

WETLANDS

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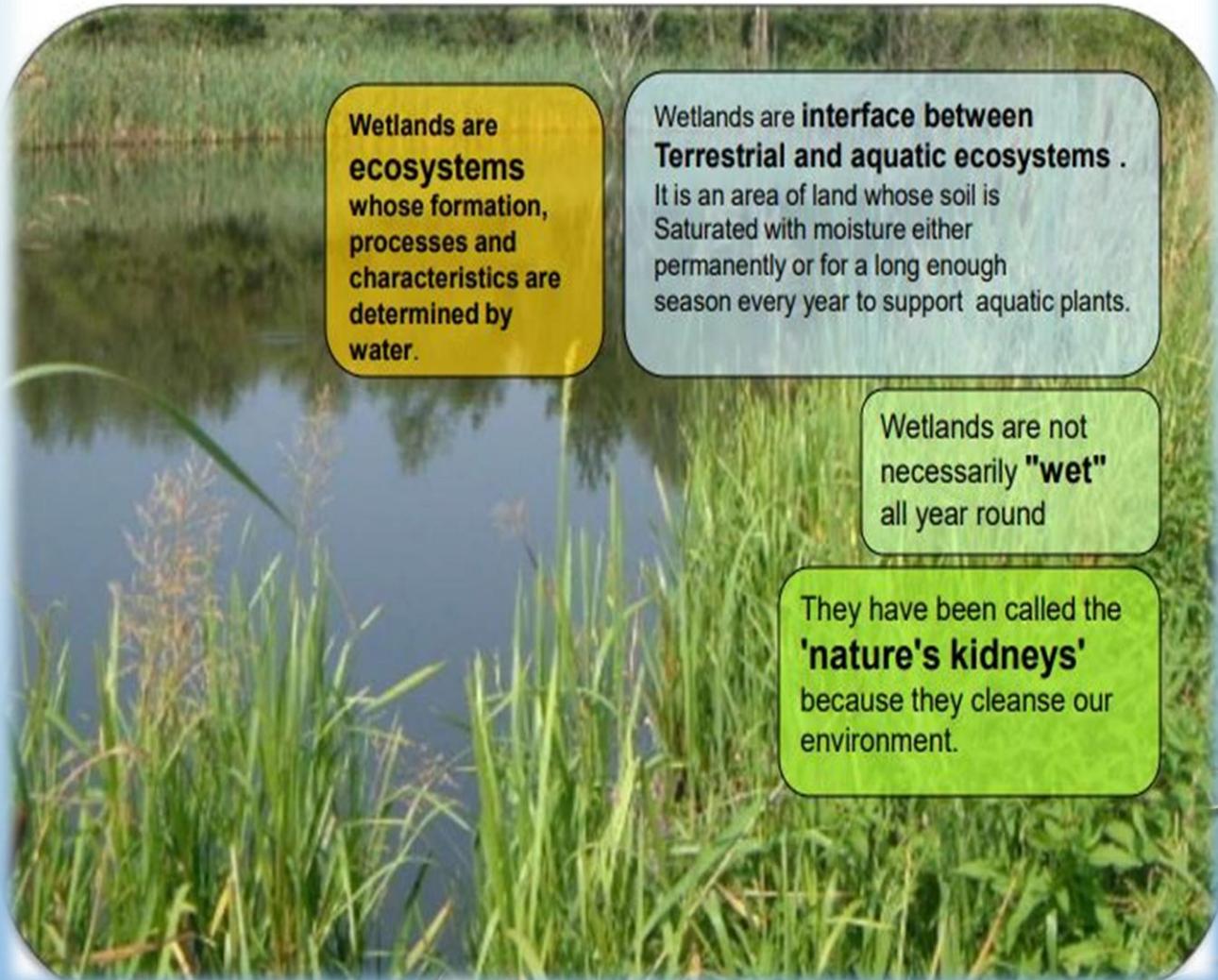
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WETLANDS

- An area fully or partially immersed in water for a part or whole of the year
- Wetlands are found along the shorelines of oceans, lakes, rivers and in local depressions.
- Water saturation determines how the soil develops and the types of plant and animal communities

What is a wetland?



Facts About Wetlands

Wetlands cover 7% of the earth's land surface and deliver 45% of the world's natural productivity (Source: www.MAweb.org).



Wetlands are typically low-lying areas



They can be natural or man-made

They can be coastal or inland

Floodplains, swamps, marshes, mangroves
deltas and lakes are some types of wetlands.

A paddy farm is also a wetland

Wetlands can contain fresh water, salt water,
or brackish (a combination of the two)



DEFINITION

Wetlands are... areas where a water table is at, near, or just above the surface and where soils are water-saturated for a sufficient length of time such that excess water and resulting low soil oxygen levels are principal determinants of vegetation and soil development. wetlands will have a relative abundance of obligate hydrophytes in the vegetation community and soils featuring “hydric” characteristics.



Ramsar convention



The Convention on Wetlands -- called the "**Ramsar Convention**" – was signed in Ramsar, Iran, in 1971.

An intergovernmental treaty - embodies the commitments of its member countries to plan for the "wise use", or sustainable use, of all of the wetlands in their territories.

Ramsar Convention definition

Under the Ramsar international wetland conservation treaty, wetlands are defined as follows:

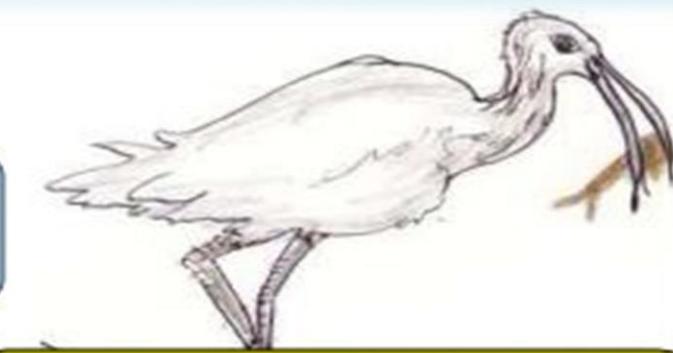
Article 1.1: "...wetlands are areas of marsh, fen, peat land or water; whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters."

Article 2.1: "[Wetlands] may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands."

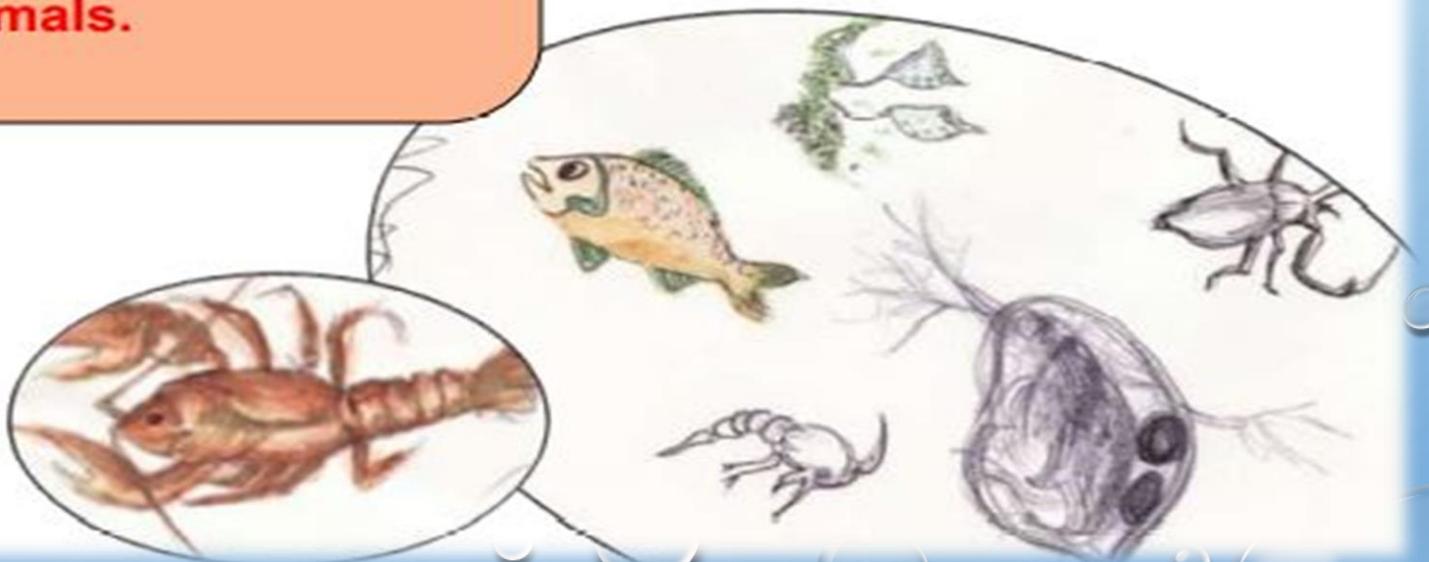
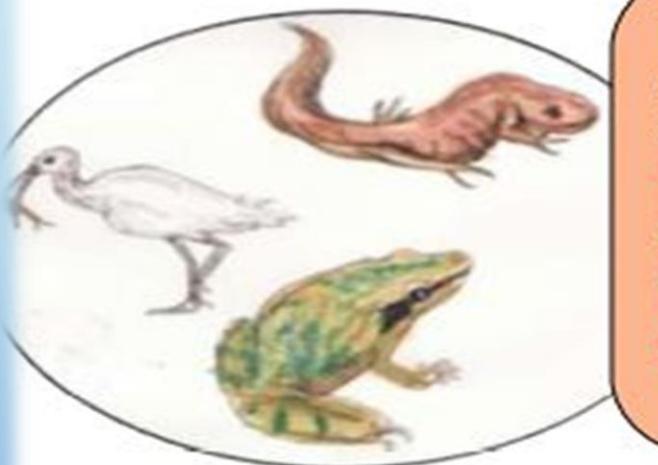
Importance of wetlands

Wetlands are among the most productive ecosystems in the world, comparable to rain forests and coral reefs.

They provide rich habitat for an immense variety of species of **microbes, plants, insects, amphibians, reptiles, birds, fish, and mammals.**



Many **species of birds and mammals** rely on wetlands for food, water, and shelter, especially **during migration and breeding.**



IMPORTANCE OF WETLANDS

- Ecosystem goods provided by the wetlands mainly include: **water for irrigation, fisheries, non-timber forest products, water supply and recreation.**
- Wetlands such as **tanks, ponds, lakes, and reservoirs** have long been providing multiple-use water services include water for **irrigation, domestic needs, fisheries and recreational uses, ground-water recharge, flood control and silt capture**
- Major services include: **carbon sequestration, flood control, groundwater recharge, nutrient removal, toxics retention and biodiversity maintenance**
- Swamps, mangroves, peat lands, mires and marshes play an important role in **carbon cycle**.
- Wetland sediments are the **long-term stores of carbon**, **short-term stores** are in wetland existing biomass (plants, animals, bacteria and fungi) and dissolved components in the surface and groundwater
- Wetlands act as a **sink for contaminants** in many agricultural and urban landscapes.
- Wetlands help to **lessen the impacts of flooding** by absorbing water and reducing the speed at which flood water flows.
- Wetlands are important in **supporting species diversity** as some vertebrates and invertebrates depend on wetlands for their entire life cycle while others only associate with these areas during particular stages of their life.
- Thus James (1995) has rightly termed these areas as **Nature's Kidney."**

IMPORTANCE OF WETLANDS

- ❖ Integral to a healthy environment
- ❖ Socio-economic importance
- Flood Control → peatlands and wet grasslands act as sponges, absorbing rainfall and controlling its flow into streams
- Help to retain water during dry periods, water table stable
- Provide clean water → they act as the earth's filters
- Wetlands removes pollutants from water
- Add moisture to the atmosphere

- Wetlands capture and retain rainfall, it prevent sediments from being washed into lakes and rivers
- Productive environment
- Maintain biological diversity
- Important feeding, breeding and drinking areas for wildlife
- A source of life for people and wildlife

- Food supply
- Shoreline and storm protection: Coastal wetlands act as frontline defenses against potential devastation Physical barriers that slows down storm surges and tidal waves
- Cultural value
- Materials and medicines
- Recreation areas
- Vital habitat: 40% species and 12% of animal species
- A refuge for migrating birds

Uses of wetlands

water management

Think of a wetland as a huge sponge

Wetlands store water when it is in excess and release it to the ground during dry periods

This helps in recharge and discharge of groundwater



They assist in flood control

They reduce the momentum of water as it flows to a river or a stream, thereby reducing soil erosion

They are also important to the nutrient cycle.



Uses of wetlands

environmental

Wetlands plants and soil store carbon instead of releasing it to the atmosphere as carbon dioxide. Thus they help moderate global climate

Wetlands help retain sediments and increase soil fertility

Plants that grow in wetlands are very effective in filtering out water pollution

Many wetlands remove pollutants from surface runoff and small streams.

Mangroves can protect shorelines from strong winds and can reduce the impact of hurricanes and tsunamis



WETLANDS VARY WIDELY:

1. Regional and local differences in soils
2. Topography
3. Hydrology
4. Water chemistry
5. Vegetation
6. Human disturbance

Wetlands occur in all continents except Antarctica

TYPES OF WETLANDS

- Wetlands can generally be classified into five basic systems, namely: Lacustrine, Riverine, Palustrine, Marine and Estuarine (Frazier, 1996).

I. Marine: Open ocean overlaying continental shelf

1. Subtidal: Substrate continuously submerged.
2. Intertidal: Substrate exposed and flooded by tides.

II. Estuarine: Deep water tidal habitat with freshwater runoff from land

1. Subtidal: as under I (1)
2. Intertidal: as under I (2)

III. Riverine: Include all wetland and deepwater habitat contained within a channel (1)

1. Lower Perennial: gradient low, no tidal influence
2. Upper Perennial: gradient high, velocity of water fast
3. Intermittent: non-tidal flowing water for only part of the year

IV. Lacustrine: Topographic depression, lacking tree, shrub and exceed 8 ha.

1. Limnetic: all deep water above 2m depth
2. Littoral: all wetland below 2m depth or non-persistent emergent

V. Palustrine: All wetland dominated by trees, shrubs and tidal wetland with salinity below 0.5%

Wetland Classification Chart

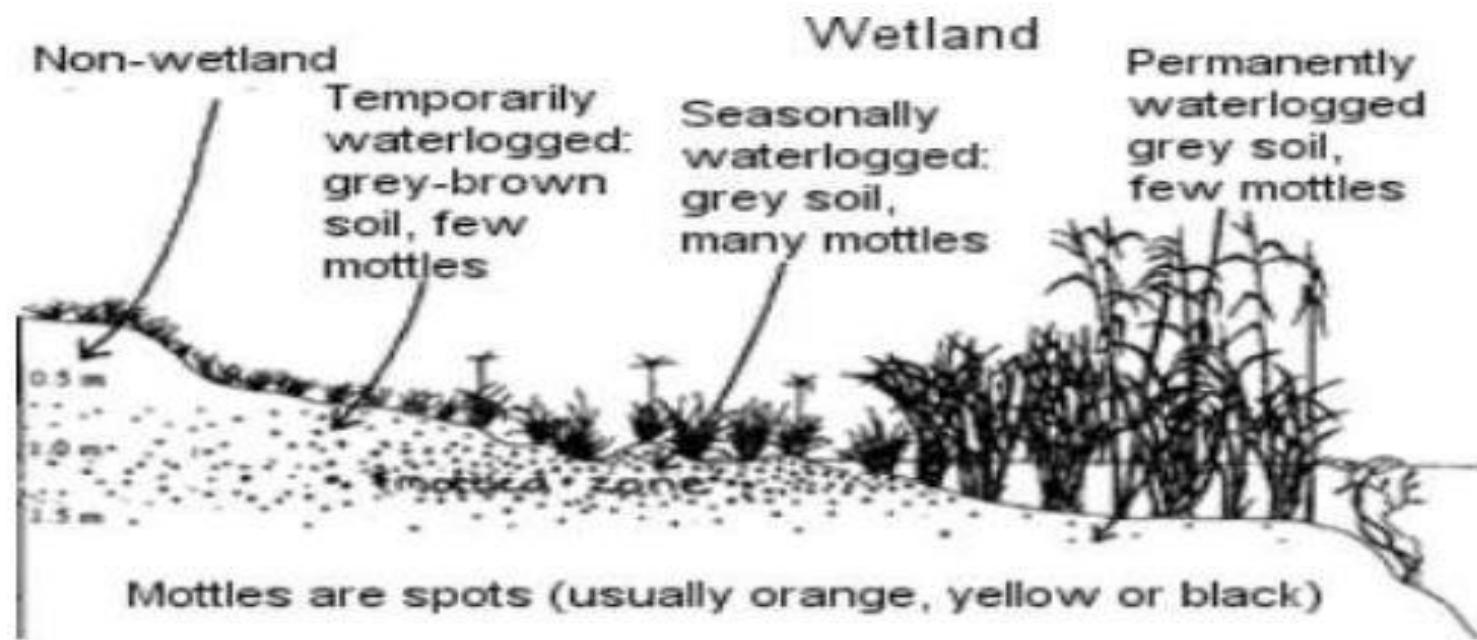
Major Categories	General Location	Wetland types
Coastal Wetlands:		
<i>Marine (undiluted salt water)</i>	<i>Open coast</i>	<i>Shrub wetland, salt marsh, mangrove swamp</i>
<i>Estuarine (salt/freshwater mix)</i>	<i>Estuaries (deltas, lagoons)</i>	<i>Brackish marsh, shrub wetland, salt marsh, mangrove swamp</i>
Inland Wetlands:		
<i>Riverine (associated w/ rivers and streams)</i>	<i>River channels and floodplains</i>	<i>Bottomlands, freshwater marsh, delta marsh</i>
<i>Lacustrine (associated w/ lakes)</i>	<i>Lakes and deltas</i>	<i>Freshwater marsh, shrub and forest wetlands</i>
<i>Palustrine (shallow ponds, misc. freshwater wetlands)</i>	<i>Ponds, peatlands, uplands, ground water seeps</i>	<i>Ephemeral ponds, tundra peatland, ground water spring oasis, bogs</i>

Wetlands – lands covered with water all or part of a year

Hydric (saturated) soils – saturated long enough to create an anaerobic state in the soil horizon

Hydrophytic plants – adapted to thrive in wetlands despite the stresses of an anaerobic and flooded environment

Hydrologic regime – dynamic or dominant presence of water



The Ramsar Classification of Wetland Type, divides wetlands into three main categories, namely:

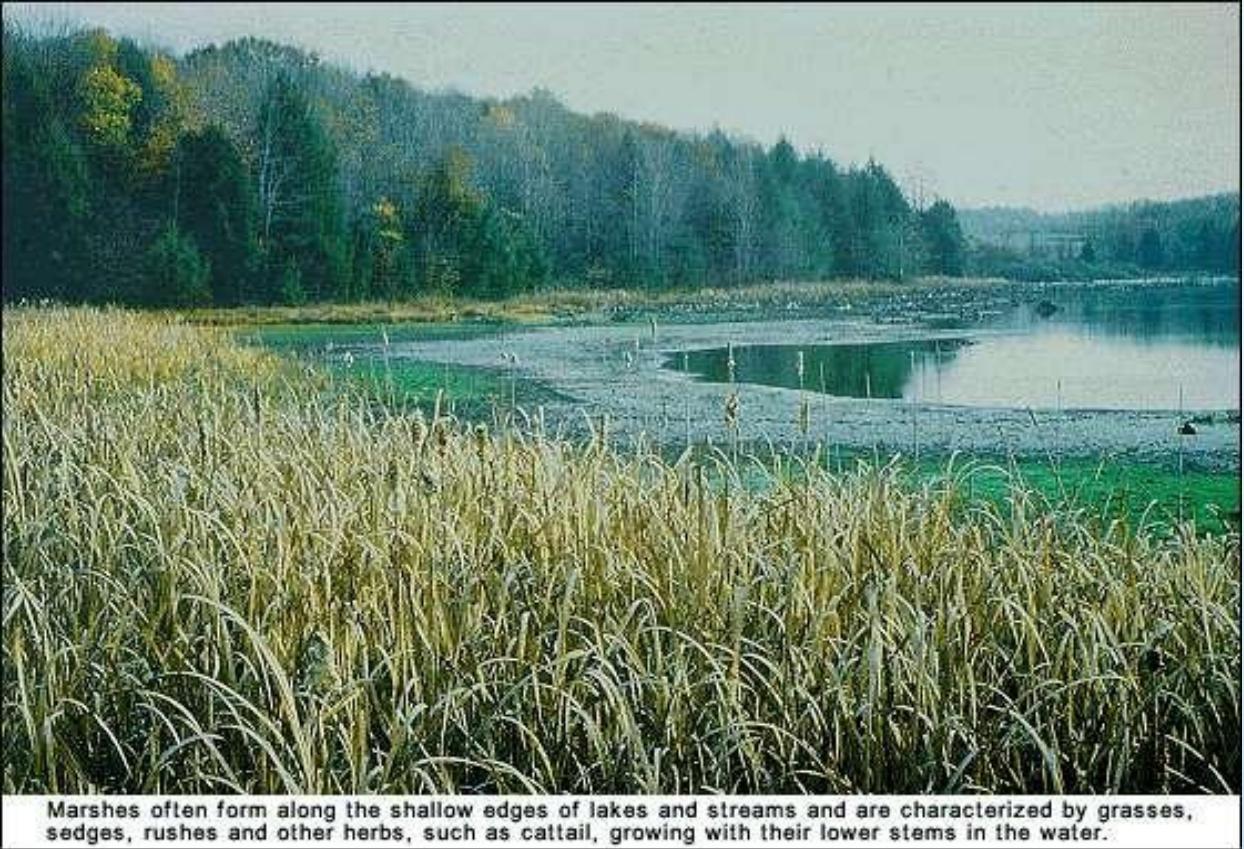
- Coastal/Marine or Tidal Wetlands
 - Inland or Non-Tidal Wetlands
 - “Man-Made” Wetlands
- The categories have further subdivisions which gives a total of 40 wetland types

TIDAL OR COASTAL WETLANDS

- Sea water mixes with fresh water to form an environment of varying salinities → Due to tidal action
- Shallow coastal areas are unvegetated mudflats or sand flats
- Grasses and grass like plants survive this condition
- Mangrove swamps with salt loving shrubs or trees are common in tropical climate

NON-TIDAL WETLANDS

- ❖ Common in floodplains along rivers and streams → Riparian Wetland
- ❖ Isolated depression surrounded by dry land → Playas, Basins and Potholes
- ❖ Along the Margins of lakes and ponds
- ❖ Low-lying areas where the GW intercepts the soil surface or where precipitation sufficiently saturates the soil → Vernal pools and Bogs
- ❖ Marshes and wet meadows → Herbaceous plants



Marshes often form along the shallow edges of lakes and streams and are characterized by grasses, sedges, rushes and other herbs, such as cattail, growing with their lower stems in the water.

Tidal marsh along the Edisto River, South Carolina (source – the US Environmental Protection Agency website).



Tom Blagden, Jr.

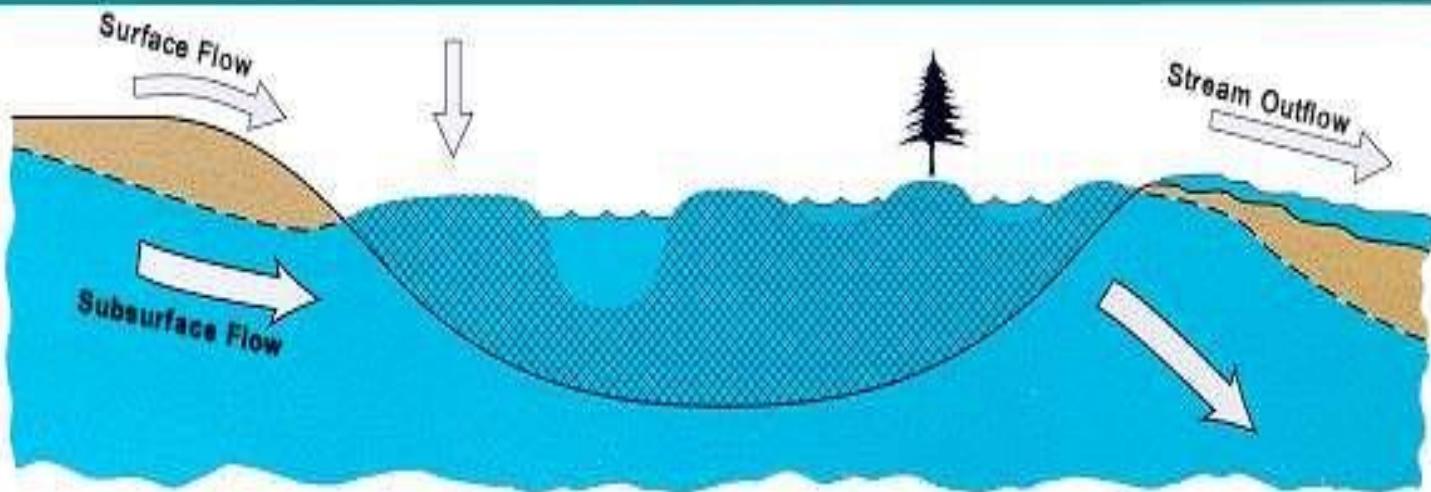
CREEK

- ❖ A tidal inlet, typically as a salt marsh or mangrove swamps. The stream is the tidal stream.

FEN

- Wetland fed by surface or groundwater.
- Flora is characterised by their water chemistry
- Fens are alkaline rather than acid areas
- Characterized by peaty soil, dominated by grasslike plants, grasses, sedges and reeds

FENS



Fens receive both surface and subsurface water and have both surface and subsurface outflows. As a result, fens tend to reflect the chemistry of the underlying geology and can be quite alkaline when fed from limestone sources.



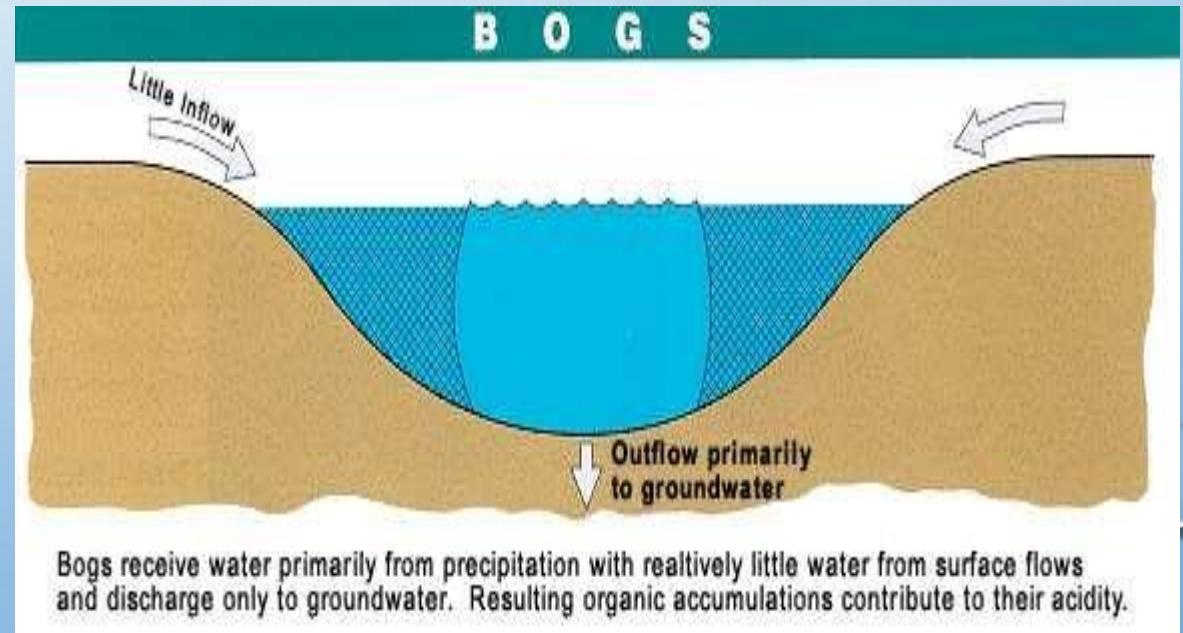
BOG: type of wetland ecosystem characterized by wet, spongy, poorly drained peaty soil, dominated by the growth of bog mosses, Sphagnum, and heaths, particularly Chamaedaphne

- Bogs are usually acid areas, frequently surrounding a body of open water.
- Bogs receive water exclusively from rainfall.



Lost Pond, in the Adirondacks of New York, is only a small part of this bog which includes the black spruce, *Picea mariana*, and tamarack, *Larix laricina*, forest in the background.

Donald J. Leopold



SWAMPS

- Temporary or permanent inundation of large areas of land by shallow bodies of water
 - hummocks present
 - Aquatic vegetation
 - Shrubs are present
- Slow-moving water associated with adjacent rivers or lake

ESTUARY

- Semi enclosed coastal body of water with one or more rivers flowing into it or the river meets the sea
- High biological productivity
- Characterized by sedimentation
- pH, salinity and water level changes depending on the river and the ocean



SWAMP



Estuaries

FJORD

- Long narrow estuary with steep sides, created in a glacially carved valley that filled by rising sea water levels

LAGOON

- Shallow salt or brackish water separated from deeper sea by a shallow sandbanks, coral reefs....
- The enclosed body of water behind a barrier reef enclosed by an atoll reef

RAMSAR WETLAND TYPE

□ COASTAL/MARINE OR TIDAL WETLANDS

- A. Permanent shallow marine waters less than six metres deep at low tide; includes sea bays and straits.
- B. Marine subtidal aquatic beds; includes kelp beds, sea-grass beds, tropical marine meadows.
- C. Coral reefs.
- D. Rocky marine shores; includes rocky offshore islands, sea cliffs.
- E. Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems.
- F. Estuarine waters; permanent water of estuaries and estuarine systems of deltas.
- G. Intertidal mud, sand or salt flats.
- H. Intertidal marshes; includes salt marshes, salt meadows, salttings, raised salt marshes; includes tidal brackish and freshwater marshes.
- I. Intertidal forested wetlands; includes mangrove swamps, nipah swamps and tidal freshwater swamp forests.
- J. Coastal brackish/saline lagoons; brackish to saline lagoons with at least one relatively narrow connection to the sea.
- K. Coastal freshwater lagoons; includes freshwater delta lagoons.

RAMSAR WETLAND TYPE

□ INLAND OR NON-TIDAL WETLANDS

- L.** Permanent inland deltas.
- M.** Permanent rivers/streams/creeks; includes waterfalls.
- N.** Seasonal/intermittent/irregular rivers/streams/creeks.
- O.** Permanent freshwater lakes (over 8 ha); includes large oxbow lakes.
- P.** seasonal/intermittent freshwater lakes (over 8 ha); includes floodplain lakes.
- Q.** Permanent saline/brackish/alkaline lakes.
- R.** Seasonal/intermittent saline/brackish/alkaline lakes and flats.*
- Sp.** Permanent saline/brackish/alkaline marshes/pools.
- Ss.** Seasonal/intermittent saline/brackish/alkaline marshes/ pools.*
- Tp.** Permanent freshwater marshes/pools; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season.
- Ts.** Seasonal/intermittent freshwater marshes/pools on inorganic soil; includes sloughs, potholes, seasonally flooded meadows, sedge marshes.*
- U.** Non-forested peatlands; includes shrub or open bogs, swamps, fens.
- Va.** Alpine wetlands; includes alpine meadows, temporary waters from snowmelt.
- Vt.** Tundra wetlands; includes tundra pools, temporary waters from snowmelt.
- W.** Shrub-dominated wetlands; shrub swamps, shrub-dominated freshwater marsh, shrub carr, alder thicket; on inorganic soils.*
- Xf.** Freshwater, tree-dominated wetlands; includes freshwater swamp forest, seasonally flooded forest, wooded swamps; on inorganic soils.*
- Xp.** Forested peatlands; peatswamp forest.*
- Y.** Freshwater springs; oases.
- Zg.** Geothermal wetlands.
- Zk.** Subterranean karst and cave hydrological systems.

* as appropriate, includes: floodplain wetlands such as seasonally inundated grassland (including natural wet meadows), shrublands, woodlands or forest.

RAMSAR WETLAND TYPE

"MAN-MADE" WETLANDS

1. Aquaculture (e.g. fish/shrimp) ponds.
2. Ponds; includes farm ponds, stock ponds, small tanks; (generally below 8 ha).
3. Irrigated land; includes irrigation channels and rice fields.
4. Seasonally flooded agricultural land.**
5. Salt exploitation sites; salt pans, salines, etc.
6. Water storage areas; reservoirs/barrages/dams/impoundments; (generally over 8 ha).
7. Excavations; gravel/brick/clay pits; borrow pits, mining pools.
8. Wastewater treatment areas; sewage farms, settling ponds, oxidation basins, etc.
9. Canals and drainage channels, ditches.

*** to include intensively managed or grazed wet meadow or pasture.*

- ❖ Nutrient dynamics is broadly defined as the way nutrients are taken up, retained, transferred, and cycled over time and distance, in an ecosystem (Hauer and Lamberti, 2006; Allan and Castillo, 2007)
- ❖ The model partitions a wetland into three basic compartments: (1) water column (free water), (2) wetland soil layer, and (3) plant biomass.
- ❖ The soil layer is further partitioned into aerobic and anaerobic zones.

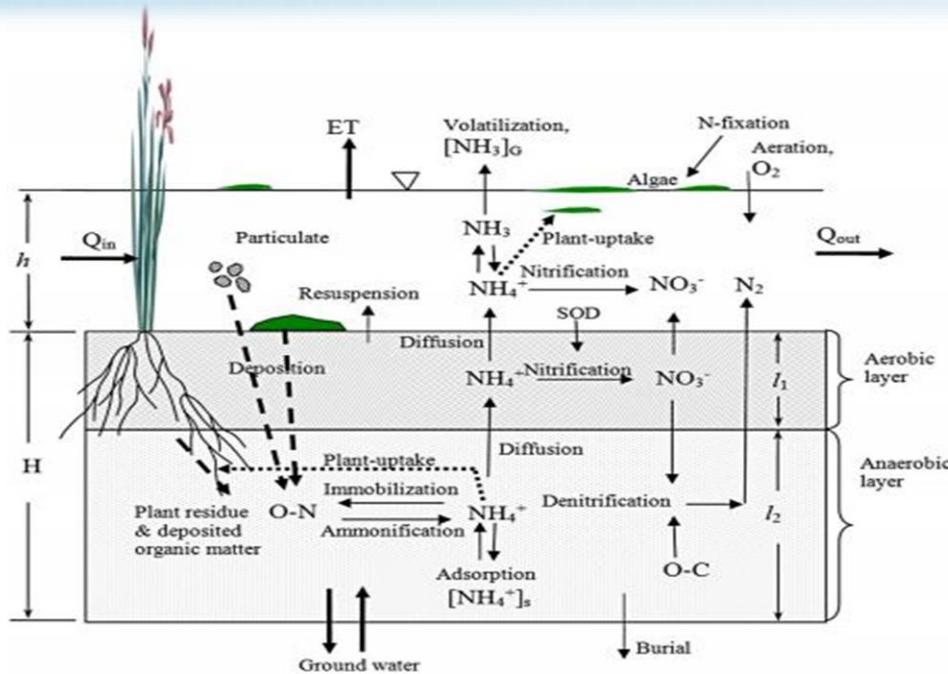


Fig. 1. Nitrogen processes in wetlands: water column, aerobic soil layer, and reduced lower soil layer.

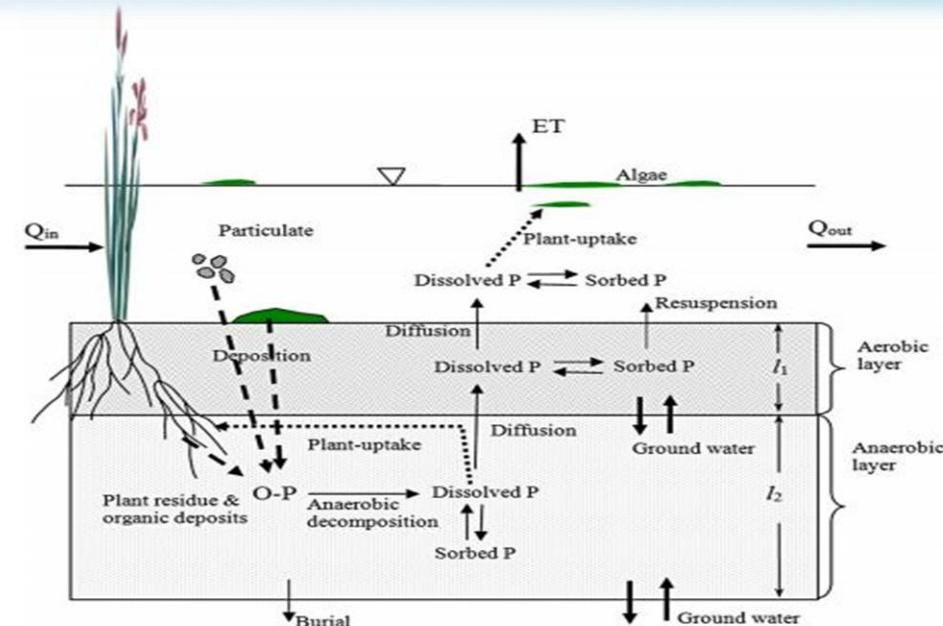


Fig. 2. Phosphorus processes in wetlands: water column, aerobic soil layer, and lower reduced soil layer.

Figs. 1 and 2 depict the conceptual model for complete biogeochemical pathways of mineralization of organic matter to ammonia and phosphate

Coastal Saline Swamp Nutrient Dynamics

Nutrients (including **nitrogen** and **phosphorus**) can enter coastal saline swamps attached to particles and suspended or dissolved in water entering from floods and run-off and can leave the wetlands during hydrological connections with terrestrial and other waterbodies.

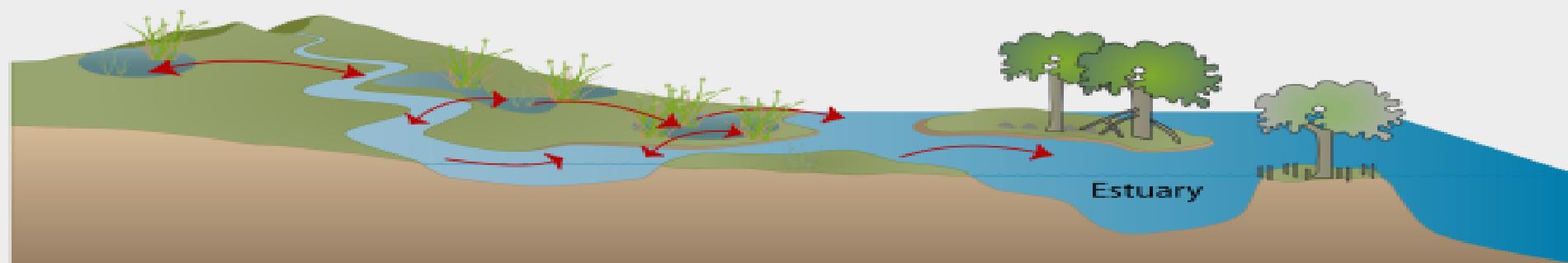
Fauna and their droppings can also be a source of nutrients into a wetland.

Studies that track the flow of carbon through ecosystems and food webs suggest that this wetland habitat type can be an important source of carbon to estuaries and marine ecosystems.

Migratory and mobile organisms, such as fish and birds, can transfer nutrients (as well as genetic material) between wetlands and into terrestrial areas.

Denitrification, for further information see [Nitrogen Cycle](#).

Landscape Nutrient Transfer

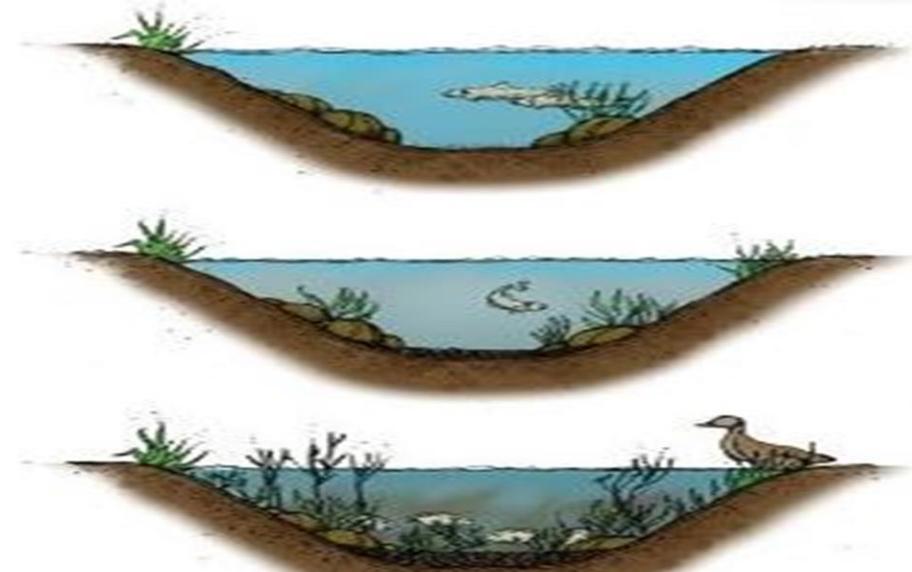


Trophic status of wetlands

- ❖ Trophic means “**of or relating to nutrition.**”
- ❖ The least productive wetlands are called ‘**oligotrophic**’, most productive wetlands are called ‘**eutrophic**’ and those with a trophic status that falls along the continuum somewhere between oligotrophy and eutrophy are termed ‘**mesotrophic**’

Trophic Classification of Aquatic Ecosystems

- **Oligotrophic** – Low levels of organic matter – tend to be deep and clear , oxygen rich bottom supports cold water fish such as trout , Phosphorus is limiting
- **Mesotrophic** – more organic matter, oxygen level in lake bottom is low
- **Eutrophic**- High levels of organic matter – abundant plant growth , poor clarity , stratified with oxygen poor bottoms
- A dead zone is an area where oxygen levels fall below 2 ppm



Oligotrophic

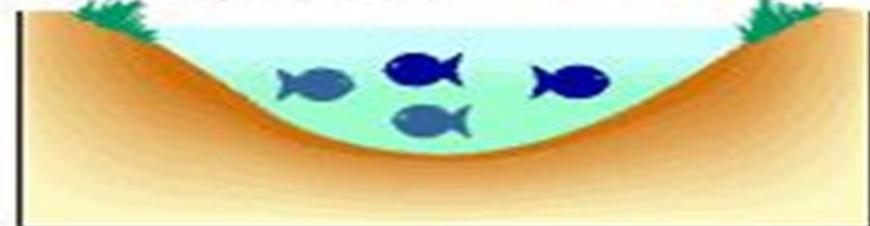
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Chlorophyll	<3 µg/L
Phosphorus	<15 µg/L
Nitrogen	<400 µg/L
Clarity	>13 feet

Mesotrophic

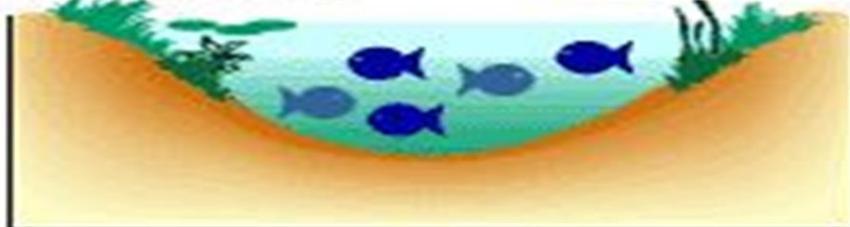
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Chlorophyll	3-7 µg/L
Phosphorus	15-25 µg/L
Nitrogen	400-600 µg/L
Clarity	8-13 feet

Eutrophic

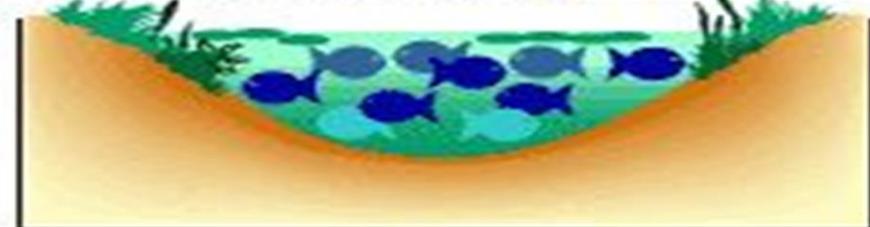
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Chlorophyll	7-40 µg/L
Phosphorus	25-100 µg/L
Nitrogen	600-1500 µg/L
Clarity	3-8 feet

Hypereutrophic

H



Chlorophyll	>40 µg/L
Phosphorus	>100 µg/L
Nitrogen	>1500 µg/L
Clarity	<3 feet

Figure 1: Trophic states, concentrations of constituents, and typical waterbody uses.

- The trophic state of lakes is indicative of their **biological productivity**, that is, the amount of living material supported within them, primarily in the form of **algae**

DISTRIBUTION AND EXTENT OF WETLANDS IN INDIA



Fig. 1. Map showing State-wise number of wetlands in India. (Note: Figure in parenthesis represents total number of wetlands in respective State.)

- ❖ India has about **757.06** thousand wetlands {201,503 wetlands and in addition, 555,557 wetlands (area <2.25 ha)} with a total area of 15.3 million ha, accounting for nearly 4.7% of the total geographical area of the country.
- ❖ Out of this, area under inland wetlands accounts for 69%, coastal wetlands 27%, and other wetlands (smaller than 2.25 ha) 4%.
- ❖ In terms of average area under each type of wetland, natural coastal wetlands have the largest area.
- ❖ Overall, inland wetlands have a water spread area of 7.4 m ha in post monsoon and 4.8 m ha in pre-monsoon, and coastal wetlands have 1.2 m ha and 1 m ha in post monsoon and pre monsoon, respectively.
- ❖ The aquatic vegetation in all the wetlands put together account for 1.32 m ha (9% of total wetland area) in post monsoon and 2.06 m ha (14% of total wetland area) in pre monsoon (SAC, 2011).

- ❖ Most of the wetlands in India are directly or indirectly linked with major river systems such as the Ganges, Cauvery, Krishna, Godavari and Tapti.
- ❖ The coastal wetlands occupy an estimated 6,750 sq km and are largely dominated by mangrove vegetation.
- ❖ About 80% of the mangroves are distributed in the Sunderbans of West Bengal and the Andaman and Nicobar Islands, with the rest in the coastal states of Odisha, Andhra Pradesh, Tamil Nadu, Karnataka, Kerala, Goa, Maharashtra and Gujarat
- ❖ Wetlands in southern peninsular India are mostly manmade and are known as **yeris** (tanks).
- ❖ They are constructed in every village and provide water for various human needs, besides serving as nesting, feeding and breeding sites for a large variety of bird species.
- ❖ Point Calimere in Tamilnadu, Ashtamudi, Sasthamkotta and Vembanad-Kol lakes in Kerala; and Kolleru lake in Andhra Pradesh are some of the natural wetland sites in South India

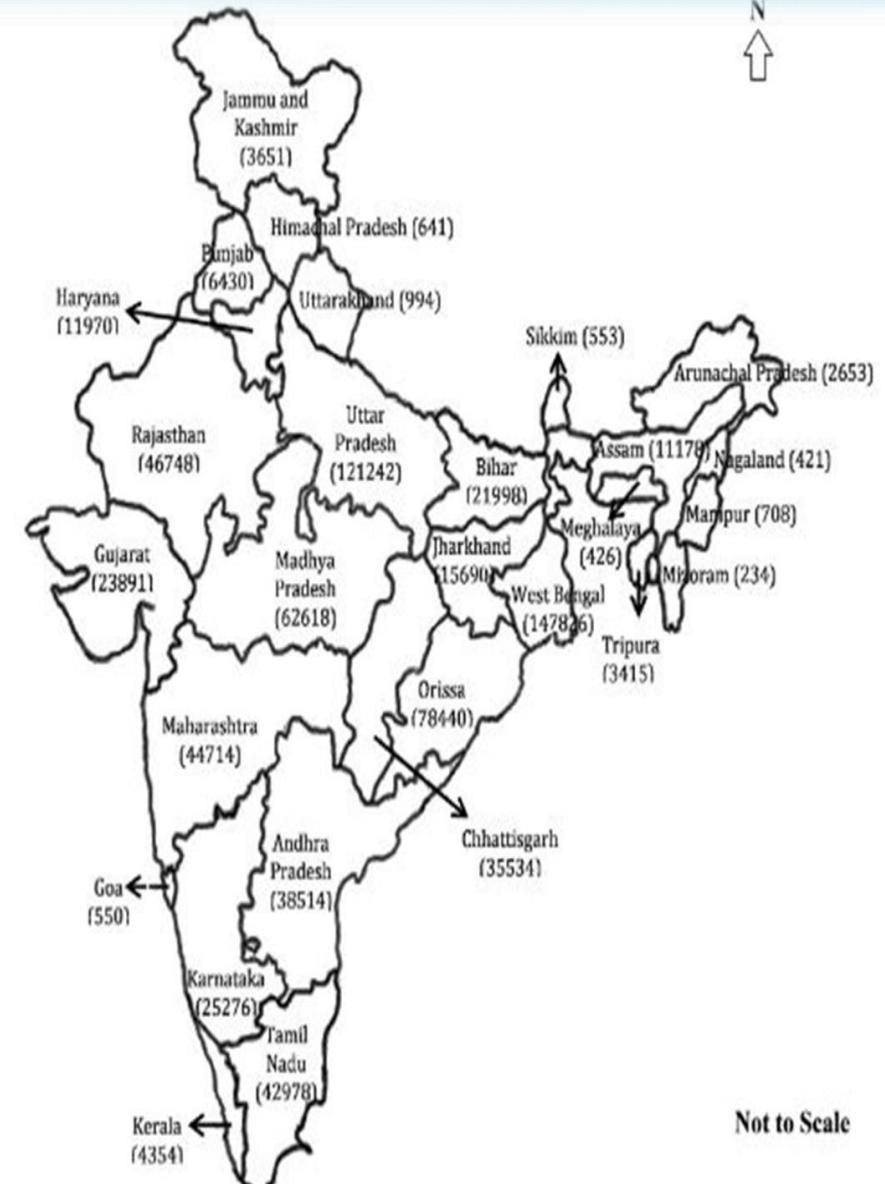


Fig. 1. Map showing State-wise number of wetlands in India. (Note: Figure in parenthesis represents total number of wetlands in respective State.)

❖ India's wetlands are generally differentiated into **8 categories** depending on their regional presence (Scott, 1989):

- ✓ The reservoirs of the Deccan Plateau in the south, together with the lagoons and other wetlands of the southwest coast.
- ✓ The vast saline expanses of Rajasthan, Gujarat and the Gulf of Kutch.
- ✓ The freshwater lakes and reservoirs from Gujarat eastwards through Rajasthan (Keoladeo Ghana National Park) and Madhya Pradesh.
- ✓ The delta wetlands and lagoons of India's east coast (Chilika Lake).
- ✓ The freshwater marshes of the Gangetic Plains and the floodplains of the Brahmaputra.
- ✓ The marshes and swamps in the hills of northeast India and the Himalayan foothills.
- ✓ The lakes and rivers of the mountain region of Kashmir and Ladakh.
- ✓ The mangroves and other wetlands of the Andaman and Nicobar Islands

❖ The wetland types found in India are categorized under 19 classes.

Sr no	wettcode	Wetland Category	Number of Wetlands	Total Wetland Area (ha)	% of wetland area	Open water area	
						Post Monsoon area	Pre Monsoon area
	1100	Inland Wetland: Natural					
1	1101	Lake/Pond	11740	729532	4.78	454416	198054
2	1102	Oxbow lake/ cut off meander	4673	104124	0.68	57576	37818
3	1103	High latitude Wetland	2707	124253	0.81	116615	109277
4	1104	Riverine wetland	2834	91682	0.60	48918	29739
5	1105	Waterlogged	11957	315091	2.06	197003	112631
6	1106	River/Stream	11747	5258385	34.46	3226238	2628182
7	1201	Reservoir/Barrage	14894	2481987	16.26	2260574	1268237
8	1202	Tank/Pond	122370	1310443	8.59	916020	349512
9	1203	Waterlogged	5488	135704	0.89	85715	33822
10	1204	Salt pan	60	13698	0.09	5293	2599
		Total - Inland	188470	10564899	69.23	7368368	4769871
	2100	Coastal Wetlands - Natural					
11	2101	Lagoon	178	246044	1.61	208915	191301
12	2102	Creek	586	206698	1.35	199743	189489
13	2103	Sand/Beach	1353	63033	0.41	-	-
14	2104	Intertidal mud flat	2931	2413642	15.82	516636	366953
15	2105	Salt Marsh	744	161144	1.06	5369	2596
16	2106	Mangrove	3806	471407	3.09	-	-
17	2107	Coral Reef	606	142003	0.93	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pan	609	148913	0.98	105253	94047
19	2202	Aquaculture pond	2220	287232	1.88	196514	186963
Total - Coastal			13033	4140116	27.13	1232430	1031349
Sub-Total			201503	14705015	96.36	8600798	5801220
Wetlands (<2.25 ha)			555557	555557	3.64	--	-
Total			757060	15260572	100.00	8600798	5801220

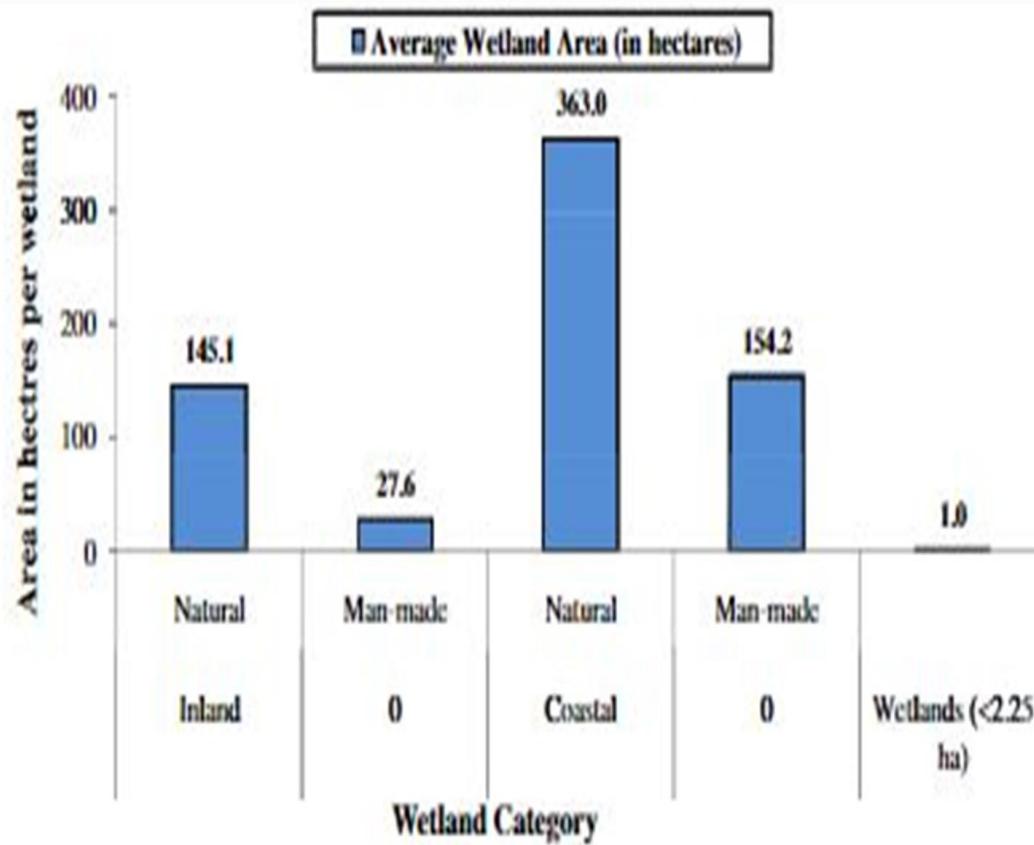


Fig. 2. Average area under different wetlands, India.

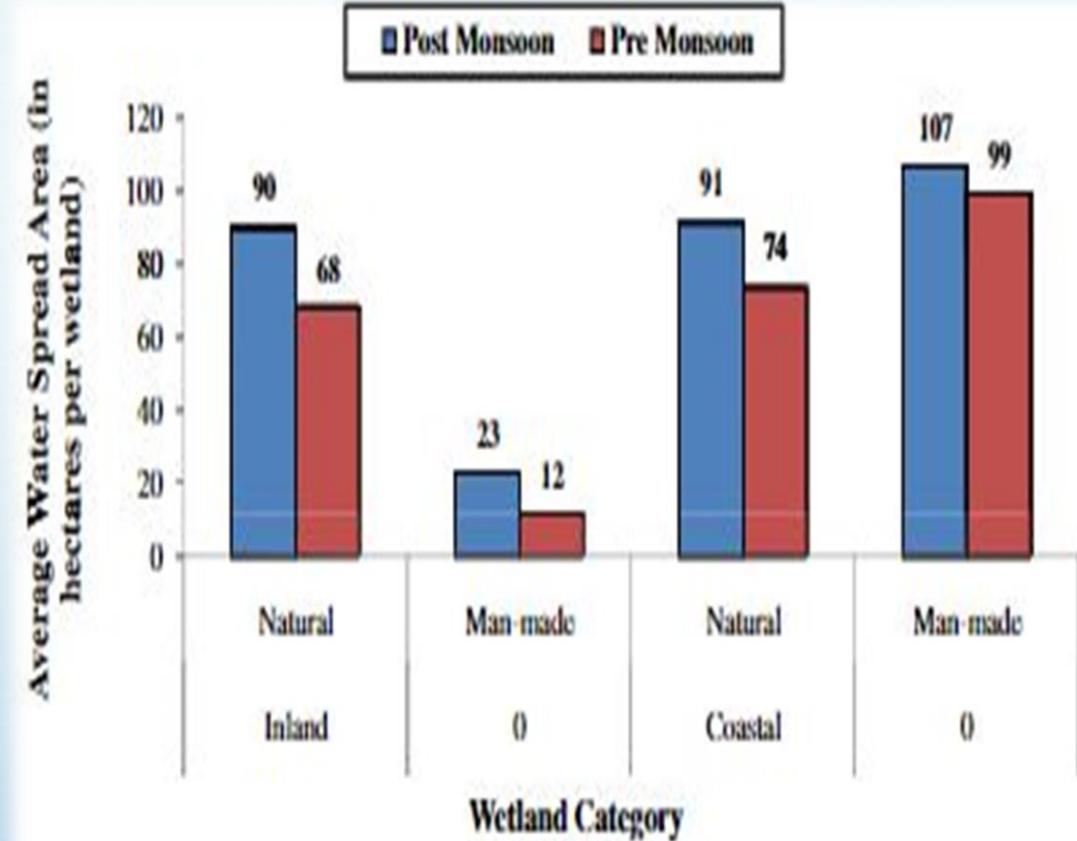


Fig. 3. Average water spread area under different wetlands, India.

- ❖ Gujarat has the highest proportion (22.8%) and UT of Chandigarh has nearly negligible part of the total wetland area in the country.

List of wetlands in India

State/Union Territory	S. No.	Wetland	Year of identification
1 Andhra Pradesh	1.	Kolleru	1987
2 Assam	2.	Deepar Beel	1994
	3.	Urpad Beel	2006
	4.	Sone Beel	2008
3 Bihar	5.	Kabar	1988
	6.	Barilla	2004
	7.	Kusheshwar Asthan	2004
4 Gujarat	8.	Nalsarovar	1988
	9.	Great Rann of Kachh	2004
	10.	Thol Bird Sanctuary	2004
	11.	Khijadiya Bird Sanctuary	2004
	12.	Little Rann of Kachh	2004
	13.	Pariej	2004
	14.	Wadhwanra	2004
	15.	Nanikakrad	2004
5 Haryana	16.	Sultanzpur	2004
	17.	Bhindawas	2004
6 Himachal Pradesh	18.	Renuka	1988
	19.	Pong Dam	1994
	20.	Chandratal	1997
	21.	Rewalsar	2004
	22.	Khajiar	2006
7 Jammu & Kashmir	23.	Wullar	1987
	24.	Tso Morari	2002
	25.	Tisgul Tso & Chisul Marshes	2002
	26.	Hokersar	2002
	27.	Mansar-Surinsar	2002
	28.	Ranjitsagar	2004
	29.	Pangong Tsar	2002
	30.	Gharana	2008
	31.	Hygam	2008
	32.	Mirgrund	2008
	33.	Shalburgh	2008
	34.	Chushul & Hanley	2008
8 Jharkhand	35.	Udhwa	2005
	36.	Tilaiya Dam	2006
9 Karnataka	37.	Magadhi	2004
	38.	Gudavi Bird Sanctuary	2004
	39.	Bonal	2004
	40.	Hidkal & Ghataprabha	2004
	41.	Heggeri	2006
	42.	Ranganthittu	2006
	43.	K.G. Koppa wetland	2006
10 Kerala	44.	Ashtamudi	1987
	45.	Sasthamkotta	1988
	46.	Kottuli	2005
	47.	Kadulandi	2005
	48.	Vembnad Kol	2005

S. No.	State/Union	S. No.	Wetland	Year of identification
11	Madhya Pradesh	49.	Barna	2004
		50.	Yashwant Sagar	2004
		51.	Wetland of Ken River	2004
		52.	National Chambal Sanctuary	2004
		53.	Ghatigaon	2004
		54.	Ratapani	2004
		55.	Denwa Tawa wetland	2004
		56.	Kanha Tiger Reserve	2004
		57.	Pench Tiger Reserve	2004
		58.	Sakhya sagar	2004
		59.	Dihaila	2004
		60.	Govindsagar	2005
		61.	Sirpur	2008
12	Maharashtra	62.	Ujni	1987
		63.	Jayakwadi	2006
		64.	Nalganga wetland	2006
13	Manipur	65.	Loktak	1987
14	Meghalaya	66.	Umiam lake	2008
15	Mizoram	67.	Tamdil	2004
		68.	Palak	2004
16	Odisha	69.	Chilika	1987
		70.	Kuanria wetland	2006
		71.	Kanjia wetland	2006
		72.	Daha wetland	2006
		73.	Anusupa	2008
17	Punjab	74.	Harike	1987
		75.	Ropar	1992
		76.	Kanjli	1988
		77.	Nangal	2008
18	Rajasthan	78.	Sambar	1987

S. No.	State/Union	S. No.	Wetland	Year of identification
19	Sikkim	79.	Khechuperi Holy Lake	2006
		80.	Tamze Wetland	2006
		81.	Tembao Wetland Complex	2006
		82.	Phendang Wetland Complex	2006
		83.	Gurudokmar Wetland	2006
		84.	Tsomgo wetland	2006
20	Tamil Nadu	85.	Point Calimere	2003
		86.	Kalivelvi	2004
		87.	Pallaikarni	2004
21	Tripura	88.	Rudrasagar	1998
		89.	Gumti reservoir	2008
22	Uttar Pradesh	90.	Nawabganj	2004
		91.	Sandi	2004
		92.	Lakh Bahoshi	2004
		93.	Samaspur	2004
		94.	Alwara Wetland	2006
		95.	Semarai Lake	2006
		96.	Nagarai lake	2006
		97.	Keetham Lake	2006
		98.	Shekha wetland	2006
		99.	Saman Bird Sanctuary	2006
		100.	Sarsai Nawar	2006
		101.	Patna Bird Sanctuary	2008
		102.	Chandotal	2008
		103.	Taal Bhaghel	2008
		104.	Taal Gambhiryan & Taal Salona	2008
		105.	Aadi jal Jeev Jheel	2008
23	Uttarakhand	106.	Ban Ganga Jhilmil Tal	2004
		107.	Asan	2008
24	West Bengal	108.	East Kolkata Wetland	2002
		109.	Sunderbans	2003
		110.	Ahiron Beel	2004
		111.	Rasik Beel	2004
		112.	Santragachi	2005
		113.	Patlakhawa- Rasomati	2008
25	Chandigarh (UT)	114.	Sukhna	2006
26	Puducherry (UT)	115.	Ousteri lake	2008

RAMSAR CONVENTION

- ✓ In February 2, 1971 convention on wetlands signed in Ramsar, Iran. Hence, also known as the **Convention on Wetlands** & named after the city of Ramsar in Iran. The Ramsar convention entered into force in India on **1st February 1982**.
- ✓ It is an intergovernmental/international treaty for “the conservation and sustainable use of wetlands” which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources
- ✓ The world’s first site was the Cobourg peninsula in Australia, designated in 1974.
- ✓ The largest sites are **Rio negro** in Brazil (120,000 sq. km), and Ngiri-Tumba-Maindombe in the Democratic Republic of Congo and Queen Maud gulf in Canada; these Sites each cover over 60,000 square km.
- ✓ The most Ramsar Sites are the United Kingdom with 175 and Mexico with 142.
- ✓ For conservation and management of identified wetlands including Ramsar sites in the country, the Centrally Sponsored Scheme of National Wetlands Conservation Programme (NWCP) was implemented till the year 2012-13.
- ✓ To have better synergy and to avoid overlap, the NWCP has been merged in February, 2013 with another scheme called National Lake Conservation Plan (NLCP) into a new integrated scheme of ‘National Plan for Conservation of Aquatic Ecosystems’ (NPCA) for holistic conservation of lakes and wetlands.

- ✓ At the time of joining the convention, each contracting party undertakes to designate at least one wetland site for inclusion in the list of wetlands of international importance.
- ✓ The inclusion of a “Ramsar site” in the list embodies the government’s commitment to take the steps necessary to ensure that its ecological character is maintained.
- ✓ There are a total of **2,406** Ramsar Sites on the territories of **171** Ramsar contracting parties across the world, covering an area of **254,343,085 ha**, including 37 Ramsar sites in India.
- ✓ As of February 2020, there are **37** Ramsar Sites in India covering **area of 1,067,939 hectares (10679.39 km²)**

State/UT	No. of Ramsar Sites
Uttar Pradesh	7
Punjab	6
Himachal Pradesh	3
Kerala	3
Union Territory of J&K	3
Odisha	2
Rajasthan	2
West Bengal	2
Andhra Pradesh	1
Assam	1
Gujarat	1
Madhya Pradesh	1
Maharashtra	1
Manipur	1
Tamil Nadu	1
Tripura	1
Union Territory of Ladakh	1
	37

THE RAMSAR SITES CRITERIA

- ❖ The nine criteria for identifying Wetlands of International Importance
 - **Group A:** Sites containing representative, rare or unique wetland types
 - ✓ **Criterion 1:** A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.

- **Group B:** Sites of international importance for conserving biological diversity
(Criteria based on species and ecological communities)
 - ✓ **Criterion 2:** A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
 - ✓ **Criterion 3:** A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
 - ✓ **Criterion 4:** A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.

THE RAMSAR SITES CRITERIA

(Specific criteria based on waterbirds)

- ✓ **Criterion 5:** A wetland should be considered internationally important if it regularly supports 20,000 or more water birds.
- ✓ **Criterion 6:** A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of water bird

(Specific criteria based on fish)

- ✓ **Criterion 7:** A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.
- ✓ **Criterion 8:** A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.

(Specific criteria based on other taxa)

- ✓ **Criterion 9:** A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.

Largest and Smallest, Newest and Oldest Ramsar Sites in India



Largest Ramsar Sites in India			
Ramsar Site	State	Area in Sq. km	
1) Sunderbans Wetland	West Bengal	4230	
2) Vembanad Kol Wetland	Kerala	1512	
3) Chilka Lake	Orissa	1165	
4) Kolleru Lake	Andhra Pradesh	901	
5) Bhitarkanika Mangroves	Orissa	650	
6) Asthamudi Wetland	Kerala	614	

Smallest Ramsar Sites in India			
Ramsar Site	State	Area in Sq. km	
1) Renuka Wetland	Himachal Pradesh	0.2	
2) Chandralatal	Himachal Pradesh	0.49	
3) Nangal Wildlife Sanctuary	Punjab	1	

Newest Ramsar Sites in India			
Ramsar Site	State	Year Declared	
• Nandur Madhameshwar	Maharashtra	2020	
• Keshopur-Miani, Beas Conservation Reserve and Nangal	Punjab	2020	
• Nawabganj, Parvati Agra, Saman, Samaspur, Sandi and Sarsai Nawar	Uttar Pradesh	2020	
• Sunderbans Wetland	West Bengal	2019	
• Nalsarovar Bird Sanctuary	Gujarat	2012	

Oldest Ramsar Sites in India			
Ramsar Site	State	Year Declared	
1) Chilka Lake	Orissa	1981	
2) Keoladeo Ghana NP	Rajasthan	1981	

Ramsar Sites in India

	Ramsar Site	State	Area (km ²)	Description
1	Ashtamudi Wetland	Kerala	614	<ul style="list-style-type: none">• It is a natural backwater in Kollam district.• River Kallada and Pallichal drains into it.• It forms an estuary with Sea at Neendakara (famous fishing harbour in Kerala).• National Waterway 3 passes through it.
2	Beas Conservation Reserve	Punjab	64	<ul style="list-style-type: none">• It is a 185-kilometre stretch of the Beas River.• The stretch is dotted with islands, sand bars and braided channels.• The Reserve hosts the only known population in India of the endangered Indus river dolphin.• In 2017, a programme was initiated to re-introduce the critically endangered gharial.
3	Bhitarkanika Mangroves	Odisha	650	<ul style="list-style-type: none">• It is part of Bhitarkanika Wildlife Sanctuary.• The core area of the sanctuary was declared Bhitarkanika National Park.• Gahirmatha Marine Wildlife Sanctuary is adjacent to the Bhitarkanika Wildlife Sanctuary.• It is famous for its saltwater crocodiles and Olive ridley sea turtle.• The core area of Bhitarkanika Wildlife Sanctuary was declared Bhitarkanika National Park.• Bhitarkanika Wildlife Sanctuary includes Gahirmatha Marine Wildlife Sanctuary.• Bhitarkanika Mangroves, a part of Bhitarkanika Wildlife Sanctuary was designated a Ramsar Wetland of International Importance in 2002.• It is famous for its saltwater crocodiles and Olive ridley sea turtle.

Ramsar Sites in India

	Ramsar Site	State	Area (km ²)	Description
4	Bhoj Wetland	Madhya Pradesh	32	<ul style="list-style-type: none">The Wetland consists of two lakes located in the city of Bhopal.The two lakes are the Bhojtal and the Lower Lake.It is a humanmade reservoir.The largest bird of India, the sarus crane is found here.
5	Chandra Taal	Himachal Pradesh	.49	<ul style="list-style-type: none">It is a high altitude lake.It supports IUCN Redlisted Snow Leopard.
6	Chilika Lake	Odisha	1165	<ul style="list-style-type: none">It is a brackish water lagoon at the mouth of the Daya River.It is the largest coastal lagoon in India.Birds from as far as the Caspian Sea, Lake Baikal, Aral Sea and other remote parts Central Asia, Ladakh and Himalayas come here.In 1981, Chilika Lake was designated the first Indian wetland of international importance under the Ramsar Convention.Nalbana Bird Sanctuary is the core area of the Ramsar designated wetlands of Chilika Lake.The Irrawaddy dolphin (critically endangered) is the flagship species of Chilika lake.Chilka is home to the only known population of Irrawaddy dolphins in India.
7	Deepor Beel	Assam	40	<ul style="list-style-type: none">A permanent freshwater lake in a former channel of the Brahmaputra river.It is a few kilometres to the left of Guwahati whereas Pobitora Wildlife Sanctuary is around 35 km to the right.

Ramsar Sites in India

	Ramsar Site	State	Area (km ²)	Description
8	East Kolkata Wetlands	West Bengal	125	<ul style="list-style-type: none"> It is multiple use wetland that serves the city of Kolkata.
9	Harike Wetland	Punjab	41	<ul style="list-style-type: none"> It is a shallow water reservoir at the confluence of Beas and Sutlej rivers.
10	Hokera Wetland	Union Territory of J&K	13.75	<ul style="list-style-type: none"> It is only 10 km from Srinagar. It is a natural perennial wetland contiguous to the Jhelum basin.
11	Kanjli Wetland	Punjab	1.83	<ul style="list-style-type: none"> The stream is considered to be the most significant in the state from the religious point of view, as it is associated with the first guru of the Sikhs, Shri Guru Nanak.
12	Keoladeo National Park	Rajasthan	28.73	<ul style="list-style-type: none"> A complex of ten artificial, seasonal lagoons, varying in size. Vegetation is a mosaic of scrub and open grassland that provides habitat for breeding, wintering and staging migratory birds. The invasive growth of the grass Paspalum distichum has changed the ecological character of large areas of the site, reducing its suitability for certain waterbird species, notably the Siberian crane.
13	Keshopur-Miani Community Reserve	Punjab	34	<ul style="list-style-type: none"> The Site is an example of wise use of a community-managed wetland, which provides food for people and supports local biodiversity.
14	Kolleru Lake	Andhra Pradesh	901	<ul style="list-style-type: none"> A natural eutrophic lake situated between the river basins of the Godavari and the Krishna. It was previously a lagoon, but now it is several kilometres inland due to the coastline of emergence and delta formation.

Ramsar Sites in India

	Ramsar Site	State	Area (km ²)	Description
15	Loktak Lake	Manipur	266	<ul style="list-style-type: none">Loktak Lake is the largest freshwater lake in the north-eastern region of the country.Keibul Lamjao the only floating national park in the world floats over it.
16	Nalsarovar Bird Sanctuary	Gujarat	123	<ul style="list-style-type: none">A natural freshwater lake (a relict sea) that is the largest natural wetland in the Thar Desert.The wetland is a lifeline for a satellite population of the endangered Indian Wild Ass.
17	Nandur Madhameshwar	Maharashtra	14	<ul style="list-style-type: none">Construction of the Nandur Madhameshwar Weir at the confluence of the Godavari and Kadwa Rivers helped create a thriving wetland.
18	Nangal Wildlife Sanctuary	Punjab	1	<ul style="list-style-type: none">Located in the Shiwalik foothills of Punjab.It supports abundant flora and fauna including threatened species, such as the endangered Indian pangolin and Egyptian vulture.It occupies a human-made reservoir constructed as part of the Bhakra-Nangal Project in 1961.The site is of historic importance as the Indian and Chinese Prime Ministers formalized the "Five Principles of Peaceful Coexistence" there in 1954.
19	Nawabganj Bird Sanctuary	Uttar Pradesh	2	<ul style="list-style-type: none">It was renamed as Chandra Shekhar Azad Bird Sanctuary in 2015.
20	Parvati Arga Bird Sanctuary	Uttar Pradesh	7	<ul style="list-style-type: none">It is a permanent freshwater environment consisting of two oxbow lakes.The Sanctuary is a refuge for some of India's threatened vulture species: the critically endangered white-rumped vulture and Indian vulture.
21	Point Calimere Wildlife and Bird Sanctuary	Tamil Nadu	385	<ul style="list-style-type: none">One of the last remnants of Dry Evergreen Forests.Habitat: Dry Evergreen Forests, Mangrove & Wetlands.

Ramsar Sites in India

	Ramsar Site	State	Area (km ²)	Description
22	Pong Dam Lake	Himachal Pradesh	156.62	<ul style="list-style-type: none"> It is also known as Maharana Pratap Sagar.
23	Renuka Lake	Himachal Pradesh	.2	<ul style="list-style-type: none"> A natural wetland with freshwater springs and inland subterranean karst formations.
24	Ropar Wetland	Punjab	13.65	<ul style="list-style-type: none"> A humanmade wetland of lake and river formed by the construction of a barrage for diversion of water from the Sutlej River.
25	Rudrasagar Lake	Tripura	2.4	<ul style="list-style-type: none"> It is a reservoir fed by three perennial streams discharging to the River Gomti. It is an ideal habitat for IUCN Redlisted Three-striped Roof Turtle.
26	Saman Bird Sanctuary	Uttar Pradesh	5	<ul style="list-style-type: none"> It is a seasonal oxbow lake on the Ganges floodplain.
27	Samaspur Bird Sanctuary	Uttar Pradesh	8	<ul style="list-style-type: none"> It is a perennial lowland marsh typical of the Indo-Gangetic Plains. The Sanctuary harbours threatened species such as the endangered Egyptian vulture.
28	Sambhar Lake	Rajasthan	240	<ul style="list-style-type: none"> The Sambhar Salt Lake is India's largest inland saltwater lake. It is a key wintering area for tens of thousands of flamingos.
29	Sandi Bird Sanctuary	Uttar Pradesh	3	<ul style="list-style-type: none"> The wetland is typical of the Indo-Gangetic plains.
30	Sarsai Nawar Jheel	Uttar Pradesh	2	<ul style="list-style-type: none"> It is a permanent marsh. It is an example of co-habitation of humans and wildlife. The site's name is derived from the large non-migratory sarus crane.
31	Sasthamkotta Lake	Kerala	3.73	<ul style="list-style-type: none"> It is the largest freshwater lake in Kerala, situated in Kollam district. River Kallada had a unique replenishing system through a bar of paddy field. The lake is now depleting due to destruction of replenishing mechanism.

Ramsar Sites in India

	Ramsar Site	State	Area (km ²)	Description
32	Sundarban Wetland	West Bengal	4230	<ul style="list-style-type: none">Sundarban Wetland is located within the largest mangrove forest in the world.It is the largest Ramsar Site in India.The Indian Sundarban, covering the south-westernmost part of the delta, constitutes over 60% of the country's total mangrove forest area and includes 90% of Indian mangrove species.
33	Surinsar-Mansar Lakes	Union Territory of J&K	3.5	<ul style="list-style-type: none">Freshwater composite lake in semi-arid Panjab Plains, adjoining the Jhelum Basin.
34	Tsomoriri (Tso Moriri)	Union Territory of Ladakh	120	<ul style="list-style-type: none">A freshwater to brackish lake lying at 4,595m above sea level.The site is said to represent the only breeding ground outside of China for one of the most endangered cranes, the Black-necked crane, and the only breeding ground for Bar-headed geese in India.The Great Tibetan Sheep or Argali and Tibetan Wild Ass are endemic to the region.With no outflow, evaporation in the arid steppe conditions causes varying levels of salinity.
35	Upper Ganga River (Brijghat to Narora Stretch)	Uttar Pradesh	265.9	<ul style="list-style-type: none">The river provides habitat for IUCN Red listed Ganges River Dolphin and Gharial Crocodile.
36	Vembanad-Kol Wetland	Kerala	1512.5	<ul style="list-style-type: none">Largest lake of Kerala, spanning across Alappuzha, Kottayam, and Ernakulam districts.It is the second largest Ramsar Site in India after Sundarbans.It is also the Longest lake of India.It is below sea level and is famous for exotic fish varieties and Paddy fields that are below sea level.
37	Wular Lake	Union Territory of J&K	189	<ul style="list-style-type: none">It is the largest freshwater lake in India.

WETLANDS IN BIHAR

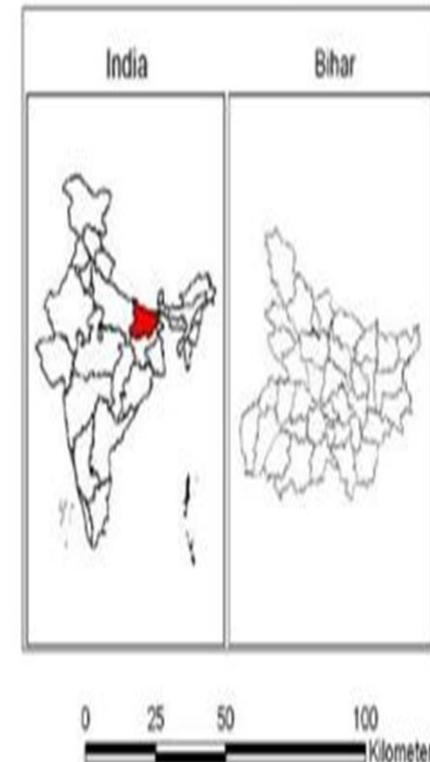


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

Legend

- Wetlands (<2.25 ha)
- Settlements
- Canal
- Railway
- Drainage (line)
- Roads
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



Data Source :

IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and

Institute of Environmental Studies and Wetland Management (IESWM), Kolkata

Sponsored By:

Ministry of Environment and Forests
Government of India



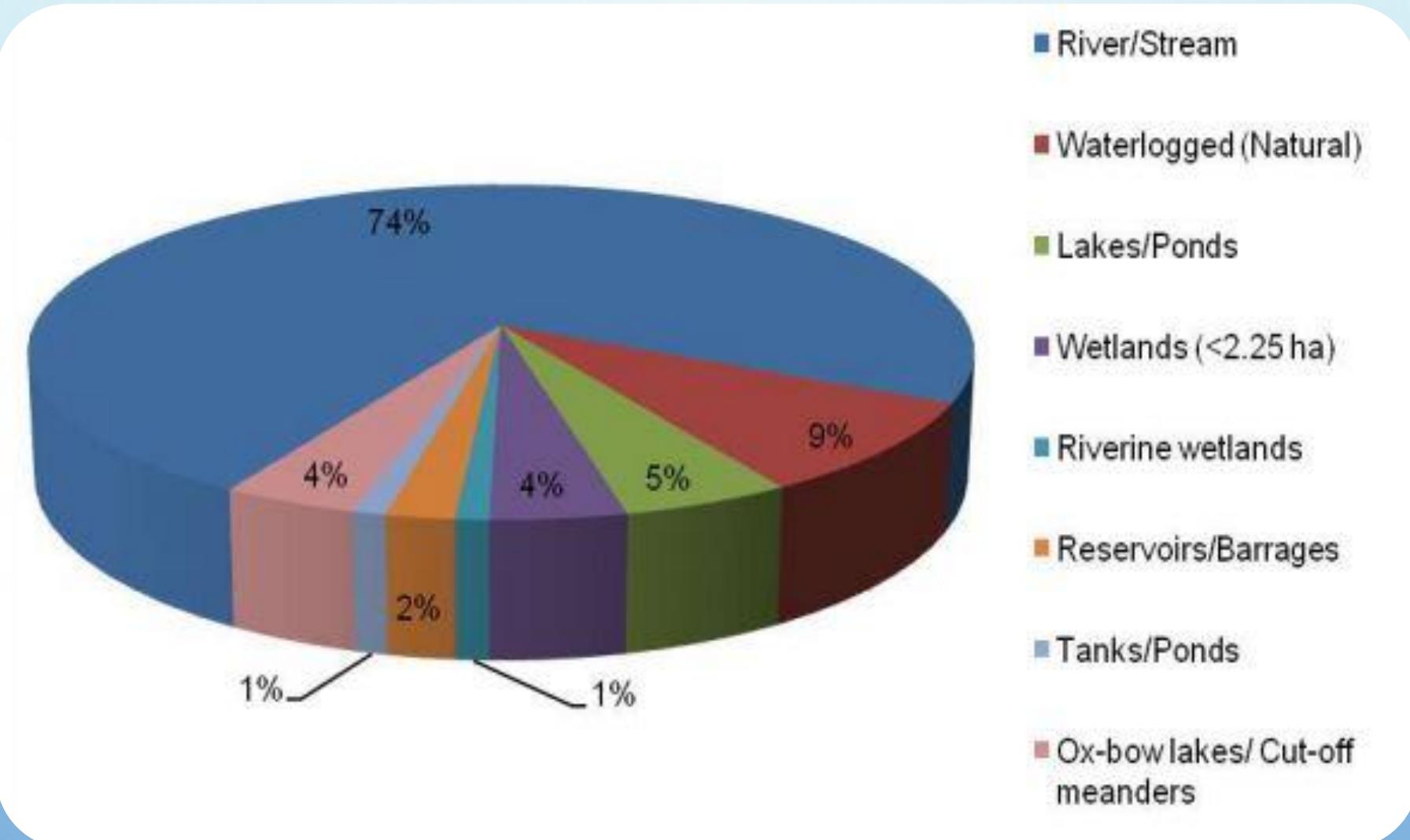
Sl. No.	Aquatic resources of Bihar	Area
1.	Rivers	3,200 km
2.	Chaura and Floodplain Wetlands	100,000 hectares
3.	Oxbow lakes or Mauns	9,000 hectares
4.	Reservoirs	7,200 hectares
5.	Ponds and Tanks	69,000 hectares

- ❖ Mauns or Ox-bow lakes, which are the cut-off portions of river meanders, form an important fishery resource in Bihar, with annual fish yield potentials ranging from 1,500 to 2,000 kg/ha. The current level of fish yields from Oxbow lakes are 160 kg/ha. (*Source *: Fisheries Development in Bihar: An Action Plan, ICAR, New delhi*)

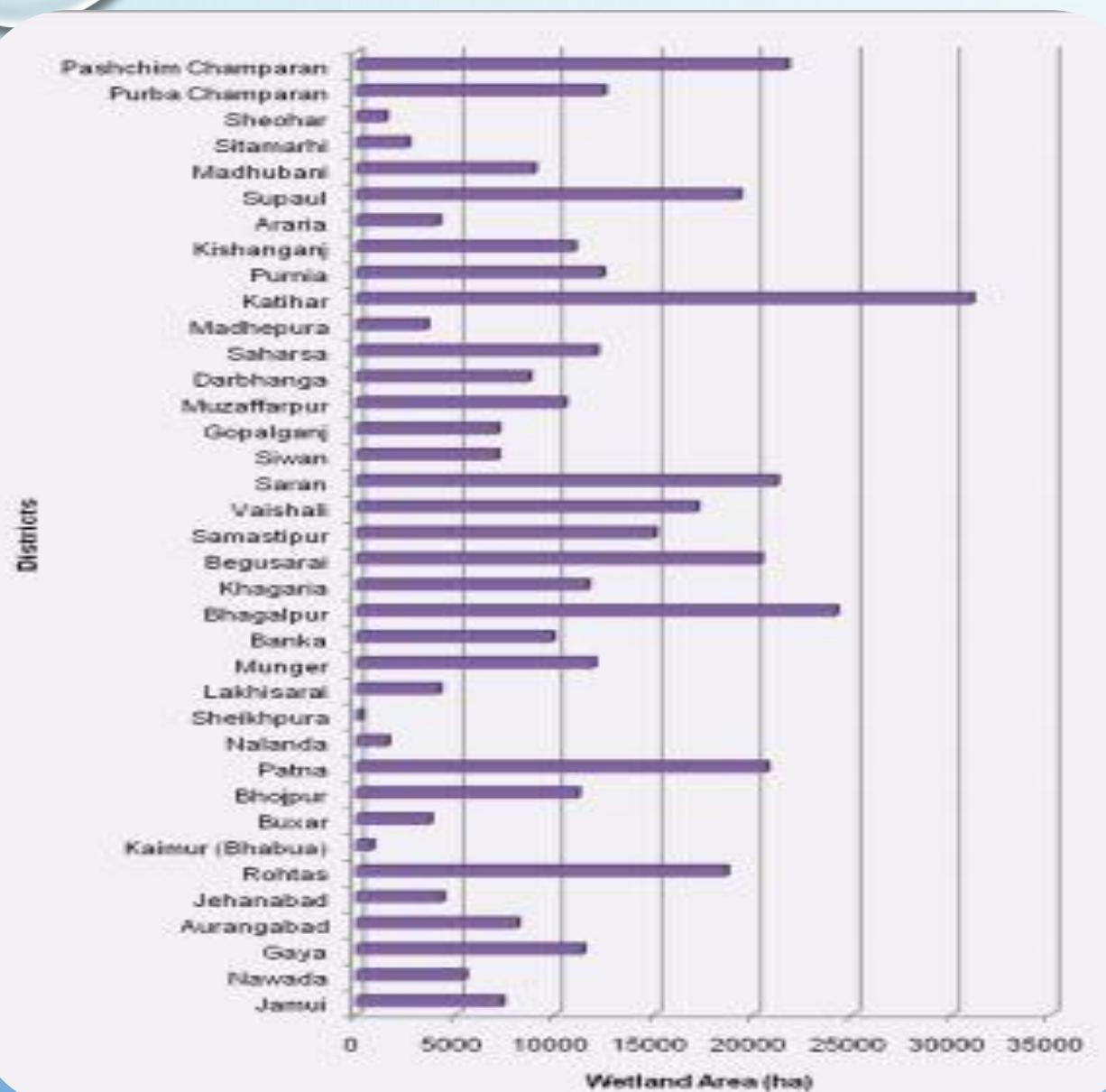


- ❖ Total 4416 wetlands have been mapped in the state with around 130 wetlands having an area of over 100 hectares.
- ❖ In addition, 17582 wetlands (smaller than 2.25 ha) have also been identified.
- ❖ Total wetland area estimated is 403209 ha that is around 4.4 per cent of the geographic area.
- ❖ The major wetland types are river/stream accounting for about 74 per cent of the wetlands (298408 ha), natural waterlogged (34878 ha), lake/pond (20281 ha), and ox-bow lake/ cut-off meander (16172 ha).
- ❖ The inland natural dominate the wetlands in Bihar which comprise about 92 per cent of the total wetland extent while the manmade accounts for about 3.5 per cent.
- ❖ The hydrology of wetlands are influenced by monsoon performance, extent of water spread and their turbidity (qualitative) in wet and dry season (post-monsoon and pre-monsoon period)

Type-wise wetland distribution in Bihar



District-wise area of wetlands in Bihar



District code	District	Geographic area *	Wetland area	% of total wetland area	% of district geographic area
		(sq. km)	(ha)		
1	Pashchim Champaran	4250	21897	5.38	5.11
2	Purba Champaran	4155	12477	3.09	3.00
3	Sheohar	443	1476	0.37	3.33
4	Sitamarhi	2628	2801	0.65	0.99
5	Madhubani	3478	8958	2.22	2.58
6	Supaul	2985	19285	4.78	6.46
7	Araria	2797	4157	1.03	1.49
8	Kishanganj	1939	10954	2.72	5.65
9	Purnia	3203	12401	3.08	3.87
10	Katihar	3010	31011	7.69	10.30
11	Madhepura	1797	3539	0.88	1.97
12	Saharsa	1196	12086	3.00	10.11
13	Darbhanga	2502	8709	2.16	3.48
14	Muzaffarpur	3123	10490	2.60	3.36
15	Gopalganj	2003	7122	1.77	3.56
16	Siwan	2213	7105	1.76	3.21
17	Saran	2624	21170	5.25	8.07
18	Vaishali	1995	17148	4.25	8.60
19	Samastipur	2579	15022	3.73	5.82
20	Begusarai	1889	20385	5.05	10.78
21	Khagaria	1486	11645	2.89	7.84
22	Bhagalpur	2502	24171	5.99	9.66
23	Banka	3020	9895	2.45	3.28
24	Munger	1419	11979	2.97	8.44
25	Lakhisarai	1229	4177	1.04	3.40
26	Sheikhpura	689	296	0.07	0.43
27	Nalanda	2362	1589	0.39	0.67
28	Patna	3130	20878	5.13	6.61
29	Bhojpur	2337	11154	2.77	4.77
30	Buxar	1634	3717	0.92	2.27
31	Kaimur (Bhabua)	1840	796	0.20	0.43
32	Rohtas	3838	18641	4.62	4.86
33	Jehanabad	1569	4345	1.08	2.77
34	Aurangabad	3389	8116	2.01	2.39
35	Gaya	4941	11422	2.83	2.31
36	Nawada	2498	5464	1.36	2.19
37	Jamui	2997	7351	1.82	2.45
Total		91689	403209	100.00	4.40

Data Source: <http://nic.in>

Wetlands and climate change

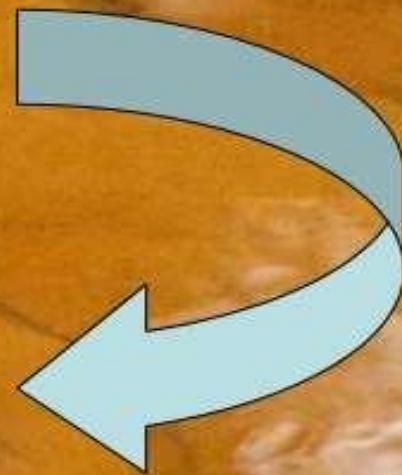
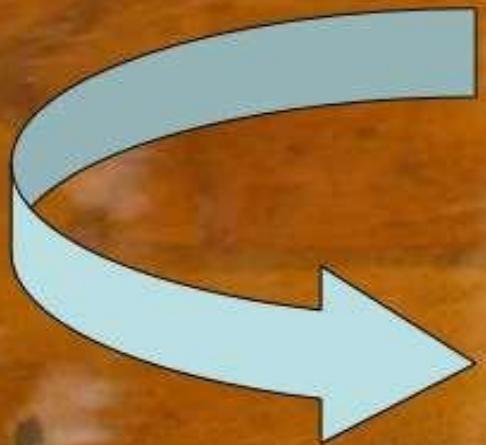
very productive
ecosystems

Accumulation of biomass
= carbon storage

Carbon release

CO_2
(carbon dioxide)

CH_4
(methane)



THREATS TO WETLANDS

- Anthropogenic pressures
- Rapidly expanding human evolution
- Development projects
- Improper use of watershed
- Converting floodplains to aquaculture
- Planting trees on bogs
- Draining marshes for agriculture
- Forestry and urban development
- Mining them for peat



A tropical beach scene featuring several palm trees with yellow flowers against a clear blue sky. The water is a bright turquoise color. In the center, the words "Thank You" are written in a large, elegant, cursive script.

Thank You