Ecosystem Wetlands Restoration Approach for Sustainable Development Planning

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1. INTRODUCTION

Wetlands are singular ecosystems situated at the transition between terrestrial and aquatic systems. Their unique properties and uncommon location provide to human important benefits, or "ecosystem services," (ES) classified into four categories by the Millenium Ecosystem Assessment (MEA, 2005; Andel, 2006) (Table 1).

Despite these benefits, only recently has interest grown in restoring wetlands because these fragile ecosystems, ecological functions and values are in danger of disappearing in all the world (Mitsch, 2007). The aquatic systems' restoration means reestablish proper hydrological functioning, controlling pollution sources, and native species' reintroduction, emphasizing river's link with the sea. Talking about wetlands ecological functions is not exhaustive, it is important to reflect on the entire wetland's culture, before and after the

Table 1. Ecosystem services obtained from wetlands (MEA, 2005)

Services	Comments and Examples
PROVISIONING	
Food	Production of fish, wild game, fruits and grains
Fresh water	Storage and retention of water for domestic, industrial, and agricultural use.
Fiber and fuel	Production of logs, fuel wood, peat, fodder.
Biochemical	Extraction of medicines and other materials from biota.
Genetic material	Genes for resistance to plant pathogens, ornamental species, and so on.
REGULATING	
Climate regolation	Source on and sink for greenhouse gases;influence local and regional temperature, precipitation, and other climatic processes.
Water/hydrological regulation	Groundwater recharge and disharge.
Water purification/ waste treatment	Retention, recovery, and removal of excess nutrients and other pollutants.
Erosion regulation	Retention of soils and sediments
Natural hazard regulation	Flood control, storm protection
Pollination	Habitat for pollinators
CULTURAL	
Spiritual and inspirational	Source of inspiration; religions attach spiritual and religious values to aspects of wetland ecosystems.
Aesthetic	Many people find beauty of aesthetic value in aspects of wetland ecosystems.
Educational	Opportunities for formal and informal education and training.
SUPPORTING	
Soil formation	Sediment retention and accumulation of organic matter.
Nutrient cycling	Storage, recycling, processing, and acquisition of nutrients

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Table 2. Wetlands functions and values

Wetland Functions	Wetland Values
Hydrologic flux and storage	Flood control,flood storage,recreation,open space,visual-cultural,timber production,shrub crops,education and research,erosion control,water quality,water supply.
a. ground water recharge to wetland and or discharge from the ecosystem	
b. water storage reservoir and regulator	
c.regional stream hydrology(disharge and recharge)	
d.Regional climate control(evapotranspiration export=large scale atmospheric losses of H20)	
Biological productivity	Flood control,flood storage,sediment control(filter for waste),waste water treatment,nutrient removal from agricultural runoff,open space,hunting,timber production,shrub crops,erosion control,food production,threatened rare species,historical cultural resources,
a.net primary productivity	
b.carbon storage	
c.carbon fixation	
d.secondary productivity	
Biogeochemical cycling and storage	Flood control,flood storage,sediment control(filter for waste),waste water treatment,nutrient removal from agricultural runoff,erosion control,water quality.
a. nutrient source or sink on the landscape	
b.C,N,S,P,etc.transformations(oxidation/reduction reactions)	
c.Denitrification	
d.Sediment and organic matter reservoir	
Decomposition	Medical
a.Carbon release(global climate impacts)	
b.Detritus output for acquatic organisms(downstream energy source)	
c.Mineralization and release of N,S,C,etc..	
Community/wildlife habitat	Recreation,open space,visual-cultural,hunting,preservation of flora and fauna, medical,education and research,food production.
a.Habitat for species(unique and endagered)	
b.Habitat for algae,bacteria,fungi,fish,shellfish,wildlife,and wetland plants.	
c.Biodiversity	

intervention. It's difficult to achieve restoration targets, because efforts are focused on ecological functions and within a broad spectrum of landscape contexts (Hobbs, 1992, 2002).What are ecological functions and values to restore, what are results and according to what principles? (Table 2)

The empirical method consists essentially in comparing the observations on natural wetlands and artificial man-made, selecting sites with similar environmental conditions but different ages for tidal inundation, salinity, etc...(NRC 1992). The constructed wetland is linked to a natural one, which acts as a reference. Biomass, the primary productivity's main indicator, changes in proportion to the constructed wetland's years, still closer to that of natural wetland. The wetland's structure and function described in soils' details, suspended sediment's sinks, always gives the interesting difference between restoring and natural