IMPACT OF FLOOD AND DELUGE ON HYDROBIOLOGY AND BIODIVERSITY ENDOWMENTS OF KUTTANAD WETLAND ECOSYSTEM, KERALA : A RAPID ASSESSMENT

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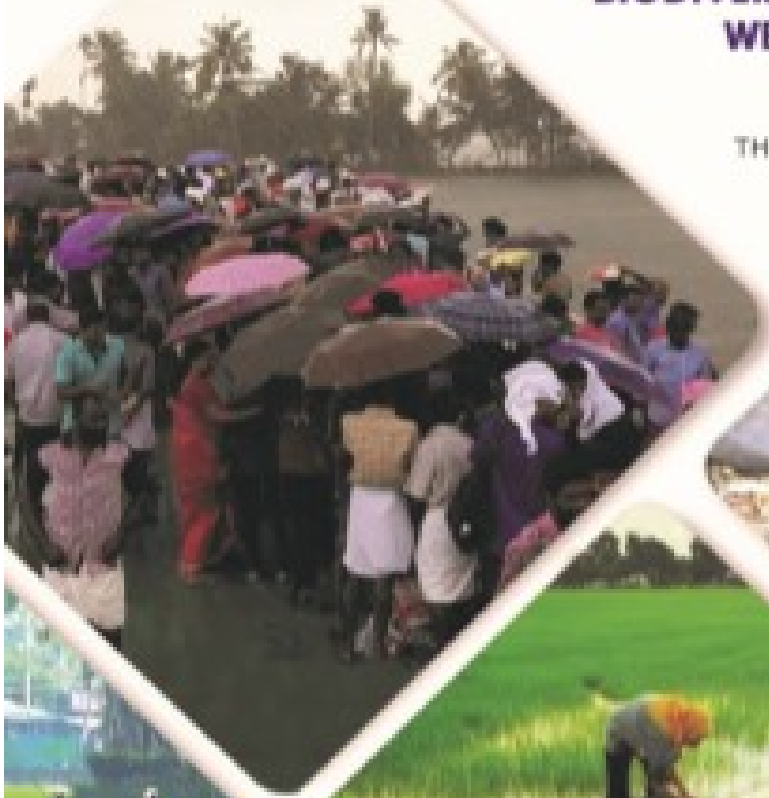

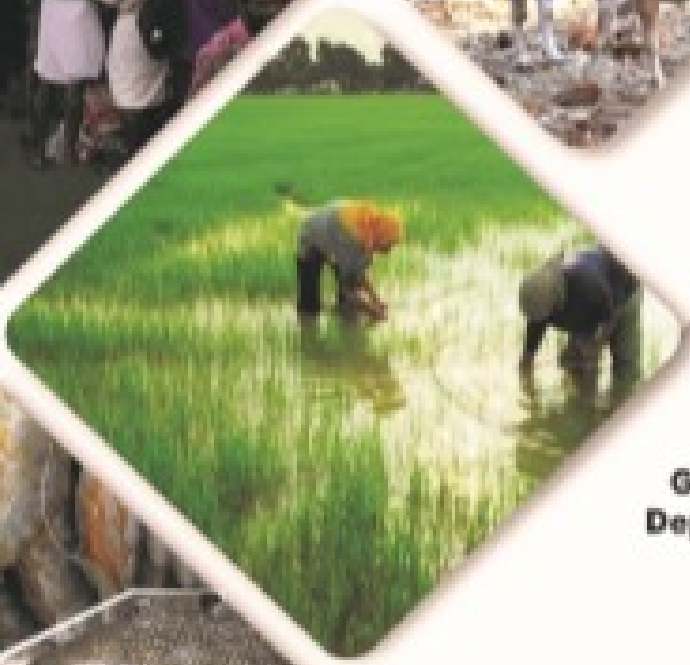

GOVERNMENT OF KERALA
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- In this study, we examined the after effects of the devastating flood event of 2018 in Kuttanad, by evaluating their effects on aquatic ecosystem and biodiversity endowments.
- Kuttanad suffered from 3 floods in succession since July 2018. Although the present study on t flood effects was started in November 2018, as we were engaged in an ongoing year-round surveillance program, as part of institutional project, year round data was available to decipher the effects of flood.
- Most studies on such disasters is based on fortuitous events and often lacks pre-disaster data. In contrast we utilized our current understanding based on long term monitoring data generated by our own team during the past few years..
- The important ecosystem parameters monitored in the study include, water and soil quality primary production, secondary aquatic production, rice productivity and effects on biodiversity including fish and fisheries
- Extremely distressing trend has been the observed on increasing trend in salinity, year after year in the Vembanad system and in the Kuttanad region after monsoon months every year. This can only be attributed to consistently declining inflow from river systems during post monsoon months and could be due to the environmental effects of the hydrological modifications made at Cochin sea mouth as part of the Vallarpadam Container Terminal Project (VCTP) for berthing large vessels. .
- Utilization of polders as water harvesting structures that enable seaward flow to hold up salinity ingression after monsoons is a valuable proposition
- During the deluge period, when flood waters entered Kuttanad, the vast padasekharams were already inundated due to the previous floods in July The deluge resulted in further re inundation over the ring dykes.
- Fishes in very large numbers were caught from numerous rivulets and inundated paddy fields. The consequences of the floods, negative and positive, varied greatly depending on the location. Regions exposed to human interventions were more vulnerable.
- Flood had both short term as well as long term impacts on biodiversity. The observations support the view that small foods lead to gains in aquatic ecosystem services, while effects of extreme episodes like the one we experienced in 2018, last longer lead to more economic losses.

- Extreme organic loading consequent to floods and prolonged water logging apparently led to anoxic conditions in water which has been critical to all life forms.
- Besides influx of large quantum of plant nutrients, N and P, the low DO due to influx of organic matter apparently favored mobilization of more P within the system by ' *internal eutrophication*' due to release of P from sediments. Long term inundation apparently favored release of P bound in sediments.
- Despite high nutrient influx, algal abundance was reduced and primary production suffered initially because waters were more turbid as light was a serious limiting factor, and flushing rates apparently exceeded algal growth rates.
- As transparency of water increased slowly, after a few months, algal growth was stimulated. This increases in primary production is attributed to increased availability of phosphorus (P) and high nitrogen N) loading, facilitated by the flood.
- We cannot consistently conclude that flooding increased or decreased primary production as productions of algal biomass are dependent also on other interacting variables as well, viz water clarity, flushing rates etc
- Pelagic fishes that lay their eggs in the inundated paddy fields in the cold floodwaters were benefitted. Evidently large schools of fishes were found abounding the polders during and after the flood. This highlights the role of flooded padasekharams as natural fish nurseries.
- The study further points to the dire need for utilizing the Kuttanad polders at least seasonally as flood water storage systems, and fish reproduction protection zones to sustain endemic fish biodiversity.
- During the flood, paddy fields were also teeming with exotic fishes, mostly escapee fishes from aquaculture farms, like *Oreochromis*, *Pangassius, Piaractus sp.* Etc. Spread of such exotics can be a serious threat to endemic ichthyofauna But huge quantiy of such estranged fishes were caught from the systems due to very active fishing during flood periods.
- The study highlights the dire need for effective measures for prevention of unlawful introductions of fishes.
- Some farms take up fish breeding in net enclosures in the flowing river itself with no checks. Breeding of such alien fish species in natural river systems with utter disregard to biosecurity shall be forbidden, invoking strict legal provisions against such offenders.

- Fish species that are dependent on bottom substratum for feeding and breeding behaved differently than seasonal breeders. The cleansing effects of the flood flows in post flood months provided them high transparency; this is evident from the catch up in yield of *Karimeen* in later months after the floods.
- Kuttanadan Konchu, *Macrobrachium rosebergii*, with poor swimming ability were encountered in large numbers in downstream regions, apparently washed down in the heavy currents, They reached the natural breeding ground, downstream early in their annual migratory route. Implications of their early arrival at the breeding grounds before salinity build up to desired level, in the heavy floods can affect their recruitment process. This need to be investigated.
- It is inferred that the extreme events that was destructive for humans was a blessing for natural populations. We may agree with the contention that flooding generally create a production boom for fish and shell fishes in oligotrophic waters and especially those that survive well in clean waters with low turbidity etc.
- The stable water quality conditions and the less turbid waters after initial pulse of flood favored the profuse growth of filamentous algae. This in effect benefitted the endemic algal browser *Etroplus suratensis*, and the known filter feeding pelecipod, *Villorita cyprinoides* both being important to the livelihoods of the ecosystem people in Vembanad.
- The study indicated that floods created a near homogenous water conditions but and highly heterogeneous habitat situations. As habitat situation changed, floral and faunal communities and biodiversity is bound to change. Changes in substratum characterizes were visible in our study.
- Annually, floods bring about silt deposition, estimated at around 1-25 tons per ha in Vembenad lakes and rivers of Kuttanad. Our study indicated that the silt deposition was as high as, 13 kg / sq m, ie., 130 tons per ha in some locations in the flood plains of Pampa river near Mannar region, Alappuzha. The situation calls for more detailed and long term investigations to capture changes in benthic biodiversity in the wetland system in days to come.
- Floods have increased the fish diversity partly due to more diverse habitats becoming available to fishes.

- Flooding improved agricultural soils by depositing sediments on floodplains, helped recharge farmland soils and significantly increased suitability of soils for farming. The increased productivity of rice is a testimony to this. This was facilitated in part by enhanced nutrient availability.
- Floods improved soil condition due to long inundation, helped washing of acidity and removal of residual salts like sodium from soils. These observation points to the benefit of inundation of lowland rice soils at least for a few months before every cropping season..
- Flooding improved soil formation by depositing sediment on flood plains and increased deposition of particulate organic carbon. This underlines the role of wetlands behaving as carbon sink, a very significant role of wetlands in the context of climate change.
- Unlike other places in Kerala, flood inundation lasted for a long period in Kuttanad. .This cannot be attributed to sea level remaining high, as the tidal heights on the dates of flooding remained low. If the flood happened 5 days prior to 16th August, coinciding with the highest high tides, and tidal floods, the disaster would have been more catastrophic.
- Long period of inundation in Kuttanad with flood water not receding fast can only be ascribed to physical hindrance to outflow and the failure due to very poor management of the Thottappally spillways system (TSW), constructed exclusively for flood control in Kuttanad..
- Evidently this indicates that structural engineering mechanisms such as spillways and ring bunds around polders or saline exclusion barrages constructed to master nature by altering hydrologic regimes cannot be solutions as such civil structures create hurdles to smooth natural flow.
- These observations indicate that river floods synchronized by tidal floods, in the context of climate variability, will lead to a seriously grave situation in Kuttanad if it merges with coastal seas, situations most disastrous and catastrophic to Kuttanad.
- The study highlights the need for nonstructural alternatives, for flood management by integration of the natural dynamics of flooding, restoration of wetland areas and reconnection of key floodplain areas etc.
- Apparently, more than anything, there is a dire need to rethink on the extent of area for rainy season rice cropping allowable in Kuttanad , as increase in area under rainy season cropping

like 45 % of the expanse as of now is a significant factor that contribute to and magnify flood damages, in Kuttanad.

- Flood cushioning role in Kuttanad paddy fields are different from paddy fields in valley bottom paddy lands in midlands of Kerala
- In valley bottom paddy lands, in midlands of Kerala, reduction in paddy field area increase flood hazards, where as in Kuttanad increase in area under rainy season rice farming enhance floods. Hence Increase in varshakrushi shall not be allowed to increase beyond 30 percent of the area. Kuttanad padasekharams to be viewed different from paddy fields in other areas, owing to its unique below sea level location and its natural role of flood water storage during rainy season.
- This also means that we cannot afford to drain away all the monsoon waters to the seas in order to avoid flooding. We have to store some of it for dry seasons, atleast for about six months. We have to satisfy the water demand.
- The present study underlines that seasonal inundation of Kuttanad padasekharams improve soil quality, in terms of algal and microbial biodiversity, and enhances rice yield, and endemic fish and other biodiversity.
- The study calls for an institutional system for continuous and systematic evaluation and corrections in land and water use in Kuttanad by giving more room for water.

  We should also explore the possibility of 'controlled flooding' as a tool to accommodate floods by applying an entirely different science and response strategy in Kuttanad.