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Flood Mitigation and River Pamba in Kerala– Insights and Measures with Special Reference to Thottappally

[1]L Mounika Assistant Professor lmounika8591@gmail.com
[2]KUMAR VEGYARAPU SHIVA Assistant Professor vschary.2020@gmail.com
Department of CIVIL
Pallavi Engineering College Hyderabad, Telangana 501505.

ABSTRACT:

Pathanamthitta and Alleppey districts in Kerala are enriched by the cultural and historical importance of the Pamba River. The rice bowl of Kerala, Kuttanad, relies on this river to meet the state's needs. The Pampa River caused devastation in and around Thottappally and the surrounding areas during the floods of 2018. The Thottappally spillway connects the Vembanad Lake to the Arabian Sea in a two-way exchange. The Kuttanad region and Thottappally have historically been on the receiving end of both seasonal and unseasonal rainfall. Despite this, though, Proper systems and methods must be in place in view of these considerations In addition, the ability to deal with an increase in inflows is critical. Flooding at Thottappally has caused a number of problems, and this article examines those difficulties and provides recommendations for preventing further losses.

Monsoon, Kuttanad, Vembanad Lake, and paddy agriculture are among of the topics covered in this article.

INTRODUCTION

Flooding is common in Kuttanad and the surrounding regions. The phrase waterlogging is more accurate here than floods. Kuttanad is prone to flooding because of its low height. A spillway was built in the Kuttanad area of Kerala in 1955 in order to divert surplus water from the region towards the Arabian Sea. This is a far cry from its anticipated 19,500 cubic metres per second discharge capacity, which was discovered to be barely 600 cubic metres per second after commissioning. Thanneermukkom bund was also built as a seawater barrier to keep saltwater out of Kuttanad during the rice harvest season. One of the few places on Earth where paddy is grown below sea level is Kuttanad.

Every time the monsoons unleash their wrath on Kerala, the rice bowl of Kuttanad finds itself in the spotlight. These waterways are both a blessing and a curse for Kuttanad. Local farmers and fisherman must maintain a fine balance between drowning beneath the floodwaters and keeping dry if they want their livelihoods to survive. Pampa, Manimala, Achankovil, and Meenachil are the four rivers that flow into the Arabian Sea at Thottappally and Thanneermukkom, respectively. Additionally, the Muvattupuzha River connects with Vaikkom Lake at Thottappally spillway. The Vembanad Lake, which covers the area between Thottappally and Thanneemukkom, receives more rain than it can hold during the monsoons, as recently shown. Considering the recent floods in Kerala, this research explores the many aspects of flooding in Kuttanad, with a particular emphasis on Thottappally. Taking a long-term perspective, it is advised to implement flood prevention measures.

Kuttanad

Kumarakom, located in the districts of Alappuzha, Kozhikode and Pathanamthitta, is Kerala's most important rice-growing area. People live and produce paddy at Kuttanad, one of the few sites below sea level in the globe where considerable numbers of people reside and farm rice. Altitudes in this area fall between 12 and 3 feet below sea level. The Vembanad Lake's paddy fields and the culture that developed around them are world-renowned. There are three distinct regions of Kuttanad: (a) Lower, (b) Upper and (c) North Kuttanad.

South India's polder-farming system, which is situated near the Vembanad Ramsar region, has been recognised as an FAO-designated "Globally Important Agricultural Heritage System" (GIAHS). As a result of the heavy use of diesel and engine oil by tourist diesel-boats, toxic residues have built up in Kuttanad's waterways and paddy fields. Despite the destruction of Kuttanad's fish and other aquatic biodiversity-richness, farming remains exceedingly uneconomical. Kuttanad's designation as a GIAHS (Globally Important Agricultural Heritage System) gives it a chance to reestablish its natural equilibrium (Jacob et al., 2018).

Paddy is grown in two kinds of polders in this wetland, Padashekaram and Kayal Nilams, both of which were recovered from the Vembanad backwaters. The recent floods in Kuttanad have kept the area in the news, mainly because they disrupted the everyday lives of the locals. Construction of the Thottappally spillway and the Thannermukkom bund, among other things, was undertaken to make farming

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possible more than once a year (Chandran and Purkayastha, 2018).

The Pampa River in Kuttanad

Pampa River: In Kerala's history and culture, the 176-mile-long River Pampa is inseparable. Kerala's third longest river, the Pampa, flows through Pathanamthitta and Cochin, as well as Kuttanad, the state's rice bowl. It is surrounded by the Western Ghats to the east, and by the Vembanad Lake and the Arabian Sea to the west, in the Pampa basin. Pampa basin, which includes the Manimala River to the north and the Achankovil River to the south, has an area of 2235 square kilometres and provides most of Kerala's water and electrical needs. Thottappally spillway and Vemband Lake in Mullappally, Alleppey district, drain into the Arabian Sea. Kuttanad's Pampa River is also linked to a number of other streams. Pampa, which has its source in Peerumedu's Pulachimalai hills, is harnessed by the Sabarigiri hydropower project's Pampa, Kakki, and Moozhiyar dams and other minor ones.

Manimala River: In the Western Ghats, the Muthuvara hills provide the water source for the Manimala River, which runs for 92 kilometres. As a tributary of the Pamba River, the Manimala River was traditionally regarded as an independent entity. Now, thanks to Google Maps and location-based mapping capabilities, this idea has been disproved. On the other hand, the Pampa River really breaks off from the Manimala River in Kuthiathode and joins it at Kallunkal. Nedumpuram is the place where Pampa River splits off from the Manimala River, bringing fresh water to numerous districts in the state of Kerala. It then merges with the Vembanad Lake in the Kuttanad region.

Meenachil River: There are various streams that flow into the Meenachil River from the Western Ghats. Kottayam district is home to the 78-mile Meenachil River, which slithers past Poonjar, Teekoy, Erattupetta and Pala. The Meenachil River, which empties into the Vembanad Lake at Kumarakom, a popular tourist attraction near Thaneermukkom bund, contributes to the region's water supply.

Achankovil River: Its source is the Rishimala, Pasukidamettu, and Ramakaltheri Rivers, and it winds its way 128 kilometres until meeting the Pampa River at its confluence. Achankovil River is a tributary of the famous Pampa, which merges with it at Veeyapuram near Thottappally in Pathanamthitta district. Achankovil Forest in the Kollam district is where the river starts.

Muvattupuzha River: Located in Ernakulam district in Kerala, the Muvattupuzha River is one of the most important rivers in the area. With the melding together of three rivers, this river is known as the Thodupuzha River. The Moovattupuzha Bridge, which connects the two rivers, is located close upstream from where they meet. From the confluence of these two rivers, the term Muvattupuzha was coined. The Muvattupuzha River is the name given to the river after the confluence. After then, it heads to the south-west before merging with the Vaikkom Lake.

Vembanad Lake receives water from four rivers: Pampa, Manimala, Meenachil, and Achankovil, which all flow into the lake. Additional water intake is provided by the Muvattupuzha River, which flows into the Vaikkom Lake. There are only two ways to access the Arabian Sea from Vembanad Lake. Thannermukkom Bund and Thottappally Spillway are two examples. In order to keep Kuttand dry during high tides, these buildings were created. They were able to use this mineral-rich river basin for paddy agriculture as a result of this.

Spillway at Thottappally

The Thottappally Spillway, built in 1955, plays a crucial role in facilitating the passage of surplus water from the Pampa river basin into this area. Kuttanad is often inundated by rising sea levels during the monsoon, which blocks the Arabian Sea's waterways. In order for water to flow smoothly, the shutters of the spillway must open and close dependent on water levels. Saline water may also leak in, therefore care must be made to keep it at bay. High tide would allow saltwater to reach Kuttanad unimpeded before the completion of the Thottappally dam.

Due of this, only one crop could be grown at a time in the past. This could only be done when the tide was low. Many times during the monsoons and when sea levels rose, the Kuttanad farmers' livelihoods were ruined by the forces of nature. Thottappally

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Spillway was built as a result of this. An official Souvenir was given out during the inauguration of all three structures. It takes a very long time, according to this record, for the monsoon floods to recede in Kuttanad. Saline water hits the Kuttanad area in December, rendering it unsuitable for farming. While working on the land, it was discovered that it had previously been occupied by trees. Additional evidence that this location was formerly at sea was discovered during the process of piling. To put it another way: The spillway was built with 40 four-tonne shutters.

After the advent of the southwest monsoon, water levels in Kuttanad used to surge beyond acceptable limits due to the buildup of floods from the river systems. Until the conclusion of the north east monsoon, the region's low-lying parts were inundated, making it difficult to grow a second crop in the fall. Floodwaters might be diverted to the Arabian Sea at the extreme southern end of the flood limit, according to detailed hydraulic investigations that were carried out in the early 1930s. A spillway was built in 1951 in Thottappally, a town of Alappuzha, Kerala, which is about 20 kilometres south of Alappuzha.

More than 90 percent of the floodwaters that reach the Kuttanad area each month during the monsoon season are pumped straight into the sea through the spillway. However, throughout the design of the spillway, the issue of water building up due to increasing sea levels had to be considered.

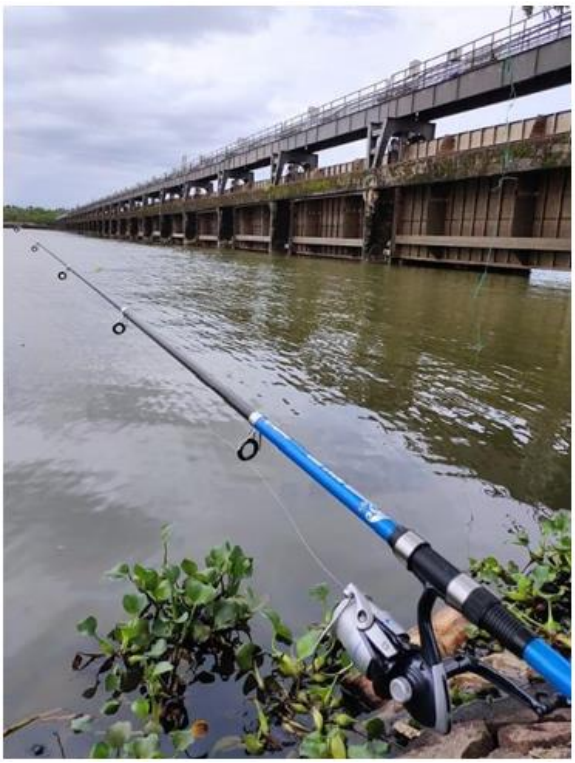

Fig. 1. Thottappally Spillway, Kerala

The sand bar on the seaward side of the spillway was not taken into consideration during the monsoon months. Hence, when the spillway was built in 1955, the actual capacity of it was less than one-third of the predicted capacity, and thus it was unable to fulfil its intended function (Thomas, 2002).

To alleviate flood conditions in the Kuttanad region, the Thottappally spillway was built in 1955 as part of Kuttanad's development plan to redirect the flood waters of Pamba, Manimala, Achenkovil and Meenachil straight to the sea. According to reports, the spillway's design capacity was 1812 cumec, but the current average maximum flow is only 630 cumec, which is less than a third of the spillway's design capacity (SRF Report, 2007).

In the Interest of Full Disclosure,

Paddy farming in Kuttanad has been marked by the erection of permanent outer bunds surrounding the R Block kayal lands in 1961 under the R Block-Holland Project. There was no way the mud embankments erected as part of the reclamation project could

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survive the constant wave action. During the monsoon season, several of them were submerged in floods. As part of Holland's R Block-Holland Scheme, bunds that stood six feet above the MSL with 10 feet of top width and a total length of 10.4 kilometres were built around R Block Kayal Lands in the R Block area of Holland (Thomas, 2002).

The Bund of Thannermukkom

A bund was planned for Thanneermukkom in Alappuzha district in order to augment the Thottappally spillway. A salt water barrier was created for this project.

Thanneermukkom on the west and Vechur on the east lie across Vembanad Lake, and they are both part of the Kuttanad Development Scheme intended to keep saline water out of the area. Despite the fact that Thanneermukkom Bund was built in 1974, it was not put into use until 1976. Fishermen in the area have highlighted a number of environmental concerns about this development. Ecological imbalance in this area, which affects fish spawning, and the unregulated spread of water hyacinth, an invasive water plant, are the key concerns. There are 62 shutters on the Thaneermukkom bund. In the kayal fields of Kuttanad, Puncha crop destruction has been a recurrent phenomena from the early days of reclamation. An attempt was made to alleviate salty water intrusion into the Kayal plains situated south of Thanneermukkom during the summer months, when freshwater intake from feeder river systems is at its lowest.

Additionally, the project's goal was to allow for a second harvest after the Puncha season, which would shield the summer crop from water salinity. Between Vechoor and Thanneermukkom, the Barrier is created over the Vembanad kayal. Regulations at the Bund are reduced in December each year and stay in place until May, when the pre-monsoon rains enhance flows from feeder rivers. This is done to keep salty water out of the lake. Most of the Puncha fields can now support a second crop thanks to the installation of this barrier (Thomas, 2002).

Reasons for Flooding in Kuttanad, India

As a consequence of heavy rainfall that fell over a long period of time, Vembanad Lake was inundated to capacity, resulting in devastating floods in 2018. It recurred in 2019 on a lower scale. There's little question Kuttanad would stay waterlogged because of its low height. However, immediate action is needed at the two Vembanad Lake outflows to the Arabian Sea. In spite of all of the Government's efforts, there is no permanent solution in the event of severe rains, thus the issue must be dealt with over time. Sea levels are increasing as a consequence of climatic shifts across the world, particularly as a result of global warming. Floods are becoming more common in Kuttanad as a result of the above-mentioned circumstances. Considering all of this, it's safe to say that the future of Kuttanad is everything but bright.

It is stated towards the conclusion of the article that certain efforts may be taken to reduce the impact of future natural disasters. Disasters such as hurricanes, earthquakes, and tsunamis have shown that man is powerless when nature unleashes its wrath. Floods may wipe out a whole civilization because of their unpredictability and the fact that they happen so often. As a result, planning and implementation of effective management strategies must begin far before a disaster occurs. In part because of the Lake's shrinking floodplain, there will be more floods and more damage. TSW and leading channel were designed to lessen flood severity in several parts of Lower Kuttanad and Lake Kuttanad, Kerala.

Poor maintenance and lack of coordination have contributed to a decline in the area's flood-control capabilities during the last several decades There are 3,500 hectares of rice fields in Purakkad Kari in Kuttanad that are affected by a decline in flood flow capacity and an ineffective management of the spillway. TSW modernisation, channel deepening and bund protection, and better spillway operation management are among the proposed measures (SRF report, 2007).

A southern branch of Periyar (north of Muvattupuzha) flows into the Cochin Kayal and subsequently into the Arabian Sea via the Kochi exit of Vembanad Lake, which has four main west-flowing rivers. Kerala's Alappuzha (Alleppey), Kottayam, and Ernakulam districts border the Vembanad Lake, which extends 80 kilometres in a northwest-southeast direction from Munambam in the north to Alleppey in the south. The lake's surface size is 200 square kilometres. Between 500 and 4 kilometres in width, the lake's depth ranges from 1 to

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12 metres (CWC Report, 2018). There was a significant amount of rainfall and runoff in these four rivers between August 15 and August 17 of this year, when the 2018 floods occurred. A number of rivers drain into the lake south of Thanneermukkom barrage, including Manimala, Meenachil, Pamba and Achenkovil, while the Muvattupuzha River empties into the Cochin backwaters north of the barrier. Located in the southern section of the Vembanad Lake, Kuttanadu is a swampy delta created by four river networks: Pamba, Manimala, Achankovil, and Meenachil. Estuaries are sometimes submerged up to 2.5 metres below sea level, and they are prone to flooding during the monsoon season as well as saltwater intrusion during the summer months. In November 2002, the Vembanad Lake was designated as a Ramsar Site. The 2018 CWC Report is available here. In the wake of the development of new land, the system's capacity has been lowered from 2.4 BCM to an incomprehensible 0.6 BCM (Planning Commission Report, 2008). There was a significant surge in water levels in low-lying portions of Kuttanad and the Kole lands of Thrissur during the 2018 floods based on satellite images and DEM, which is pretty high by any standards (Vishnu et al., 2018).

Lessons to be learnt from Holland's defences against North Sea

The Netherlands, one of the world's most prosperous countries, rose to prominence by waging a protracted war against the North Sea. Engineering wonders are the North Marine sea barriers built by this nation. The North Sea has been wreaking havoc on the Dutch shores for as long as anybody can remember, taking the lives of people and property in equal measure. Flood management has been a primary priority for the government in this country since the floods of 1953, which claimed the lives of tens of thousands of people.

The low-lying area was protected from the sea by dykes and other man-made obstacles. Holland's low altitude was the primary issue it had to deal with. Its land mass is submerged to a depth of more than three-quarters. The whole design was built on a cutting-edge dam with detachable, hollow, and floatable gates. Additionally, they might be taken out if necessary. The ability of fish to freely move between these gates contributed to the preservation of a relatively constant habitat. Flooding from a storm surge will swiftly submerge the gates so that they can't be used by the sea. It has been a lifesaver for millions of people thanks to this man-made barrier. The building is held in place by massive pillars each 30 to 40 metres tall and weighs roughly 18,000 tonnes. This incredible construction spans a distance of nearly 3 kilometres.

Windmills pumped water for 40 years while dykes kept off the North Sea. The procedure is still going on, with the main change being that instead of dykes, computer-controlled barriers and cutting-edge pumps are now being employed. To make this happen, they've sunk tens of millions of dollars. To deal with the North Sea's ever-increasing fury, a complex scheme known as Deltaplan or Deltaworks was envisioned. Holland has dykes and dams spanning more than 3700 kilometres.

It is impossible for floodwaters to reach Rotterdam's port, one of the world's busiest seaports, because to massive man-made moveable arms. This robot is regarded to be the largest ever built. The Maeslant storm surge barrier is the world's largest moveable barrier and was created to save Rotterdam, the Dutch metropolis, from a storm that occurs only once every 10,000 years. It is part of the Dutch government's significant investment in sea-level protection in the face of increasing sea levels.

Table 1. Rainfall and runoff in Pamba, Manimala, Achankovil and Manimala river systems up to Vembanad Lake

River	Catchment Area (in Sq.km)	Rainfall depth 15 Aug 2018 (1 day)	Rainfall depth 15 - 16 Aug 2018 (2 days)	Rainfall depth 15 - 17 Aug 2018 (3 days)	Runoff depth 15 Aug 2018 (1 day)	Runoff depth 15 - 16 Aug 2018 (2 days)	Runoff depth 15 –17 Aug 2018 (3 days)
Achankovil	1359	122	231	329	124	235	336
Pamba & Manimala	2656	173	382	517	346	762	1030
Meenachil	820	146	327	437	90	201	268
Total	**4835**	**441**	**940**	**1283**	**560**	**1198**	**1634**

It is possible that Kerala and Kuttanad, with an emphasis on Thottappally, may learn a lot from Holland's incredible engineering achievements. Fortunately, Kerala's inland waters are protected from the sea by a sand bar. There are just a few seawater-only entrances, such the Thottappally. The key to managing flood waters in Kuttanad is cutting-edge engineering technology. Constant monitoring and the resolve to persevere will certainly provide a

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comprehensive solution to the floodwater challenges faced by Thottappally.

FINDINGS

Locals in Kuttanad are no strangers to waterlogging. In spite of this, the number of floods is rising rapidly. As a result of their location and elevation, Alleppey's low-lying Kuttanad and surrounding districts are inherently at risk of flooding. In light of recent monsoons and their aftermath, prompt and frequent mitigation measures must be done to avoid a repeat. Pampa, Achenkoil, Manimala, and Meenachal are four main rivers that flow into the Arabian Sea in and near Thottappally, Kerala, during the monsoon season. Although the local population has raised environmental concerns, the Thottapally spillway and Thaneermukkom bund are crucial in decreasing floods in Kuttanad and the surrounding regions.

RECOMMENDATIONS

Using cutting-edge technology, it is necessary to continuously monitor the sea level in relation to river intake throughout the year. At regular intervals, the sand and silt from the channel going to the sea must be cleared. Due to the fast rate of sand collection, it is necessary to monitor the channel's depth on a frequent basis using trustworthy techniques. Regular visits by a team of professionals and local residents should be made to guarantee that all flood mitigation measures are properly and consistently carried out throughout the whole year. Experts in marine geology, sea and ports, and oceanography should be constantly in communication with Thottappally's trained employees in order to design appropriate mitigation techniques. This region's dams must be cleaned out on a regular basis to keep them free of silt and sand. Thus, the dams' storage capacity will rise. If it is practicable, Holland's technique may be used to pump water out of low-lying places as the influx rises. According to current conditions, the elimination of sandbars at Thottappally based on a scientific analysis is the best way to prevent flooding. Engineers from Holland who have built the world's largest sea walls are available for consultation. The Western Ghats to Thottappally outflows should be monitored by computer-controlled flood protection systems.

CONCLUSION

Low-lying places throughout the globe will be devastated by increasing sea levels caused by climate change. Thottappally and the surrounding Kuttanad regions will continue to be flooded in the future. Based on the study's findings and recommendations, mitigating methods may be implemented in the Pampa basin as soon as possible. Automated remote control and remote control technology will have to be deployed. This Ramsar site will be better protected if it is constantly monitored utilising all of the available knowledge. If saltwater intrusion is maintained at an appropriate level, ecological imbalances may be remedied. During heavy rains, flood prevention measures must be exact. A more secure and environmentally sound future for this area may be achieved by putting in place well-trained individuals and using the appropriate technologies.

REFERENCES

1. Chandran, S.and Purkayastha, S. 2018.History of Reclaimed Kayals in Kuttanad Wetland and Associated Social Divide In Alappuzha District, Kerala.Trans. Inst. Indian Geographers., 41(1): 69-80Researchgate Give title of journal and details of pages!
2. Jacob, M., Mathew, M M., Ray. and J G., 2018.Critical Analysis of the ‘Globally Important Agricultural Heritage System (GIAHS)’ of the FAO: A Case Study of Kuttanad, South India., Modern concepts and Developments in agronomy., 3(3): 1-9
3. Government of India Central Water Commission Hydrological Studies Organization Hydrology (S) Directorate. 2018 – Study Report – Kerala Floods of Augist 2018: 1-46
4. Varma, D., Anil Kumar N., Bala Ravi, S. and Nair, S. 2007. Measures to Mitigate Agrarian Distress in Alappuzha and Kuttanad Wetland Ecosystem. A Study Report by M. S. Swaminathan Research Foundation ., 1-227
5. Thomas, P M. 2002. Problems and Prospects of Paddy Cultivation in Kuttanad Region A Case Study Of Ramankari Village In Kuttanad Taluk, A Project of Kerala Research Programme on Local Level Development (KRPLLD), Thiruvananthapuram: 1-92

P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2020.26.03.008

6. Vishnu, C L., Sajinkumar, K S., Oommen,T., Coffman R A., Thrivikramji, K P. and Rani, V R, 2019. Satellite-based assessment of the August 2018 flood in parts of Kerala, India, Geomatics, Natural hazards and risk, 10(1): 758-767Vol 10 issue 1
7. https://www.thehindu.com/news/national/kerala/dutch-know-how-for-flood-mitigation/article28751260.ece accessed on 1/1/2020 https://www.researchgate.net/publication/326682004_HISTORY_OF_RECLAIMED_KAYALS_IN_KUTTANAD_
8. WETLAND_AND_ ASSOCIATED_SOCIAL_DIVIDE_IN_ALAPPUZHA_DISTRICT_KERALA accessed on 3/1/2020
9. https://www.earthmagazine.org/article/dutch-masters-netherlands-exports-flood-control-expertise accessed on 4/1/2020