Scaling-up Public Education and Awareness Creations towards the Conservation of Black Crowned Crane (*Balearica pavonina* L.) in Jimma Zone, Ethiopia

Topic: Functions of Wetland Ecosystems, Current Challenges and Way forward: Review martial

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Functions and Values of Wetlands…

- Wetlands perform a multiple array of ecological functions that have only recently begun to be appreciate by humans.
- Wetland is likely performing vital ecological functions as ecosystems.

Functions and Values of Wetlands…

- Understanding of the complexities of wetland ecosystems is still developing,
- the more people learn about wetlands, the more valuable wetlands become.
- As documented by wetland ecologists wetlands have the following environmental benefits :
  - ✓ water purification,
  - ✓ flood protection,
  - ✓ shoreline stabilization,
  - ✓ groundwater recharge and streamflow maintenance.

Functions and Values of Wetlands…

- Wetlands also provide habitat for and wildlife, including endangered species, fish, etc.
  - the benefits of wetlands provide varies based on the of wetland .
  - how a particular wetland works depends on its location and its type.

Water Purification

- Wetlands maintain water quality by trapping sediments and retaining excess nutrients and other pollutants including heavy metals.
- Especially important when a wetland is connected to groundwater or surface water sources (such as rivers and lakes) that are in turn used by humans for drinking, swimming, fishing or other activities.
- These same functions are also critical for the wildlife including fish that inhabit these waters.

Water Purification

- Sediments, nutrients, and toxic chemicals enter wetlands primarily by way of runoff (rain and stormwater that travels over land surfaces on its way to receiving waters).
- In urban areas, runoff washes over buildings and streets in industrial, commercial, and residential areas where it picks up pollutants and carries them to receiving waters,

Water Purification

- In rural areas, agricultural and forest practices can affect runoff. It may carry pesticides and fertilizers if these have been applied to the land.
- Where the runoff drains a freshly plowed field or clear-cut area, it may carry too much sediment.

Water Purification

- Studies revealed that sediments, which are particles of soil, settle into the gravel of streambeds and disrupt or prevent fish from spawning, and can smother fish eggs.
- Other pollutants heavy metals are often attached to sediments and present the potential for further water contamination.
- Wetlands remove these pollutants by trapping the sediments and holding them.
- slow velocity of water in wetlands allows the sediments to settle to the bottom where wetland plants hold the accumulated sediments in place.

Water Purification

- Runoff waters often carry nutrients that can cause water quality problems.
  - ✓ An example of such an occurrence is an algae bloom.
- Other than the aesthetic problems associated with algae blooms (a green, smelly slime) they result in low levels of oxygen in the water which can result in the death of fish and other aquatic life.
- Some algae release toxins that can kill pets and livestock when bloom conditions occur.

Water Purification

- Wetlands protect surface waters from the problems of nutrient overload by removing the excess nutrients some of which are taken up and used by wetland plants,
- Some of which are converted to less harmful chemical forms in the soil.
- Toxic chemicals reach surface waters in the same way as nutrients, and can cause disease, death, or other problems upon exposure to plants and animals including humans.

Water Purification

- In a function similar to nutrient removal, wetlands trap and bury these chemicals or may even convert some of them to less harmful forms.
- Disruptions of the wetland soils could release the toxins back into the aquatic environment.

Flood Protection

- Almost all wetlands can provide flood protection by holding the excess runoff after a storm, releasing it slowly.
- The size, shape, location, and soil type of a wetland determine its capacity to reduce local and downstream flooding.
- If wetlands cannot prevent flooding, they lower flood peaks by temporarily holding water and slowing the water's velocity.
- Wetland soil acts as a sponge, holding much more water than other soil types.

Shoreline Stabilization

- Wetlands that occur along the shoreline of lakes or along the banks of rivers and streams help protect the shoreline soils from the erosive forces of waves and currents.
- The wetland plants act as a buffer zone by dissipating the water's energy and providing stability by binding the soils with their extensive root systems.

Groundwater Recharge and Streamflow Maintenance

- Studies revealed that aquifers and groundwater are "recharged," i.e., replenished with water by precipitation that **seeps** into the ground and by surface waters.
- wetlands connected to groundwater systems or aquifers are important areas for groundwater exchange by retaining water it provide time for infiltration to occur.
- Groundwater, in turn, provides water for drinking, irrigation, and maintenance of streamflow and lake and reservoir levels.

Groundwater Recharge and Streamflow Maintenance

- During periods of low streamflow or low lake water levels the slow discharge of groundwater often helps maintain minimum water levels.
- Wetlands located along streams, lakes, and reservoirs may release stored water directly into these systems contributing to their maintenance.
- Wetlands' many intricate connections with groundwater, streamflow, and lake and reservoir water levels make them essential in the proper functioning of the hydrologic cycle.

Ground water recharge

- Wetlands help maintain the level of the water table and exert control on the hydraulic head (O'Brien 1988; Winter 1988).
  - ✓ this provides force for ground water recharge and discharge to other waters as well.
- The extent of ground water recharge by a wetland is dependent upon soil, vegetation, site, perimeter to volume ratio, and water table gradient (Carter and Novitzki 1988; Weller 1981).

Ground water recharge

- Ground water recharge occurs through mineral soils found primarily around the edges of wetlands (Verry and Timmons 1982) .
  - ✓ The soil under most wetlands is relatively impermeable.
- A high perimeter to volume ratio, such as in small wetlands, means that the surface area through which water can infiltrate into the ground water is high (Weller 1981).

Ground water recharge

- Ground water recharge is typical in small wetlands such as prairie potholes, which can contribute significantly to recharge of regional ground water resources (Weller 1981).
- Researchers have discovered ground water recharge of up to 20% of wetland volume per season (Weller 1981).

Hydrologic Flux and Storage

Water balance

- Wetlands play a critical role in regulating the movement of water within watersheds as well as in the global water cycle (Richardson 1994; Mitsch and Gosselink 1993).
- Wetlands, by definition, are characterized by water saturation in the root zone, at, or above the soil surface, for a certain amount of time during the year.
- This fluctuation of the water table (hydroperiod) above the soil surface is unique to each wetland type.

Hydrologic Flux and Storage

- Wetlands store precipitation and surface water and then slowly release the water into associated surface water resources, ground water, and the atmosphere.
- Wetland types differ in this capacity based on a number of physical and biological characteristics (Taylor et al. 1990):
- Landscape position,
- Soil saturation,
- The fiber content/degree of decomposition of the organic soils,

Hydrologic Flux and Storage

- Vegetation density and type of vegetation
- Landscape position affects the amount and source of water in a wetland.
- For example, wetlands that are near a topographical height, such as a mountain bog, will not receive as much runoff as a marsh in a low area amidst fields.
- Wetlands can be precipitation dominated, ground water dominated, or surface flow dominated.

Hydrologic Flux and Storage

- Wetlands on local topographic heights are often precipitation dominated.
- Precipitation dominated wetlands may also be in flat or slightly elevated areas in the landscape, where they receive little or no surface runoff.
- Generally such wetlands have a clay and peat layer that retains the precipitation and also prevents discharge from ground water.
- Wetlands also form in landscape positions at which the water table actively discharges, particularly at the base of hills and in valleys.

Hydrologic Flux and Storage

- Such groundwater dominated wetlands may also receive overland flow but they have a steady supply of water from and to groundwater.
- Most wetlands in low points on the landscape or within other water resources are dominated by overland flow.

Climate control

Climate control is another hydrologic function of wetlands.

- Many wetlands return **over two-thirds** of their annual water inputs to the atmosphere through evapotranspiration (Richardson and McCarthy 1994).
- Wetlands may also act to moderate temperature extremes in adjacent uplands (Brinson 1993).

Oxidation-Reduction

- The fluctuating water levels (also known as hydrologic flux) that are characteristic of wetlands control the oxidation-reduction (redox) conditions that occur.

Climate control

- These redox conditions governed by hydroperiod play a key role in:
  - ✓ nutrient cycling,
  - ✓ availability, and export;
  - ✓ pH;
  - ✓ vegetation composition;
  - ✓ sediment and organic matter accumulation;
  - ✓ decomposition and export; and metal availability and export.

Oxidation-Reduction

- When wetland soil is dry, microbial and chemical processes occur using oxygen as the electron acceptor.
- When wetland soil is saturated with water, microbial respiration and biological and chemical reactions consume available oxygen.
- This shifts the soil from an aerobic to an anaerobic, or reduced, condition.
- As conditions become increasingly reduced, other electron acceptors than oxygen must be used for reactions.
- These acceptors are, in order of microbial preference, nitrate, ferric iron, manganese, sulfate, and organic compounds.
- Wetland plants are adapted to changing redox conditions.

Oxidation-Reduction

- Wetland plants often contain arenchymous tissue (spongy tissue with large pores) in their stems and roots that allows air to move quickly between the leaf surface and the roots.
- Oxygen released from wetland plant roots oxidizes the rhizosphere (root zone) and allows processes requiring oxygen(Steinberg and Coonrod, 1994), such as :
    - ✓organic compound breakdown,
    - ✓decomposition,
    - ✓denitrification, to occur

Hydrologic flux and life support

- Changes in frequency, duration, and timing of hydroperiod may impact spawning, migration, species composition, and food chain support of the wetland and associated downstream systems (Crance 1988).
- Normal hydrologic flux allows exchange of nutrients, detritus, and passage of aquatic life between systems, as a result wetland functions include:
  - ✓ water quality,
  - ✓ water supply,
  - ✓ flood control,
  - ✓ erosion control,
  - ✓ wildlife support ,
  - ✓ recreation, culture, and commercial benefits.

Biogeochemical Cycling and Storage

- Studies revelaed that wetlands may be a sink for or transform nutrients, organic compounds, metals, and components of organic matter.
- Wetlands may also act as filters of sediments and organic matter.
- A wetland may be a permanent sink for these substances if the compounds become buried in the substrate
- Or are released into the atmosphere;
- Or a wetland may retain them only during the growing season or under flooded conditions.

Biogeochemical Cycling and Storage

- Wetland processes play a role in global cycles of
  - ✓ Carbon,
  - ✓ Nitrogen
  - ✓ Sulfur
- By transforming them and releasing them into the atmosphere.

Biological Productivity

- Wetlands are among the most productive ecosystems in the world (Mitsch and Gosselink 1993). Immense varieties of species of microbes, plants, insects, amphibians, reptiles, birds, fish, and other wildlife depend in some way on wetlands.
- Wetlands with seasonal hydrologic pulsing are the most productive.
- Wetland plants play an integral role in the ecology of the watershed.
- Wetland plants provide breeding and nursery sites, resting areas for migratory species, and refuge from predators (Crance 1988).

Biological Productivity

- Decomposed plant matter (detritus) released into the water is important food for many invertebrates and fish both in the wetland and in associated aquatic systems (Crance, 1988).
- Physical and chemical characteristics such as:
  - ✓ climate,
  - ✓ topography,
  - ✓ geology,
  - ✓ hydrology,

Biological Productivity

- Inputs of nutrients and sediments determine the rate of plant growth and reproduction (primary productivity) of wetlands (Brinson 1993; Mitsch and Gosselink 1993; Weller 1981; Crance 1988).
- A wetland with more vegetation will intercept more runoff and be more capable of reducing runoff velocity and removing pollutants from the water than a wetland with less vegetation (Demissie and Khan 1993; Richardson and McCarthy 1994; NC DEM 1993).

Biological Productivity

- Wetland plants also reduce erosion as their roots hold the streambank, shoreline, or coastline.
- Values associated with biological productivity of wetlands include:
  - ✓ water quality,
  - ✓ flood control,
  - ✓ erosion control,
  - ✓ community structure and wildlife support,
  - ✓ recreation,
  - ✓ aesthetics, and commercial benefits.

Decomposition

- Decomposition rates vary across wetland types, particularly as a function of climate, vegetation types, available carbon and nitrogen, and pH (Johnston 1991).
- A pH above 5.0 is necessary for bacterial growth and survival (Richardson 1995).
- Liming, to increase pH, accelerates decomposition, causing the release of carbon dioxide from wetlands and land subsidence (Richardson 1995).

Decomposition

- The nutrients and compounds released from decomposing organic matter may be exported from the wetland in soluble or particulate form, incorporated into the soil, or eventually transformed and released to the atmosphere.
- Decomposed matter (detritus) forms the base of the aquatic and terrestrial food web.
- Decomposition requires oxygen and thus reduces the dissolved oxygen content of the water.
- High rates of decomposition such as occur after algae has bloomed can reduce water quality and impair aquatic life support.

Community structure and wildlife support

- The inundated or saturated conditions occurring in wetlands limit plant species composition to those that can tolerate such conditions.
- Beaver, muskrat and alligators create or manipulate their own wetland habitat that other organisms, such as fish, amphibians, waterfowl, insects, and mammals can then use or inhabit (Weller 1981; Mitsch and Gosselink 1993).

Community structure and wildlife support

- Wetland shape and size affect the wildlife community and the wetland's function as suitable habitat (Kent 1994; Brinson 1993; Harris 1988).
- The shape of the wetland varies the perimeter to area ratio. The amount of perimeter versus area has importance for the success of interior and edge species (Kent 1994b).

Fish and Wildlife Habitat

- Many species of birds, fish, mammals, reptiles, and amphibians rely on wetland habitat for breeding, foraging, and cover.
- The special wetland conditions provide unique habitat for species that cannot survive elsewhere.
- Migratory birds depend on wetlands, and many endangered and threatened animal species require wetlands during part of their life cycle.

Wetlands and livelihoods

- Wetlands are not only home to many plants and animals but also to a lot of human communities.
- The people who live in a wetland area depend on it for food, housing, income, etc.

Challenges wetlands are facing

- The size of the wetlands is decreasing at alarming rate and its biodiversity are highly threatened which in turn decreases its ecosystem benefits to support the livelihood of the local people.
- The extraction of clay soil for the small-scale brick producing local industries is aggravating land degradation in the area.
- Conversely, deforestation is increasing due to growing demand for fuel wood from the small-scale brick producing industries and the Jimma area dwellers in Ethiopia.
- Urban and Agricultural land expansion

Challenges

- Deforestation and farming of uplands/watersheds e.g.; Jiren mountain, Bada Buna area, Dedo and Sokoru undulating highlands in Jimma area, other highlands, etc),
- Agricultural expansion,
- Industrialization (small scale industries, laviajos, hotels, loges, etc),
- Investments of multiple scale,
- Improper Agroforestry as escape goat of conserving Natural environment,

Challenges

- Overgrazing
- Un-integrated conservation efforts
- Reliance on advocacies with little practical conservation action ,
- Pollution,
- Siltation

are few among many challenges.

Challenges

- With the currently growing threats, it is necessary intervening to save the unique ecosystems such as wetlands.
- Unless conservation measures are applied,
  - ✓ the wetlands are at risk of complete degradation and may disappear in few years to come.
- Decision makers cannot take wetland management decisions based on intuition alone.
  - ✓ they need facts and values to make informed decision.
  - ✓ though, other types of values are also useful, economic values are vital in making economic choices and conservation decisions.

Summary

- Wetlands are important features in the landscape that provide numerous beneficial services for people and for wildlife.
- Some of these services or functions include protecting and improving water quality, providing wildlife habitats, storing floodwaters, and maintaining surface water flow during dry periods.
- These beneficial services, considered valuable to societies worldwide, are the result of the inherent and unique natural characteristics of wetlands.

Summary

- Wetlands are essential component of the ecosystem structure and functions
- In a biosphere the wetland play key role to maintain the ecosystem functions in plants, animals, fungi and other microbial life.
- This critical ecosystem – the wetland needs considerable attention conservation efforts at all levels.

Way forward

- Basic and Demand Driven Action researches,
- Policy advises through policy papers from research,
- Understand policies and strategies,
- Sustainable awareness at all levels,
- Strategic action in integrated production and enhance productivity,

Way forward

- Capacity building at local level to implement sustainable development strategies while improving livelihoods,
- Clear land use plan and implementation,
- Sustainable Policy Makers Commitment,
- Advocacies need be accompanied with practical portfolios to convince and participate local communities,
- Sustainable watershed and water bodies management