Environmental Significance of Riparian Agroecosystems with special reference to Influence on Wetland Livelihood

Dr. Reshma J.K.[1] & Dr. Allan Thomas[2]
[1]Asst. Professor and Head, PG Department of Environmental Sciences All Saints' College, Thiruvananthapuram, Kerala.
[2]Asst. Professor and Head, Department of Extension College of Agriculture, Vellayani, Kerala.

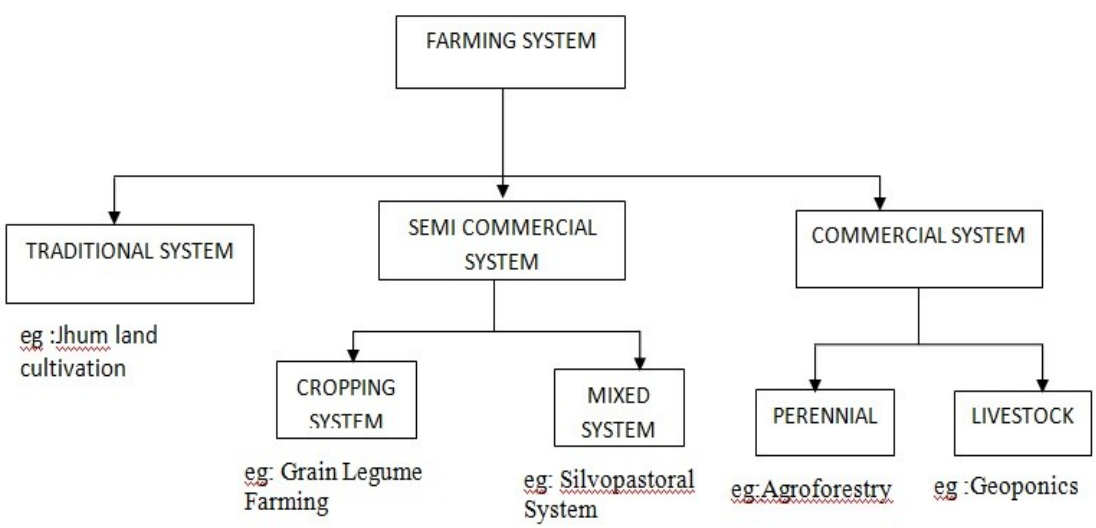
Received: February 12, 2019 Accepted: March 24, 2019

INTRODUCTION

Riparian Agroecosystem (Agriculture + Ecosystem = Agroecosystem) is construed as a spatially and functionally coherent unit of agricultural activity along river banks, subsuming both biotic & abiotic components, their respective interaction as well. An agroecosystem appends the region that is stuffed in by agricultural activity, prodigally by changes to the complexity ofspecies assemblagesandenergy flows, as well as to the net nutrient balance. Traditionally an agroecosystem, particularly one managed intensively, is epitomized as having a simpler species composition and simpler energy and nutrient flows which makes it unique from other "natural" ecosystems. Moreover, agroecosystems are often confederated with elevated nutrient input, as in the case of forest gardens, probably the world's oldest and most resilient agroecosystemswhich is balanced byeutrophication of consociated ecosystems not directly engaged in agriculture.

Substaintial components of Agroecosystem derive all its energy requirements from solar input along with atmospheric and human inputs that come from outside the system, which are referred to as "consumption and markets. Some of the unparagoned features of agroecosystems are monoculture, use of genetically modified organisms and artificially selected crops, row crops, increased soil aeration, simplification of biodiversity and maintenance at an early succession state.

Major quintessence of Agroecosystem on the pretext of methods adopted are given in **Figure 1**:



ENVIRONMENTAL SIGNIFICANCE OF RIPARIAN AGROECOSYSTEMS:

Multifunctional agriculture (MFA) is the term that has been widely used to indicate multiple functions and benefits provided by agroecosystems and it recognizes theinescapable interconnectedness between agriculture's different roles and functions, that is, that agriculture is a multi-output activity, producing not only commodities, but also non-commodity outputs, such as environmental services, landscape amenities, and cultural heritages (UNEP, 2016).

Environmental Services offered by riparian agroecosystems are manifold which is enlisted in the following table.

ECOSYSTEM SERVICES	DESCRIPTION	ON-FARM BENEFITS	OFF-FARM BENEFITS
Provision offood,fuel, fiber,&biochemicals	Harvestable goods from agroecosystems	Food and other goods for on- farm consumption or sale	Goods for agricultural markets
Soil structure and fertility enhancement	Soil structure and processes of nutrient cycling and delivery of nutrients to plants; processing organic matter and transforming detritus and wastes	Support for crop growth; can limit need for chemical fertilizers	May limit need to mine or manufacture chemical fertilizer
Erosion Protection	Soil retention; limiting soil loss through wind and water erosion	Maintain soil, and the nutrients it contains, to support production	Potential reduction of sediment transfer to downstream systems & users
Hydrologic services:Water flow regulation	Bufferingandmoderation ofthe hydrologic cycle,including water infiltration intosoils and aquifers,moderationof runoff, andplants transpiration	Water in soils, aquifers, and surface bodies available to support plant growth	Stabilize streambase flow and mitigate flooding to downstream areas;recharge into aquifersandbodies of water; planttranspiration may support precipitation patterns
Hydrologic services:Water purification	Filtration and absorption of particles and contaminants by soil and living organisms in the water and soil	Clean water available for human consumption, irrigation, and other on-farm uses	Clean water available to downstream users
Pollination	Transfer of pollen grains to fertilize flowers	Necessary forseedsetandfruit production in flowering plants and crops	Necessaryforoutcrossingin non cultivatable flowering plants
Pest control	Controlofanimalandinsect pests bynaturalenemies – predators, parasites,and pathogens	Minimize crop damage and limit competition with crops	May limit need for pesticides that threaten environmental and human health
Weed control	Botanical component of pest control; suppressing weeds, fungi, and other potential competitors through physical and chemical properties of cover crops, intercrops, and other planted	Minimize weed competition with crops	May limit need for herbicides that threaten environmental and human health

	elements		
Carbon Sequestration	Atmospheric carbon dioxide is taken up by trees, grasses, and other plants through photosynthesis and stored as carbon in biomass and soils	Few demonstrableon-farm benefits	Regulation of the carbon cycle; mitigation of greenhouse gas contributions to atmospheric change
Genetic Resources	Poolofgeneticdiversityneeded to supportbothnaturaland artificial selection	Distinct genotypes (cultivars) allow fruit set in orchards and hybrid seed production; trait diversity (from landraces and wild relatives) supports disease resistance, new hybrids, and climate adaptations	Prevention against large-scale crop failure
Cultural & Aesthetic services	Maintaining landscapes that support: Aesthetics and inspiration; spiritual and religious values; sense of place; cultural heritage; recreation and ecotourism	Aesthetics and inspiration; spiritual and religious values; sense of place; cultural heritage; recreation and ecotourism	Aesthetics and inspiration; spiritual and religious values; sense of place; cultural heritage; recreation and ecotourism

Table 1: (Source: Biodiversity & Ecosystem Services of Agroecosystem,K Garbach, 2014)

DIVERSITY IN FARMING PRACTICES

Preservation of biodiversity and natural species must be given utmost importance when it comes to farming practices in agroecosystems. Riparian ecosystem offer services such as habitat for endemic species, preventing soil erosion and enhanced microbial diversity, minimizing floods, enhancing wildlife corridors etc. The riparian forest has been recognized as "keystone ecosystem", because it harbours certain unique habitats which are highly influenced by water (reference) thereby enhancing the biological diversity of the region. A broad portfolio of genetic resources increases the likelihood of maintaining biomass production, reduced loss to pests and diseases, and more efficient use of available nutrients.

AGROFORESTRY:

Agroforestry is the practice of deliberately integrating woody vegetation (trees or shrubs) with crop and/or animal systems to benefit from the resulting ecological and economic interactions.

Riparian agroecosystem, can reduce non-point source water pollution from agricultural land by reducing surface runoff from fields; filtering surface and groundwater runoff and stream water, and reducing bank erosion (Dosskey, 2001). Agriculture also acts as a GHG sink, with soil a major sink of CO2 through the fixation of carbon bycrop and pasture land, while soil also has a substantial capacity to break down CH4 into the less activeCO2, although little is known about the fixation of N2O by soils(Con.*et al*, 2001).Silvopasture systems, in special, have shown high efficiency in,recovering soil quality and increasing carbon stocks.

Studies indicate that deeper-rooting tree component of an agroforestry system will be able to intercept nutrients leached out of the crop rooting zone, thus reducing pollution and, by recycling nutrients as leaf litter and root decomposition, increasing nutrient use efficiencies. Buffer strips can significantly decrease pollution run-off, with reductions of 70-90% reported for suspended solids, 60-98% for phosphorus and 70-95% for nitrogen.

To mention a few, the benefits of agro ecosystems are increased vegetation cover as in hedgeswhich protects agricultural land from excessive water or wind erosion, reservoir of genes for improving plantand livestock productivity, reduces flood and landslide risk and increased infiltration during rainy season. Mangroves, the well-knowncoastal buffers, reduces the strength of waves before they reach the shore and so protect against cyclone damage to coasts and seaside communities. Biomass stock in soiland litter was the

soil parameter considered the most appropriate to be used as an indicator in monitoring the impact of agroecosystems in ES provision.

Agriculture can also affect ''natural'' habitats through the escape of domesticated species, increased fragmentation of land leads to damaging effects on species populationsize and distributions, and the potential loss in species diversity. Disturbances caused by intense usage of riparian zone for agriculture activities have caused much spatial variation in the reported values of native species richness, composition and productivity.

ORGANIC FARMING

Positive effects of organic farming on plant diversity have been linked to organic management practices including prohibition of herbicide or mineral fertiliser inputs, sympathetic management of non-cropped areas, and more mixed farms.Organic farming has been found in general to have a positive impact on bird biodiversity, but with variations in responses reflecting species-specific responses(Geiger *et al.*, 2010).

Increase in crop residues at the soil surface creates, over time, a higher level of soil organic matter in this critical zone, making working the soil easier particularly in dry conditions. Infiltration rates were higher or equal to conventional arable land and this could be related to the significant improvement in maximum water holding capacity for organically managed soils. This has implications for flood prevention, as organically managed land has an increased capacity to store water.

GRAIN LEGUME FARMING :

Along with above said farming practices, green legume farming practices encompasses cultivation of forage legumes having proteins, dietary fibre, Carbohydrates & resistant starch. Its roots is like a domicile for symbiotic Bacteria , Rhizobia which aids in Nitrogen Fixation. It uses relatively insoluble mineral nutrient sources, encourages shallow ploughing and reduced tillage techniques to protect the soil and its biological activity and use manures and slurries to conserve nutrients and avoid pollution, including through composting. It also promotes crop rotations and polycultures to restore soil fertility, help control weed, pest and disease with preventive cultural measures, supplemented by mechanical, thermal and biological controls if required. This farming practice relies on home-grown feeds for livestock, limiting stocking rates to levels consistent with the EU nitrates directive, and thus reducing pollution risks.

INFLUENCE OF RIPARIAN AGROECOSYSTEM ON WETLAND LIVELIHOOD

Ramsar Convention defines a wetland as any land area that is saturated or flooded with water, either permanently or seasonally, along with all beaches and shallow coastal areas. This definition covers all inland wetlands such as marshes, ponds, lakes, fens, rivers, floodplains, and swamps as well as the whole range of coastal wetlands which include saltwater marshes, estuaries, mangroves,lagoons and coral reefs.

Rice farming

Rice, grown in wetland paddies, is the staple diet of 3.5 billion people across the globe. Almost a billion farming communities of Asia, Africa and the Americas confide in rice farming , as a major source of livelihood. Around 70.5 % of the rice is produced by small-scale farmers in Karnataka, India are consumed by riparian communities of Cauvery River Basin.

Fishing

The average requirement of fish per head is about 19kg per annum. Coastal marshes and estuaries are the flourishing blooming zone of Commercial edible Fishes, which is accessible to Farmers by Aquaculture practices. More than 66% people of Cauvery River Basincount on aquaculture as an utmost source of Livelihood.

Tourism and leisure

International tourists spent US $ 1.3 trillion worldwide in 2013, and an estimated half of them seek relaxation in wetland areas, especially coastal zones. The travel and tourism sectors support 266 million jobs, and account for 8.9 % of the world's employment. Cauvery River Basin is notorious for its sanctity, which attract people from across the globe.

Transport

Rivers and inland waterways are some of the major navigable routes for trade & commercial purpose, connecting places together. Cauverybasin harbours 13 rivers, which carry 12 million passengers and 50 million tons of freight each year, sustaining 41 shipping companies.

Water provision

Sophisticated modes are adopted for accessible reach out of fresh water & waste water treatment, while

employing large workforces. The bottled water industry delivered over 70 billion gallons of water in 2013.Danone sells major brands such as Evian, Volvic, Bonafont and ,Bisleri,Mizone, andemploys more than 37,000 people in its water businesses .

Traditional wetland product-based livelihoods

Medicinal plants, dyes, fruits, reeds and grasses are just a few of the wetlandproducts that provide jobs, especially in developing countries.*Terminaliaarjuna*, *Pongamiapinnata, Hopeaparviflora*, *Pongamiapinnata, Ficusbenghalensis, Salix* in Cauvery River Basin aresome of the evergreen species producing wetland products.

Wetland function	Economically valuable good(s) and/or service(s)	Technique(s) typically used to quantify the value of the service(s)
Recharge of groundwater	Increased water quantity	Net factor income or replacement cost
Discharge of groundwater	Increased productivity of dowstream fisheries	Net factor income, replacement cost or travel cost
Water quality control	Reduced costs of water purification	Net factor income or replacement cost
Retention, removal and transformation of nutrients	Reduced costs of water purification	Net factor income or replacement cost
Habitat for aquatic species	Improvements in commercial and/or recreational fisheries either on or offsite. Non-use appreciation of the species	Net factor income, replacement cost, travel cost or contingent valuation
Habitat for terrestrial and avian species	Recreational observation and hunting of wildlife. Non-use appreciation of the species	Travel cost or contingent valuation
Biomass production and export (both plant and animal)	Production of valuable food and fiber for harvest	Net factor income
Flood control and storm buffering	Reduced damage due to flooding and severe storms	Net factor income or replacement cost
Stabilization of sediment	Erosion reduction	Net factor income or replacement cost
Overall environment	Amenity values provided by proximity to the environment	Hedonic pricing

Table 2: **Wetland functions, Associated Economically Valuable Goods and Services, and Techniques used to quantify them**

(Source : *Wetland Functions and Values* , M Montenegro and DS Karp, 2010)

Wetland is the lifeline for farmers during famine & water scarcity. For decades,riparian communities have been involved in cultivation of food crops to meet the household's demands during the dry season and to augment cash income through market sales.

PROJECTS INITIATED FOR CONSERVATION

The Government of India, now, is contemplating tointroduce "River Regulation Zone" to safeguardriparian habitat and to ensure that river beds remained safe from large-scale encroachment and developmental activities.Stringent Initiatives adopted by NGO in a bid to conserve such sensitive ecosystems involves "Madu Ganga" Wetland conservation project conducted by Earth Environment Project, Sri Lanka,National Wetland Conservation Programme, developed by Wetland Conservation Board & Mangrove Restoration programmes enforce sustainable livelihoods by puritanical rules to the public. One of clamorous incident that came to light lately in Kerala, India is the mercury contamination of Kuttanad wetland, caused a dreadful mayhem to the riparian communities.

CONCLUSION

Agroecosystems & wetlands are aforethought as lungs & kidneys of nature respectively. These fragile systems are highly jeopardized to destruction and it is high time that country needs to enact a permanent policy to protect and conserve riparian buffers to avoid further degradation and loss of biodiversity in the unregulated areas along the river.

ACKNOWLEDGEMENT

The authors are greatly thankful to the management and staff of All Saints' College and College of Agriculture for extending support and necessary guidance to prepare this article.

BIBLIOGRAPHY

1) Wallschlager, D., Desai, M.V.M., Spengler, M., Windmoler, C.C. and Wilken, R.D. (1998). Mercuryspeciation in floodplain soils and sediments along a contaminated river transect. Journal ofEnvironmental Quality, 27:1034-1044.
2) Wasay, S.A., Barrington, S. and Tokunaga, S. (1998). Retention form of heavy metals in threepolluted soils. Soil and Sediment Contamination,7:103–119.
3) Weber, J. (1993). Review of possible paths for abiotic methylation of mercury (II) in theaquaticenvironment. Chemosphere, 26: 2063-2077.
4) SenaratnaSellamuttu, S., de Silva, S., Nagabhatla, N., Finlayson, C.M., Pattanaik, C. and Prasad, N. (2012)
5) The Ramsar Convention's wise use concept in theory and practice: an inter-disciplinary investigation ofpractice in Kolleru Lake, India. Journal of International Wildlife Law and Policy 15, 228–250.
6) Shiklomanov, I.A. and Rodda, J. (2003) World Water Resources at the Beginning of the 21st Century. UnitedNations Educational, Scientifi c and Cultural Organization (UNESCO), Paris.
7) Smith, L.E.D., Nguyen-Khoa, S. and Lorenzen, K. (2005) Livelihood functions of inland fi sheries: policyimplications in developing countries. Water Policy 7, 359–384.
8) Springate-Baginski, O., Allen, D. and Darwall, W.R.T. (eds) (2009) An Integrated Wetland Assessment Toolkit:
9) A Guide to Good Practice. International Union for Conservation of Nature (IUCN), Gland, Switzerlandand IUCN Species Programme, Cambridge, UK.
10) Szuster, B., Molle, F., Flaherty, M. and Srijantr, T. (2003) Socioeconomic and environmental implications ofinland shrimp farming in the Chao Phraya Delta. In: Molle, F. and Srijantr, T. (eds) Perspective on Socialand Agricultural Change in the Chao Phraya Delta. White Lotus Press, Bangkok, Thailand.
11) Tran Huu, T., Mai Van, X., Do Nam and Navrud, S. (2009) Valuing direct use values of wetlands: A case studyof Tam Giang–CauHai lagoon wetland in Vietnam. Ocean and Coastal Management 52, 102–112.doi:10.1016/j.ocecoaman.2008.10.011
12) Troell, M., Joyce, A. and Chopin, T. (2009) Ecological engineering in aquaculture – potential for integratedmulti-trophic aquaculture (IMTA) in marine offshore systems. Aquaculture 297, 1–9.
13) UNEP (2006) Marine and Coastal Ecosystems and Human Well-being: A Synthesis Report Based on theFindings of the Millennium Ecosystem Assessment.United Nations Environment Programme, Nairobi.
14) UNEP (2010) Blue Harvest: Inland Fisheries as an Ecosystem Service. WorldFish, Penang, Malaysia andUnited Nations Environment Programme, Nairobi.
15) "A New Framework for Planning the Future of Coastal Louisiana after the Hurricanes of 2005." Working Group for Post-Hurricane Planning for the Louisiana Coast. University of Maryland Center for Environmental Science
16) "Constructed Wetlands for Wastewater Treatment and Wildlife Habitat: Case Studies." (EPA832-R-93-005) 1993. U.S. Environmental Protection Agency, Washington
17) "Economic Valuation of Wetlands: A Guide for Policy Makers and Planners"
18) "Flood Damage Reduction in the Upper Mississippi River Basin – A Ecological Alternative." 2004. Donald L. Hey, et al. The Wetland Initiative, Chicago, IL.