ECOLOGICAL RESTORATION

The process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed is called ecological restoration or eco-restoration. Eco-restoration involves: To bring back original normalcy of function, structure, potential, service and process of eco system. Eco-restoration focuses on rectification of four basic component of ecosystem:

1. Mineral cycle,
2. Water cycle,
3. Energy flow and
4. Succession

RESTORATION OF AQUATIC ECOSYSTEMS

Due to various anthropogenic activities to cater the needs of growing population, the degradation of freshwater ecosystems by a variety of stressors has increased logarithmically. As a result, many aquatic ecosystems are in need of some drastic corrective measures/restoration. Restoration is the "return of an ecosystem to a close approximation of its condition prior to disturbance" or the reestablishment of pre-disturbance aquatic functions and related physical, chemical and biological characteristics. It is a holistic process not achieved through the isolated manipulation of individual elements. The objective is to emulate a natural, self-regulating system that is integrated ecologically with the landscape in which it occurs. Often, restoration requires one or more of the following processes: reconstruction of antecedent physical conditions, chemical adjustment of the soil and water; and biological manipulation, including the reintroduction of absent native flora and fauna.

These principles focus on scientific and technical issues, but as in all environmental management activities, the importance of community perspectives and values is to be considered. Coordination with the local people and organizations that may be affected by the project can help build the support needed to get the project moving and ensure long-term protection of the restored area. In addition, partnership with all stakeholders can also add useful resources, ranging from finance and technical expertise to volunteer help with implementation and monitoring. Restoration principles are:

- **Preserve and protect aquatic resources:** Existing, relatively intact ecosystems are the keystone for conserving biodiversity, and provide the biota and other natural materials needed for the recovery of impaired systems.
- **Restore ecological integrity:** Ecological integrity refers to the condition of an ecosystem - particularly the structure, composition, and natural processes of its biotic communities and physical environment.
- **Restore natural structure:** Many aquatic resources in need of restoration have problems that originated with harmful alteration of channel form or other physical characteristics, which in turn may have led to problems such as habitat degradation, changes in flow regimes, and siltation.
- **Restore natural function:** Structure and function are closely linked in river corridors, lakes, wetlands, estuaries and other aquatic resources. Reestablishing the appropriate natural structure can bring back beneficial functions.
- **Work within the watershed and broader landscape context:** Restoration requires a design based on the entire watershed, not just the part of the water body that may be the most degraded site. Activities throughout the watershed can have adverse effects on the aquatic resource that is being restored. By considering the watershed context in this case, restoration planners may be able to design a project for the desired benefits of restoration, while also withstanding or even helping to remediate the effects of adjacent land uses on runoff and non-point source pollution.
- **Understand the natural potential of the watershed:** Restoration planning should take into account any irreversible changes in the watershed that may affect the system being restored, and focus on restoring its retaining natural potential.
- **Address ongoing causes of degradation:** Identify the causes of degradation and eliminate or remediate ongoing stresses wherever possible.

- **Develop clear, achievable, and measurable goals:** Goals direct implementation and provide the standards for measuring success. The chosen goals should be achievable ecologically, given the natural potential of the area, and socio-economically, given the available resources and the extent of community support for the project.
- **Focus on feasibility** taking into account scientific, financial, social and other considerations.
- **Anticipate future changes:** As the environment and our communities are both dynamic, many foreseeable ecological and societal changes can and should be factored into restoration design.
- **Involve the skills and insights of a multi-disciplinary team:** Universities, government agencies, and private organizations may be able to provide useful information and expertise to help ensure that restoration projects are based on well-balanced and thorough plans.
- **Design for self-sustainability:** Ensure the long-term viability of a restored area by minimizing the need for continuous maintenance of the site. In addition to limiting the need for maintenance, designing for self sustainability also involves favoring ecological integrity, as an ecosystem in good condition is more likely to have the ability to adapt to changes.
- **Use passive restoration, when appropriate:** Simply reducing or eliminating the sources of degradation and allowing recovery time will allow the site to naturally regenerate. For some rivers and streams, passive restoration can reestablish stable channels and floodplains, re-grow riparian vegetation, and improve in-stream habitats without a specific restoration project. Passive restoration relies mainly on natural processes and it is still necessary to analyze the site's recovery needs and determine whether time and natural processes can meet them.
- ***Restore native species and avoid non-native species:*** Many invasive species outcompete natives because they are expert colonizers of disturbed areas and lack natural controls.

- **Use natural fixes and bioengineering techniques, where possible:** Bioengineering is a method of construction combining live plants with dead plants or inorganic materials, to produce living, functioning systems to prevent erosion, control sediment and other pollutants, and provide habitat. These techniques would be successful for erosion control and bank stabilization, flood mitigation, and even water treatment.
- **Monitor and adapt where changes are necessary:** Monitoring before and during the project is crucial for finding out whether goals are being achieved. If they are not, "mid-course" adjustments in the project should be undertaken. Post-project monitoring will help determine whether additional actions or adjustments are needed and can provide useful information for future restoration efforts. This process of monitoring and adjustment is known as adaptive management. Monitoring plans should be feasible in terms of costs and technology, and should always provide information relevant to meeting the project goals.

These principles focus on scientific and technical issues, but as in all environmental management activities, the importance of community perspectives and values should not be overlooked. The presence or absence of public support for a restoration project can be the difference between positive results and failure. Coordination with the people and organizations that may be affected by the project can help build the support needed to get the project moving and ensure long-term protection of the restored area. Thus, a sustainable water system encompasses issues such as:

- **Environment:** watershed protection, ecosystem balance, wastewater and bio-solids.
- **Community:** sufficient and reliable water supply, participation in planning and recreational use to water.
- **Economy:** Evolution and diversification, sustainable and long-term growth.

Within this overall vision, water management system will require, among other steps, the following action to be taken:

- Through strategic partnerships among national agencies, provincial agencies and local/city departments.
- Developing alternate water sources-reclaimed/treated water, desalination, rainwater and water reuse.
- Implementing new technologies for water fees/metering, leak detection and water auditing systems.
- Engage the community through education, local and regional planning processes and outreach to cultural and community groups.
- Scientific investigations involving aquifer monitoring, coastal marine environment study, supply-demand forecasting and pollution prevention.

The principal components of water management system include:

- *Supply optimization,* including assessments of surface and groundwater supplies, water balances, wastewater reuse, and environmental impacts of distribution and use options.
- *Demand management,* including cost-recovery policies, water use efficiency technologies; and decentralized water management authority.
- *Equitable access* to water resources through participatory and transparent management, including support for effective water users association, involvement of marginalized groups, and consideration of gender issues.
- *Improved policy, regulatory and institutional frameworks,* such as the implementation of the polluter-pays principle, water quality norms and standards, and market-based regulatory mechanisms.
- *Intersectoral approach* to decision-making, and combining authority with responsibility for managing the water resource.

Water quality and quantity are becoming increasingly critical factors of socioeconomic development in many parts of the world. One of the milestones in managing international and transnational water resources and boundaries was the meeting and agreement on trans boundary water management signed in Helsinki in 1966.

1. the geography of the basin including, in particular, the extent of the drainage area in the territory of each basin state;
2. the hydrology of the basin including, in particular, the contribution of water by each basin state;
3. the climate affecting the basin;
4. the past utilization of the waters of the basin, including in particular, existing utilization;
5. the economic and social needs of each basin state;
6. the population dependent on the waters of the basin of each state;
7. the comparative costs of alternative means of satisfying the economic and social needs of each basin state;
8. the availability of other resources;
9. the avoidance of unnecessary waste in the utilization of the waters of the basin;
10. the practicability of compensation to one or more of the co-basin states as a means of adjusting conflicts among users; and
11. the degree to which the needs of a basin state may be satisfied without causing substantial injury to a co-basin state.

POLICY OPTIONS

Burgeoning human populations coupled with agricultural and industrial developments increase the water requirements. As escalating need for food in dry climate areas increases the need for irrigation, water and water supply systems are increasingly becoming reasons for conflict. The development and implementation of a comprehensive forward-looking integrated water resources management scheme must include water law as an integral component. This is especially important in upstream/downstream situations where conflicts of water use are increasingly inevitable.

It is evident from recent water disputes/conflicts, that what has to be shared between those upstream and those downstream in a river basin is not the water currently going in the river (as suggested by the concerned authorities), but rather the rainfall over the river basin (which takes into account scarce rainfall period) and solutions should *be* based on sound economics, science, and enlightened and enhanced political commitment. In summary, policy:

1. Defines the legal entitlement to water and identifies the rights and obligations tied to water use and thus provides the prescriptive parameters for its development.
2. Provides the framework to ensure the ongoing integrity of the regime. (i.e. monitoring, regulation, compliance, dispute avoidance and settlement).
3. Permits the rational modification of existing regimes (i.e. to meet changing needs).

Water development issues must be viewed in an overall context. In conflicts between upstream and downstream users, the scenario at all levels (national, regional and international) is much the same: the downstream user generally develops first and is keen to preserve into perpetuity these senior-in-time uses. The upstream user is thus placed in the unenviable situation of justifying the legitimacy of new uses, which almost certainly will adversely affect the existing uses downstream. Planning (the formulation of plans and policies) is an important and often-indispensable means to support and improve operational management. Planning has six related functions, such as:

- To assess the current situation (including the identification of conflicts and priorities), formulate visions, set goals and targets, and thus orient operational management.
- To provide a framework for organizing policy relevant research and public participation.
- To increase the legitimacy, public acceptance of, or even support for operational management.
- To facilitate the interaction and discussion among managers and stakeholders, offer a common point of reference (the plan or policy), and thus provide co-ordination. Planning should involve, in a systems framework, all phenomena, institutions and issues that affect the allocation and protection of inland waters. It should not result in negative effects on other natural resources and should consider linkages to plans for biodiversity management, coastal protection, ocean health, and human health and well being.

- Planning should be focussed and coherent and be in proportion to the resources available for implementation. Planning should be rooted in the real problems to be solved and be realistic.
- Planning systems should be evaluated to check whether they serve their purpose; planning systems should not be taken for granted; given the differences in problem situations and cultures, planning systems should reflect the local situation.

Forest Ecosystem restoration

Forest restoration is defined as "actions to re-instate ecological processes, which accelerate recovery of forest structure, ecological functioning and biodiversity levels towards those typical of climax forest" i.e. the end-stage of natural forest succession. Climax forests are relatively stable ecosystems that have developed the maximum biomass, structural complexity and species diversity that are possible *within the limits imposed by climate and soil and without continued disturbance from humans* (more explanation here). Climax forest is therefore the target ecosystem, which defines the ultimate aim of forest restoration. Since climate is a major factor that determines climax forest composition, global climate change may result in changing restoration aims.

Forest restoration is a specialized form of reforestation, but it differs from conventional tree plantations in that its primary goals are biodiversity recovery and environmental protection.

Natural Regeneration

Tree planting is not always essential to restore forest ecosystems. A lot can be achieved by studying how forests regenerate naturally, identifying the factors that limit regeneration and devising methods to overcome them. These can include weeding and adding fertilizer around natural tree seedlings, preventing fire, removing cattle and so on. This is "accelerated" or "assisted" natural regeneration. It is simple and cost-effective, but it can only operate on trees that are already present, mostly light-loving pioneer species. Such tree species are not usually those that comprise climax forests, but they can foster recolonization of the site by shade-tolerant climax forest tree species, via natural seed dispersal from remnant forest. Because this is a slow process, biodiversity recovery can usually be accelerated by planting some climax forest tree species, especially large-seeded, poorly dispersed species. It is not feasible to plant all the tree species that may have formerly grown in the original primary forest and it is usually unnecessary to do so, if the framework species method can be used.

Post fire Regeneration

In large parts of the world, forest fires cover a heavy toll on forests. That can be because of provoked deforestation in order to substitute forests by crop areas, or in dry areas, because of wild fires occurring naturally or intentionally. A whole section of forest landscape restoration in linked to this particular problem, as in many cases, the net loss of ecosystem value is very high and can open the drop to an accelerated further degradation of the soil conditions through erosion and desertification. This indeed has dire consequences on both the quality of the habitats and their related fauna. Nevertheless, in some specific cases, wild fires do actually allow to increase the biodiversity index of the burnt area, in which case the Forest Restoration Strategies tend to look for a different land-use.

Mine Restoration

Mine restoration is the process of restoring land that has been mined to a natural or economically usable state. Although the process of mine reclamation occurs once mining is completed, the planning of mine reclamation activities occurs prior to a mine being permitted or started. Mine reclamation creates useful landscapes that meet a variety of goals ranging from the restoration of productive ecosystems to the creation of industrial and municipal resources. In the United States, mine reclamation is a regular part of modern mining practices. Modern mine reclamation minimizes and mitigates the environmental effects of mining.

Restoration of land used for surface mining has two primary goals:

(1) To return the land to productivity with a usable contour and

(2)To protect the environment. Surface-mine reclamation considers several factors, including the effects of the surface-mining process on land-surface