Ecological Engineering

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Environmental Management

- Invasive species
- Buffer zones
- Erosion control
- Landscape planning
- Stream management
- Coastal zone management
- Water cycle management
- Watershed management

Invasive species management

- Invasive species aggressively invade new continents so that these species becomes dominant in their new geographical area
- These includes plants, mammals, birds, fish, amphibians and reptiles, arthropods, mollusks, and plant and animal diseases.
- The degrade natural communities and damage agricultural species with pest and diseases.

- These species arrived on contents after 16 century after human global travel, commerce and migration increased.
- Invasive species causes environmental degradation.
- Types of invasive species
  - Alien species from other continents
  - Hybrid species with introgressed genes (sometimes exotic species form hybrid with native species, so that subsequently the newly emerged hybrid becomes dominant in either novel or native geographical location).

- Transgenic weeds (hybrid of native and transgenic)

Eichhornia crassipes

Lythrum salicaria (purple lossestrife*)*

Invasive species control

- Restoration of natural conditions following anthropogenic disturbance
  - Best time to control invasive species is immediately after first individual established and before it sets seeds.
  - Natural disturbance such as fire, flooding, manual removal, shading, substrate removal, herbicide and biocontrol.
  - Success of implementing natural disturbance is dependent.

- Habitat protection via banning of invasive introductions
  - Many countries have laws to prevent international introduction of invasive species.
  - In USA, it is regulated by USDA Animal and Plant Health Inspection Service

- Biological control
  - Biocontrol can achieved by introduction of a parasite from the region of the invasive species origin.
  - Control of *Opuntia vulgaris* in India-species which was introduced from Brazil.
  - A sclae inset *Dactylopius ceylonicus* was released in 1795, insect completely controlled cactus in India.

- In a similar attempt to control Opuntia on the islands of Nevis in the Lesser Antilles, disaster occurred with wide reaching and unintened consequences.
- In 1957, cactus moth (*Cactoblastis cactorum*) was released to control Optunita, but the moth escaped to destory population of the rare O. spinosissima.

Table 2 Mechanisms for the control of invasive plant species

Method	*Advantages*	*Disadvantages*
Hand or machine cutting	Labor intensive although less so than some other methods	Most species grow back from underground parts
Root pulling	Removes underground parts of plant that may regrow	Disrupts the soil and may encourage reinvasion of the exotic species from seeds or plant fragments
Herbicide application	Easy to accomplish relative to more labor intensive methods	May kill native species
Handcutting with herbicide application to cut shoots (Bradley method)	Very effective removal mechanism, especially for woody species	Uses herbicides, although in very small amounts
Herbicide	Can be effective in the removal of certain species; less labor intensive than other mechanisms, so that it can be used to treat large tracts of land	Improper usage may harm the health of users and/or the environment
Biocontrol (release of insects or pathogens transferred from their continent of origin)	Can target the invading species only	Pests may be unpredictable; native species may be damaged

- Physical control of invasive species
  - It includes digging, removal and harvesting
  - Invasive species can be snipped at the base by hand with a long handled clipper
  - Mechanical mowing with a tractor or by hand with a scythe

Coastal Zone Management

- Coastal waters are suffering from increasing eutrophication, increase in turbidity, harmful algal blooms, fisheries collapse, and loss of biodiversity.
- These waters are increasingly polluted and impacted by oil spills, has impacts of climate change.
- If these issues are not address, coastal water will degrade and ultimately may suffer adversely.

- Management
  - In costal waters applications of ecohydology are the use of macrophytes to enhance the internal consumption rate, and benthic suspension feeders, such as bivalve mollusks, sponges, tunicates and polychetes to filter and pelletize excess nutrients and planktons.

- Costal water quality can be restored by planning to store sea grass and coral reefs
- By adapting ecohydology as the guiding principle for managing human activities on land at the same time protecting fisheries (fisheries buy out programme); engineering technology to treat wastewater.
- Ecological engineering combination with technology → creation of freshetes (the flood of a river from heavy rain or melted snow) and smarter land use.

- Necessitates changing present governmental practices based on political geography or specific activities (e.g. farming, water resources, fisheries, and urban development).
- A high level of collaboration among stakeholders in order to develop best practices.

Shoreline erosion management

- Erosion is displacement of solids (e.g. soil, mud and rocks) by agents such as wind, water or ice by downward movement in response to gravity or by living organisms.
- Rate of erosion depends upon environmental factors such as soil texture, gradient of slope, ground cover (vegetation, land use) and current velocity of streams.

- Due to rapid agricultural/indstrial development and mismanagement of natural ecosystem, erosion (especially soil).
- Soil erosion is accelerated by water (e.g. rain detaching and transporting soil), wind, or tillage, and affects greatly agriculture area and natural environment.

Figure 1 Severe soil erosion in a wheat field near Washington State University, USA. Photographer: Jack Dykinga, http://www.ars.usda.gov/is/graphics/photos/k5951-1.htm.

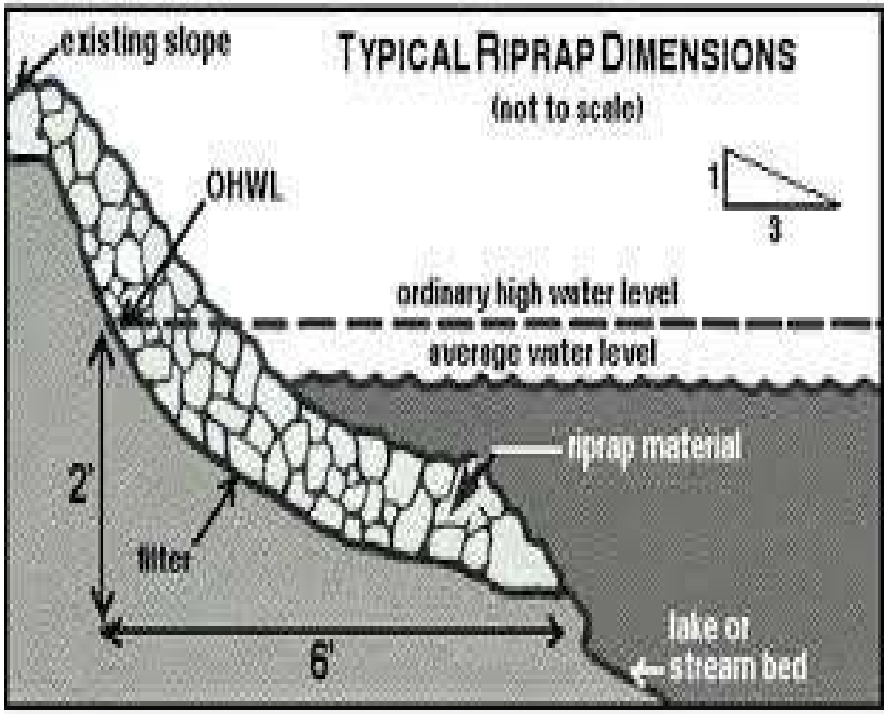
Figure 2 Wind erosion on Ulen fine sandy loam, Grand Forks, North Dakota, USA. Photographer: Adrian Fox, http://www.nrcs.usda.gov/TECHNICAL/ECS/agronomy/Photo%20File/FrontAgr3.jpg.

Figure 3 Yangtze River showing the sediment-rich water, the Three Gorges, Hubei Province, China. From http://www.soilerosion.net/.

- Main ‘on-site’ impacts of soil erosion:
  - Loss of nutrient rich upper layer
  - Reduced water holding capacity
  - Agricultural productivity
  - Main ‘on-site’ impacts of soil erosion:
  - Transportation of soil → accumulation of sediments
  - Agricultural pollutants in watercourses → silting up of dams, disruption of ecosystems of lakes, contamination of drinking water and downstream watercourses.
  - The border area between land and water (e.g. shoreline, riparian zone) is extremely sensitive to erosion.

- Sand bar was dredged via a clam shell and placed in an used gravel parking lot within the park, to naturally dewater.
- Creation of a stabilized area where the multipurpose trail is located adjacent to an ecologically sensitive area.
- Placed riprap by taking into consideration the worst case scenario.
- Placement of the riprap below the water line created an artificial stone shoreline → erosion/wave energy dissipater.

- Third phase: placing of the dewatered dredged material (sand) over the newly place riprap, creating a higher elevation dune line.
- A buffer of c.8-9 m between the water and trail.



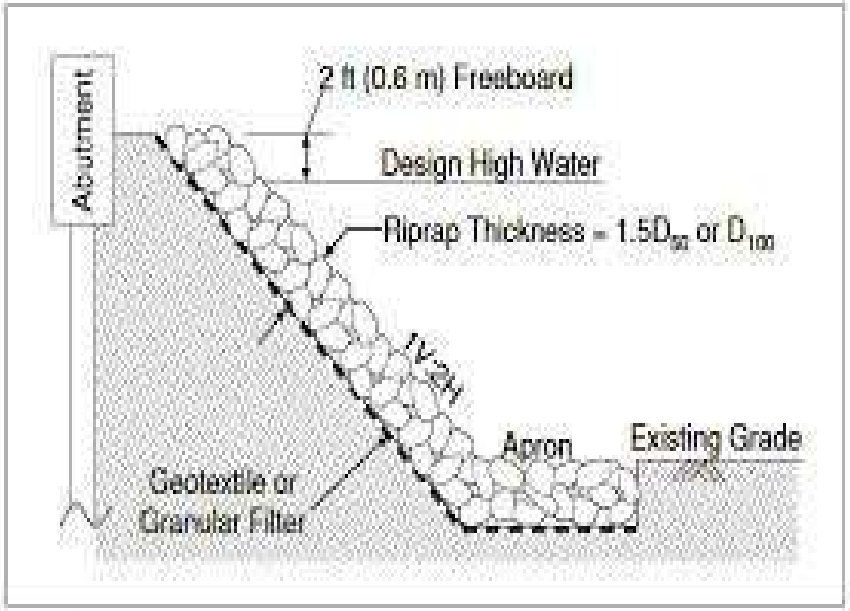


Figure 14.8. Typical cross section for abutment riprap (Lagasse et al. 2006).

- To enhance ‘natural’ appearance of shoreline, randomly spaced down trees and stumps from the park.
- To function as a groins, tree root bases were anchored behind the rip rap in the fill, and the trunks extended out past the rip rap and into the water, also serving as sediment catch basin.

- Prior to planting indigenous vegetation, plant community goals were established to ensure that the plants would thrive in newly created environment.
- Final preparation of the site prior to planting include the additional top soil to the upper layer of sand, and shaping of the dune line.
- Final phase, vegetation planting, use local source plant material.