that will be self -maintaining

Reclamation Objectives:
The objectives for reclaiming derelict landscapes should be

- Restoration of health and fertility of the landscape, sometimes leading to an improvement on the original state of health and fertility
- Removal and prevention of pollution
- A result that either allows flexibility in future land uses or provides specifically for a planned land use
- A landscape which is visually acceptable and fits into surrounding landscape without discord
- Providing an agreeable habitat for wildlife in a balanced ecosystem

The fundamental aspects of re-establishing a disturbed landscape are

- to provide a viable growing medium (Soils, water, suitable slopes) etc.,
- To select or encourage appropriate vegetation

Influencing Factors:

I. Functioning of the site after reclamation

- Economics
- Topographical factors
- Aesthetics
- Constraints of land uses.

II. Limitations imposed by materials found on site

III. Limitations imposed by the technical possibilities of machinery and known reclamation techniques

PROCESS:

In every built up region, one finds derelict land

- Such parcels may be blighted by vacant or deteriorating structures or by undesirable uses.
- They may be narrow strips or fragments by passed and left because of their unsuitability as building sites
- They may comprise extensive wastelands created by strip mining, gravel pits or heavy fills.
- They may include swamps or wetlands misused as public dumps or eroded gullies choked with debris
- Often they are backed up against railroad and transmission rights of way and include steep slopes or water courses.

A whole city or region may be revitalized, given form, breathing space and recreation places by the reclamation of derelict lands.

1. **REMOVAL OF BLIGHT:**

A first step in the upgrading of a community landscape is the removal of offending trash, debris, weeds and all other forms of pollution.

2. **RESHAPING THE DISFIGURED EARTH:**

When the land has been subjected to erosion, uncontrolled landfills, strip mining, or pit extraction, there will be a need for regrading and recontouring.

3. **RESTORING THE TOPSOIL SECTION**

Depleted farm fields, contaminated watershed s, slag dumps often require major soil restoration measures as part of their rehabilitation.

Topsoil – Topsoil is composed of disintegrated rock and the remains of plants and animals. It is the upper surface of the earth's crust which can support the growth of indigenous vegetation and cultivated crops.

Stage I: Preventing further degradation (i.e erosion prevention and the sealing off or treatment of mine waste and other contaminants

Stage II: Rebuilding the top soil sections: The new topsoil section may be applied directly on the stabilized land surface, if a supply is available from a well-managed sanitary landfills. A satisfactory section can be constructed by the addition and intermixing of materials such as sand, humus or other soil conditions. (Humus - organic constituent of soil formed by the decomposition of plants)

4. **REESTABLISHING THE NATURAL COVERS.**

Vegetation protects soil from blowing winds or by the runoff of falling rain. As a soil protector, their
roots, shoots and tendrils together with decaying leaves, twigs and branches form a tightly interlaced mat that absorbs and hold the water, allowing its percolation into the earth.

- Retention and protection of as much of the existing vegetation, if any, on site will enhance the appearance and condition of the site when reclaimed or developed.
- The selection of plant materials is dependent upon land use objectives, various site factors, and the species that can grow in the site.

Temporary erosion control plantings: Temporary erosion control planting are selected for their ability to establish a quick cover. (e.g grass – Cynadon dactylon)

Permanent Plantings: Plants well adapted to the site should be selected i.e., they should be able to reproduce and sustain their populations for a substantial period of time.

- Deep rooting plants are best for slopes
- In natural settings, a visual blending of disturbed and undisturbed areas is achieved by selection of new plant materials similar in size, form, texture, and color to those in adjacent undisturbed areas.

Some of the important factors which may influence a designer in the plant selection of plants and methods are

1. The physical, chemical and biological nature of the derelict surface
2. The extent to which levels vary over the site
3. The ease or difficulty of drainage
4. The risk of subsidence or settlement
5. The means of access available or possible to provide
6. The haulage distance involved
7. The availability of filling and topsoil
8. Any liability to flooding or waterlogging
9. The adjoining land uses
10. The existence or absence of public services
11. The purpose for which the land is to be reclaimed

5. IDENTIFYING LAND USE

The use of land after reclamation is influenced by many factors. Different land uses have different requirements. Some common uses are

- Industrial development
- Housing

- Recreation
- Agriculture
- Nature reserves

When the nature of the after use cannot be decided the design should aim at providing a landscape which will not limit a large number of possible land uses.

Projects That Turn Damaged and Neglected Spaces Into Healthy, Beautiful Environments
http://inhabitat.com/10-landscape-design-projects-that-turn-damaged-and-neglected-spaces-into-healthy-beautiful-environments/

Reclamation: Wetlands from Wasteland

As seen in Groundswell, Constructing the Contemporary Landscape, MOMA, 2005

Reclamation: Wetlands from Wasteland

Fresh Kills Park in Staten Island, NY
Designer: James Corner Operations

Fresh Kills Landfill has become a model for landfill reclamation around the world, having been transformed into a vast green space full of wildlife. The site is large enough to support many sports and programs that are unusual in the city, including activities and features such as horseback riding, mountain biking, nature trails, kayaking, and large-scale public art. Demonstrating the role of wetland buffers in battling rising waters, Fresh Kills absorbed a critical part of the storm surge during **Hurricane Sandy**. With the help of advanced landfill gas collection infrastructure throughout the area, methane is actively harvested from the decomposing waste, providing enough gas to heat 22,000 homes. The transformation of what was formerly the world's largest landfill into a productive and beautiful cultural destination demonstrates how landscape architecture can restore balance to the land.

Reuse: Abandoned Transportation Infrastructure

Reuse: Abandoned Transportation Infrastructure

The High Line in New York City
Designer: James Corner Field Operations, Diller Scofidio + Renfro, and Piet Ouldorf

The **High Line** is a one mile stretch of abandoned elevated railroad on New York's West Side, which was under threat of demolition. After years of public advocacy, it has been resurrected as a park that's become one of the city's most popular destinations. **The park's attractions** include naturalized plantings that are inspired by the self-seeded landscape that grew on the disused tracks, unexpected views of the city and the Hudson River, and cultural attractions that are thoughtfully integrated into the architecture and plant life. The project cost substantially less that it would have been to wholly demolish and redevelop the area, and further serves as a precedent for adaptive reuse.

Remediation: Brownfield into Greenfield

*Photo © **Michael Van Valkenburgh Associates***

Remediation: Brownfield into Greenfield

Alumnae Valley, Wellesley College, Wellesley MA
Designer: Michael Van Valkenburgh Associates

Michael Van Valkenburgh Associates worked with Wellesley College to revitalize the toxic brownfield of Alumnae Valley, an area which previously hosted the college's power plant, industrialized natural gas pumping stations, and a 175-space parking lot. Managing the corrupted soil involved several strategies: removing the most toxic soil, capping and collecting the mildly contaminated soil, and then finding a way to reuse it as part of the landscape. The site was originally shaped by Ice Age glaciers. The mounds along the paths mimic the original sculpting of the land while storing remediated soil. The integration of topography, hydrology, and campus life brings Alumnae Valley back into harmony with its surroundings.

Case Studies of Successfully Reclaimed Mining Site:
http://cornerstonemag.net/case-studies-of-successfully-reclaimed-mining-sites/

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DEPARTMENT OF ARCHITECTURE

COURSE MATERIAL

Subject Name: Sustainable Landscape Planning UNIT IV SUBJECT CODE: SARA7331

Environmental And Social Benefits Of Urban Forestry And Strategies Used In Planning Management Of Urban Forestry

URBAN FORESTRY:

The urban forest may be defined as the sum of all woody associated vegetation in and around the dense human settlements, ranging from small communities in rural settings to metropolitan regions.

Urban forest is the sum of small trees, residential trees, park trees and greenbelt vegetation.

It includes all the trees in unused public and private land, trees in transportation and utility corridors.

Some of these trees and forests were wilfully planted and are carefully managed by their owners, while others are accidents of land use decisions, economics, topography, and neglect Moeller (1977) offered the first (albeit lengthy) description of the urban forest

- They are dynamic ecosystems that provide critical benefits to people and wildlife. Urban forests help to filter air and water, control storm water, conserve energy, and provide animal habitat and shade. They add beauty, form, and structure to urban design.
- Urban forestry advocates the role of trees as a critical part of the urban infrastructure. Urban foresters plant and maintain trees, support appropriate tree and forest preservation, conduct research and promote the many benefits trees provide.

The Ecology of the Urban Forest

The urban forest is a flexible concept that encompasses rows of street trees and dusters of trees in city parks, green belts between cities, and eventually forests that are more remote from the inner city. The urban forest occupies that part of the urban ecosystem made up of vegetation and related natural resources found in urban, turban, and adjacent lands, regardless of ownership as we move across the urban-rural gradient, the mix of benefits provided by the urban forest changes. The limit of the urban forest cannot be defined by a line on a map. The urban forest of today is thought of as more than just trees. The urban forest is part of an urban ecosystem in which trees are certainly an important component, however, a great diversity of other vegetation may be found in cities, ranging from non-forested wetlands and grass or brush-covered sites to natural forests, mature parks, selected cultivars on streets, and landscaped private property.

In a pioneer 8 conference, Waggoner and Ovington (1962) early on documented a building consent such that man had an important role in shaping the suburban forest, and how this forest could serve important ecological roles for society.

In addition, the urban forest is part and parcel of the human according to DeGraaf (1974), provides environment, and, habitat for a great diversity of wildlife in a city. The idea of a city as a habitat for people (consisting of structures, vegetation, and other animal species) leads to the concept of the ecosystem. Urban ecology, which is based on this concept, is defined as a blend of elements from biological ecology (natural science) and human ecology (social science). Smith (1971) described urban ecology as including the natural processes of weather, vegetation, and animal life, their interaction with man made environments, the behavioural, physiological, and developmental pro cesses of man that seem directly related to aspects of the natural environment, and the value systems that affect the inclusion of natural elements in the creation of urban environments.

Land Use and the Urban Forest

The concept of the urban forest is best understood when viewing cities from the air. For example, in the eastern United States, cities appear to be surrounded by forests and almost threatened with disappearance beneath the forest canopy. Instead of urban spread and development totally eliminating the surrounding forests, new housing and business subdivisions make significant efforts to preserve residual trees and replant those from construction. With the exception of commercial and industrial districts, cities often appear to be located in forests, as residential and park trees and trees on undeveloped land form a nearly continuous canopy of green.

History of Trees in the City

Early Use of Trees have probably been a part of cities since their first development. Since agriculture led to the first permanent settlements it stands to reason that domesticated plants were a part of the community, including trees cultivated for food. The early Egyptians described trees (Chadwick 1971).

Trees were valued for shade and aesthetics, and Urban Forestry being transplanted with balls of soil more than 4,000 years ago included in gardens around temples and palaces for priests and rulers. Even with this use it is likely most trees were selected for their utilitarian value (fruit) as well as their beauty. In thirteenth-century China, Kublai Khan required tree planting along all public roads in and around Beijing for shade and to mark them during the winter when snow covered them (Profous 1992) However, it is not likely that trees were abundant in ancient cities, except in the gardens of rulers and on the grounds of temples.

The civilizations of the Maya, Inca, and Aztecs built large cities with monumental architecture, and they supported their cities with agriculture and agroforestry systems. Drawings and descriptions of pre-Columbian America suggest many Native American tribes developed extensive agricultural communities, which included extensive gardens with planted trees.

Benefits of Urban Forestry:

Environmental Impacts

Urban forests mitigate the effects of urban heat island through evapotranspiration and the shading of streets and buildings. This improves human comfort, reduces the risk of heat stroke and decreases costs to cool buildings. Urban forests improve air quality by absorbing pollutants such as ozone, nitrogen dioxide, ammonia, and particulate matter as well as performing carbon sequestration. Urban forestry can be an important tool for stormwater management as trees absorb and store rainwater through the canopy, and slow down and filter runoff with their roots. Other benefits include noise control, traffic control, and glare and reflection control.

Mental Health Impacts

A 2018 study asked low income residents of Philadelphia "how often they felt nervous, hopeless, restless, depressed and worthless." As an experimental mental health intervention, trash was removed from vacant lots. Some of the vacant lots were "greened", with plantings of trees, grass, and small fences. Residents near the "greened" lots who had incomes below the poverty line reported a decrease in feelings of depression of 68%, while residents with incomes above the poverty line reported a decrease of 41%. Removing trash from vacant lots without installing landscaping did not have an observable mental health impact.

Urban Wildlife

Urban forestry provides potential habitat for urban wildlife. In addition, it creates great opportunities for observing wildlife to the general public.

Social Impact

Urban forest related events such as planting festivals can significantly reduce social isolation problems, enhance people's experience and raise environmental awareness. Urban forests also encourage more active lifestyles by providing space for exercise and are associated with reduced stress and overall emotional well-being. Urban forests may also provide products such as timber or food, and deliver economic benefits such as increased property values and the attraction of tourism, businesses and investment. Street trees, if managed and cared for, are beneficial in creating sustainable and healthy communities.

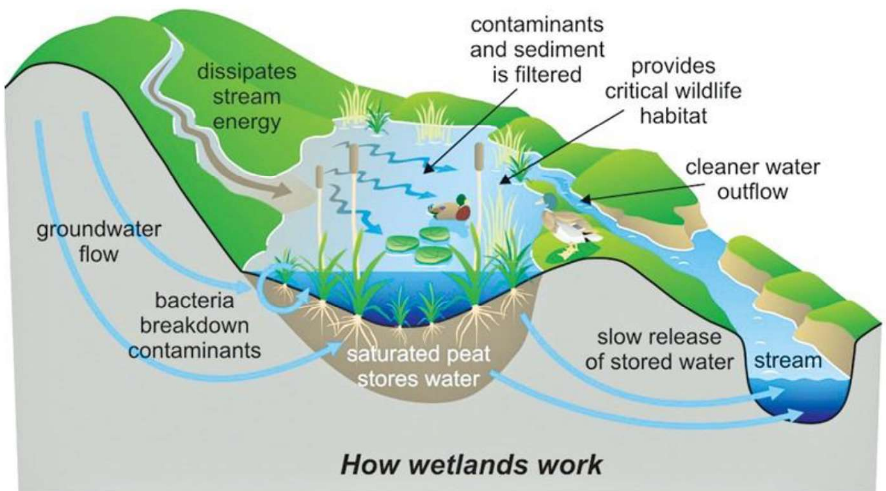
Criteria/indicators typically focus on a category of urban forest management and usually include subjects such as:

- The urban forest vegetation and its characteristics such as canopy cover, age distributions, and species diversity.
- Having a community focus that involves industry cooperation, and community and stakeholder involvement.
- The planning of the urban forest and whether it is successful in the management and funding of the urban forest.

The incorporation of indicators into management plans are a strong aid in the implementation and revision of management plans and help reach the goals within the plan.

A key part of a master plan is to map spaces where trees will be planted. In the paper *A methodology to select the best locations for new urban forests using multicriteria* *analysis*, three different steps are outlined for determining planting areas. The first stage is an excluding stage, which uses a set of criteria to exclude poor locations and indicate potential locations for planting. Second is a suitability stage, which evaluates the potential locations to determine a more selective group of suitable spots. Finally, the feasibility stage is a final test to determine if the suitable locations are the most feasible planting areas with minimal site use conflicts.

"WETLANDS" IMPORTANCE AND ECOLOGICAL FUNCTIONS AND STRATEGIES



Wetlands are areas where water is the primary factor controlling the environment and the associated plant and animal life. They occur where the water table is at or near the surface of the land, or where the land is covered by water.

Five major wetland types are generally recognized:

• marine (coastal wetlands including coastal lagoons, rocky shores, and coral reefs);

• estuarine (including deltas, tidal marshes, and mangrove swamps);

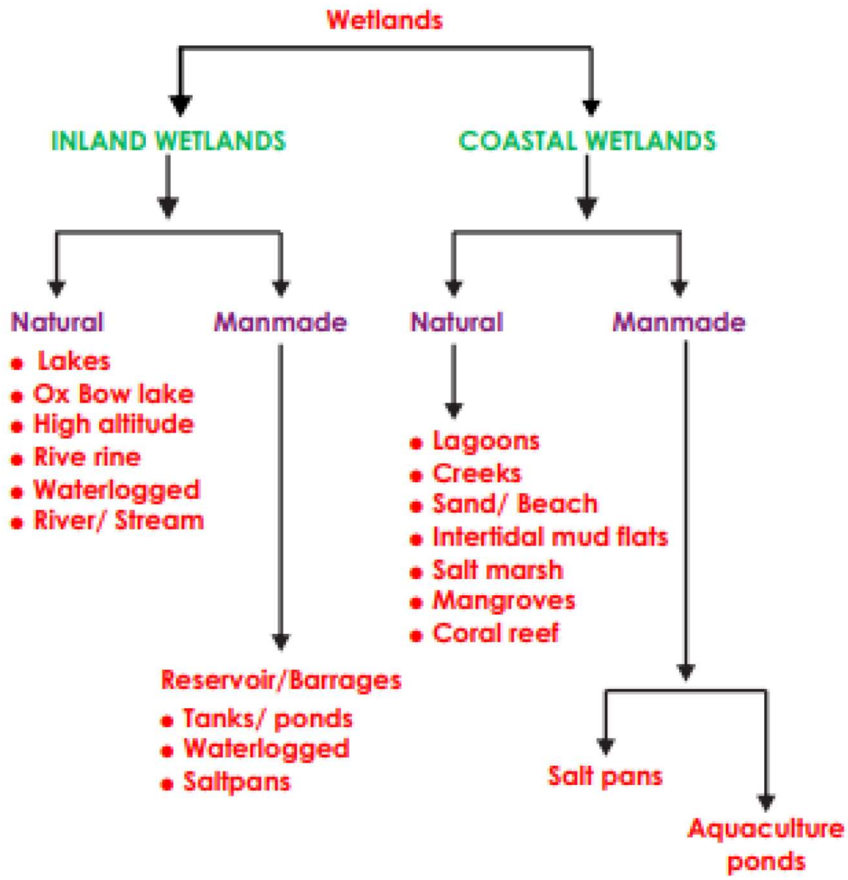
• lacustrine (wetlands associated with lakes);

• riverine (wetlands along rivers and streams); and

• palustrine (meaning "marshy" – marshe

In addition, there are human-made wetlands such as fish and shrimp ponds, farm ponds, irrigated agricultural land, salt pans, reservoirs, gravel pits, sewage farms and canals. s, swamps and bogs).

TYPES OF WETLANDS




Marine wetlands


Riverine wetlands


Palustrine wetlands


Lacustrine wetlands

The Ramsar Contracting Parties, or Member States, have committed themselves to implementing the "Three Pillars" of the Convention: to designate suitable wetlands for the List of Wetlands of International Importance ("Ramsar List") and ensure the effective management; to work towards the wise use of all their wetlands through national land-use planning, appropriate policies and legislation, management actions, and public education; and to cooperate internationally concerning transboundary wetlands, shared wetland systems, shared species, and development projects that may affect wetlands.

The mission of the Ramsar Convention (Ramsar, 1996) is "the conservation and wise use of wetlands by national action and international cooperation as a means to achieving sustainable development throughout the world".

Importance Of Wetlands

- Erosion control
- Ground water recharge
- Water purification

Threats to Wetlands

- Urbanization
- Anthropogenic activities
- Pollution
- Climate Change.

Wetlands Loss and Degradation

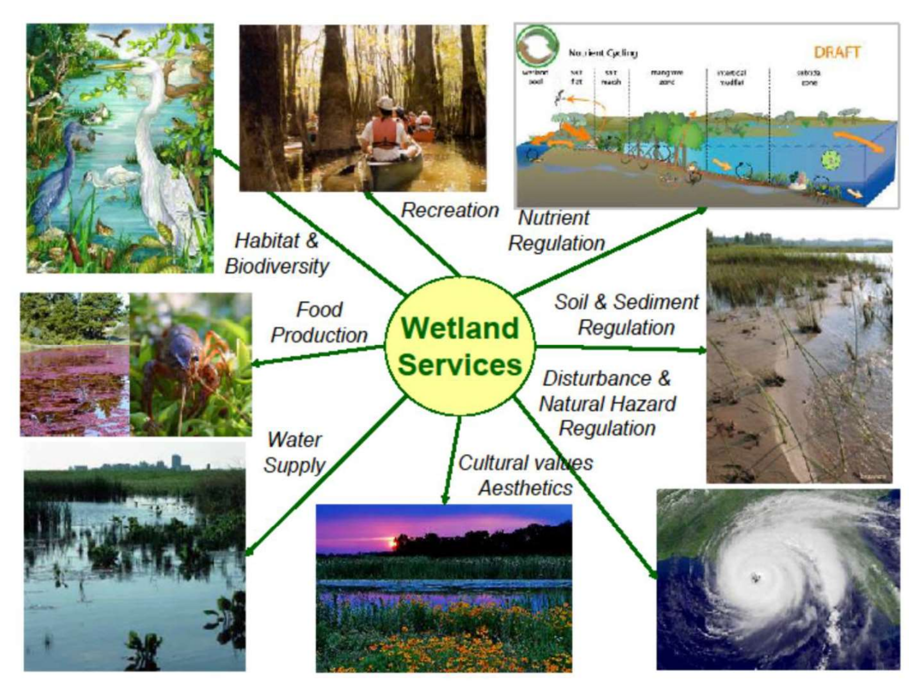
- Wetland loss is the loss of wetland area, due to the conversion of wetland to non- wetland areas, as a result of human activity (Reduction in wetland area).
- Agricultural conversion
- Reclamation for development
- Excessive siltation
- Climate change impact

Wetland degradation" is the impairment of wetland functions as a result of human activity (Reduction in wetland functions).

- Reduced water quality
- Changes in the water regime
- Excessive biomass removal
- Loss of biodiversity
- Introduction of exotic species
- Climate change impacts

USE VALUES			NON-USE VALUES
Direct Use Value	**Indirect Use Value**	**Option And Quasi-Option Value**	**Existence Value**
• Fish • Agriculture • Fuel Wood • Recreation • Transport • Wildlife Harvesting • Peat/Energy	• Nutrient retention • Flood control • Storm Protection • Ground Water Recharge • External Ecosystem Support • Micro-Climatic Stabilization • Shoreline Stabilization, etc.	• Potential future uses(as per direct and indirect uses) • Future value of information	• Biodiversity • Culture, heritage • Bequest values

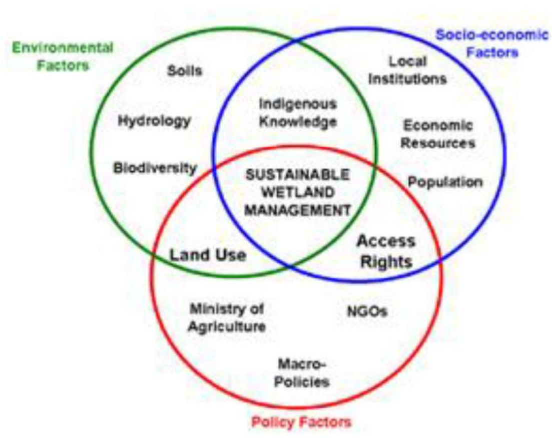
Table No. 4. Classification of total economic value for wetlands



Sustainable Wetland Management

Given the fragility of wetlands, their importance for water supply and the growing pressures to convert them to agriculture uses, there is an urgent need to try to achieve sustainable use of wetlands. This requires management regimes which help maintain some of the natural characteristics of wetlands while also allowing partial conversion to allow activities which can meet the economic needs of communities. A balance has to be struck between the environmental functioning of wetlands and their use for livelihood purposes. Responding to economic/market conditions so as to create sustainable use regimes is critical.

Sustainable wetland management regimes are found in various situations. Usually they involve minimal conversion of the wetland and limited degradation of the catchment. However, more interventionist regimes can be found which are sustainable where more complex water management regimes are applied. Wetlands play a vital role in the carbon cycle and wetland loss may have impacts which encourage global warming and climate change.

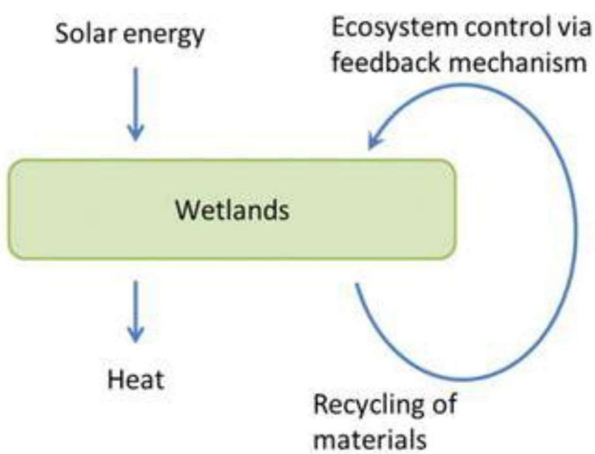


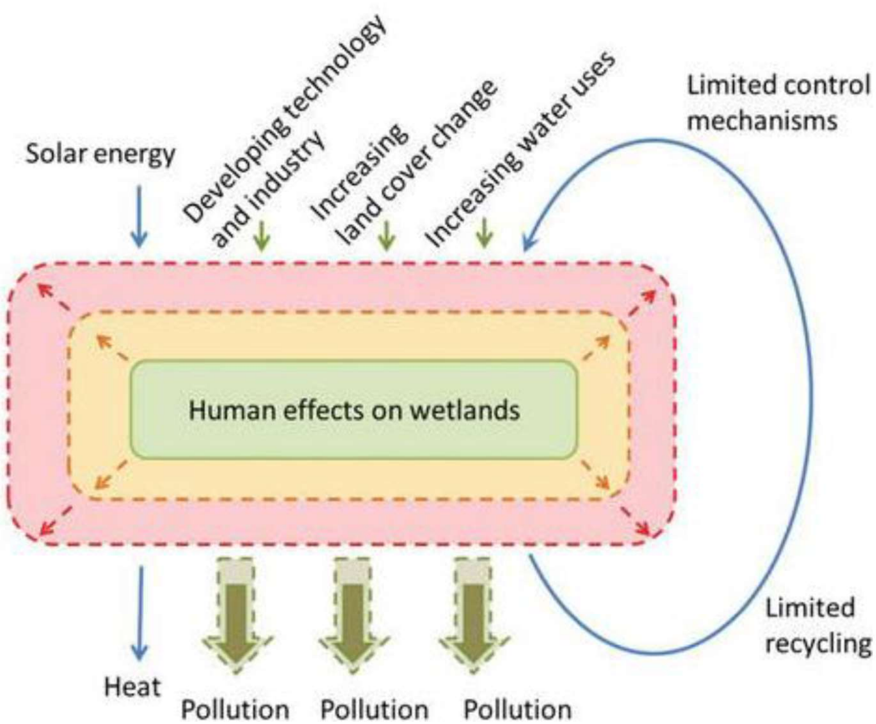
Understanding the implications of wetland transformation for carbon sequestration and the way in which different wetland management regimes can impact upon this process

'The World has enough for everybody's need, not everybody's greed' – these famous words of Mahatma Gandhi symbolize the project that we have undertaken.

The ecologically-sensitive Pallikaranai Marsh, one of the last remaining natural wetlands in south India has been deteriorating steadily due to ill – planned urbanization, destructive reclamation and dumping of solid waste reveal that the marsh water is polluted, mercury level is seven times more than the permissible limit.

The results of this study are truly significant and can help in the betterment of the locality and also motivate the civic body to start working towards protecting this marsh.





Assignment as group work to analyze Pallikarni Marsh and submit report.

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INSTITUTE OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF ARCHITECTURE

COURSE MATERIAL

Subject Name: Sustainable Landscape Planning UNIT IV **Subject Code: SAR5624**

Impact of mining on landscape and mitigation

Environmental impacts of mining can occur at local, regional, and global scales through direct and indirect mining practices. The implantation of a mine is a major habitat modification, and smaller perturbations occur on a larger scale than exploitation site, mine-waste residuals contamination of the environment for example. Adverse effects can be observed long after the end of the mine activity. **Mining** adversely **affects** the environment by inducing loss of biodiversity, soil erosion, and contamination of surface water, groundwater, and soil. The leakage of chemicals from **mining** sites **can** also have detrimental effects on the health of the population living at or around the **mining** site.

Destruction of the habitat is the main component of biodiversity losses, but direct poisoning caused by mine-extracted material, and indirect poisoning through food and water, can also affect animals, vegetation and microorganisms. Habitat modification such as pH and temperature modification disturb communities in the surrounding area. Endemic species are especially sensitive, since they require very specific environmental conditions. Destruction or slight modification of their habitat put them at the risk of extinction. Habitats can be damaged when there is not enough terrestrial product as well as by non-chemical products, such as large rocks from the mines that are discarded in the surrounding landscape with no concern for impacts on natural habitat.

Concentrations of heavy metals are known to decrease with distance from the mine, and effects on biodiversity tend to follow the same pattern. Impacts can vary greatly depending on mobility and bioavailability of the contaminant: less-mobile molecules will stay inert in the environment while highly mobile molecules will easily move into another compartment or be taken up by organisms. For example, speciation of metals in sediments could modify their bioavailability, and thus their toxicity for aquatic organisms.

Biomagnification plays an important role in polluted habitats: mining impacts on biodiversity, assuming that concentration levels are not high enough to directly kill exposed organisms, should be greater to the species on top of the food chain because of this phenomenon.

Adverse mining effects on biodiversity depend a great extent on the nature of the contaminant, the level of concentration at which it can be found in the environment, and the nature of the ecosystem itself. Some species are quite resistant to anthropogenic disturbances, while some others will completely disappear from the contaminated zone. Time alone does not seem to allow the habitat to recover completely from the contamination. Remediation practices take time, and in most cases will not enable the recovery of the original diversity present before the mining activity took place.

Mitigating Impacts

At many sites, the key reclamation, soil treatment, and water quality concerns owe their origin to the same process — the oxidation of sulfide minerals, especially the iron sulfide, pyrite. Oxidation of sulfide minerals can produce acidic conditions that release metals in both waste materials and water.

Now, mine closure and a number of activities to mitigate the impacts of mining are an integral part of all metal mine planning and mineral development from the discovery phase through to closure:

- Reclamation
- Soil treatment
- Water treatment
- Preventing acid rock drainage
- Controlling gas emissions

Reclamation entails the re-establishing of viable soils and vegetation at a mine site. Although regulatory agencies may require complex reclamation designs, simple approaches can be very effective. One simple approach depends on adding lime or other materials that will neutralize acidity plus a cover of top soil or suitable growth medium to promote vegetation growth. Modifying slopes and other surfaces and planting vegetation as part of the process stabilizes the soil material and prevents erosion and surface water infiltration. Even this simple approach is likely to cost a few thousand dollars per acre to implement. Where soils have a sustained high acidity, the costs of using this approach can increase, sometimes to tens of thousands of dollars per acre. The challenge to find cost-effective reclamation approaches continues.

Soil Treatment

High levels of metals in soils, not just acidity, can be harmful to plants, animals, and, in some cases, people. A common approach used in dealing with contaminated soil is to move it to specially designed repositories. This approach can be very expensive and controversial, but it is sometimes required. With this approach, the volume and toxicity of the soil is not reduced, the soil is just relocated. Effective soil treatment approaches in the future depend upon better understanding of the risks associated with metals in mine wastes. These "natural" metals in minerals may not be as readily available in the biosphere, and therefore, they may not be as toxic as the metals in processed forms, such as lead in gasoline.

Future approaches may include:

- Using chemical methods to stabilize metals in soils, making them less mobile and biologically available.
- Using bacteriacides that stop the bacterial growth that promotes the oxidation of pyrite and the accompanying formation of sulfuric acid.
- Using bioliners, such as low permeability and compacted manure, as barriers at the base of waste piles.

- Permanently flooding waste materials containing pyrite to cut off the source of oxygen, stop the development of acidic conditions, and prevent mobilization of metals.

Water Treatment

The most common treatment for acidic and metal-bearing waters is the addition of a neutralizing material, such as lime, to reduce the acidity. This "active" treatment process, which causes the dissolved metals to precipitate from the water, usually requires the construction of a treatment facility. The ongoing maintenance that such a plant requires makes this treatment technique very expensive.

Aside from the expense, some active treatment plants generate large amounts of sludge. Disposal of the sludge is a major problem. Because of the cost and the physical challenges of dealing with sludge, alternatives to active treatment facilities are needed. Some possible alternatives include:

- Using "passive" wetland systems to treat metal-bearing water. This approach has been successfully used where the volumes and acidity of the water are not too great. Passive wetland systems have the added advantage of creating desirable wildlife habitat.
- Using in-situ treatment zones where reactive materials or electric currents are placed in the subsurface so that water passing through them would be treated.
- Combining treatment with the recovery of useful materials from contaminated water.

Impacts of Mining

Impacts on water resources

- Perhaps the most significant impact of a mining project is its effects on water quality and availability of water resources within the project area.
- Key questions are whether surface and groundwater supplies will remain fit for human consumption, and whether the quality of surface waters in the project area will remain adequate to support native aquatic life and terrestrial wildlife.

Acid mine drainage and contaminant leaching

- When mined materials (such as the walls of open pits and underground mines, tailings, waste rock, and heap and dump leach materials) are excavated and exposed to oxygen and water, acid can form if iron sulfide minerals (especially pyrite, or 'fools gold') are abundant and there is an insufficient amount of neutralizing material to counteract the acid formation.
- The acid will, in turn, leach or dissolve metals and other contaminants from mined materials and form a solution that is acidic, high in sulfate, and metal-rich (including elevated concentrations of cadmium, copper, lead, zinc, arsenic, etc.)

- Leaching of toxic constituents, such as arsenic, selenium, and metals, can occur even if acidic conditions are not present. Elevated levels of cyanide and nitrogen compounds (ammonia, nitrate, nitrite) can also be found in waters at mine sites, from heap leaching and blasting.
- Metals are particularly problematic because they do not break down in the environment.

- They settle to the bottom and persist in the stream for long periods of time, providing a long-term source of contamination to the aquatic insects that live there, and the fish that feed on them.
- Even in very small amounts, metals can be toxic to humans and wildlife. Carried in water, the metals can travel far, contaminating streams and groundwater for great distances.
- The impacts to aquatic life may range from immediate fish kills to sublethal, impacts affecting growth, behavior or the ability to reproduce.

Erosion of soils and mine wastes into surface waters

For most mining projects, the potential of soil and sediment eroding into and degrading surface water quality is a serious problem.
Sediment-laden surface runoff typically originates as sheet flow and collects in rills, natural channels or gullies, or artificial conveyances. The ultimate deposition of the sediment may occur in surface waters or it may be deposited within the floodplains of a stream valley. Historically, erosion and sedimentation processes have caused the build-up of thick layers of mineral fines and sediment within regional flood plains and the alteration of aquatic habitat and the loss of storage capacity within surface waters

Major sources of erosion/sediment loading at mining sites can include open pit areas, heap and dump leaches, waste rock and overburden piles, tailings piles and dams, haul roads and access roads, ore stockpiles, vehicle and equipment maintenance areas, exploration areas, and reclamation areas. A further concern is that exposed materials from mining operations (mine workings, wastes, contaminated soils, etc.) may contribute sediments with chemical pollutants, principally heavy metals.

Impacts of mining projects on air quality

- Airborne emissions occur during each stage of the mine cycle, but especially during exploration, development, construction, and operational activities. Mining operations mobilize large amounts of material, and waste piles containing small size particles are easily dispersed by the wind. The largest sources of air pollution in mining operations are:
- Particulate matter transported by the wind as a result of excavations, blasting, transportation of materials, wind erosion (more frequent in open-pit mining), fugitive dust from tailings facilities, stockpiles, waste dumps, and haul roads.
- Exhaust emissions from mobile sources (cars, trucks, heavy equipment) raise these particulate levels; and Gas emissions from the combustion of fuels in stationary and mobile sources, explosions, and mineral processing.

Climate change considerations

Every EIA for a project that has the potential to change the global carbon budget should include an assessment of a project's carbon impact. Large-scale mining projects have the potential to alter global carbon in at least the following ways:

Lost CO_2 uptake by forests and vegetation that is cleared. Many large-scale mining projects are proposed in heavily forested areas of tropical regions that are critical for absorbing atmospheric carbon dioxide (CO_2) and maintaining a healthy balance between CO_2 emissions and CO_2 uptake. Some mining projects propose long-term or even permanent destruction of tropical forests. EIAs for mining projects must include a careful accounting of how any proposed disturbance of tropical forests will alter the carbon budget. The EIA should also include an analysis of the potential for the host country to lose funding from international consortiums that have and will be established to conserve tropical forests.
CO_2 emitted by machines (e.g., diesel powered heavy vehicles) involved in extracting and transporting ore.
The EIA should include a quantitative estimate of CO_2 emissions from machines and vehicles that will be needed during the life of the mining project. These estimates can be based on the rate of fuel consumption (typically diesel fuel) multiplied by a conversion factor that relates units (typically liters or gallons) of fuel that is consumed and units (typically metric tons) of CO_2 that is emitted.

PAPERS HAVE BEEN SHARED WITH STUDENTS FOR ALL UNITS TO READ MORE

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