December 20, 2019
Cheruthoni riverbed,
Idukki District

CHAPTER IV
IMPACT OF CHANGE IN LAND USE AND LAND COVER

4 IMPACT OF CHANGE IN LAND USE AND LAND COVER

'Land Cover' refers to the Earth's surface cover such as forest land, wasteland, grassland, barren soil, river/ water bodies and built-up area etc. whereas the utilisation/ modification of the land for various socio-economic purposes such as urbanisation, afforestation and cultivation is classified as Land Use. Change in the Land Use and Land Cover (LULC) alters the natural hydrological processes of a region. Increased urbanisation results in the loss of existing natural drainage capacity of that area and prevents rainwater infiltration into the soil. This results in a rapid increase in the surface runoff generated which leads to surface flooding which can only be mitigated with proper drainage infrastructure.

Towards assessing the impact of changes in land use pattern on the floods of 2018, Audit availed the services of IISc to conduct an LULC analysis of the Periyar basin with specific reference to the two selected districts of Idukki and Ernakulam. To make the assessment, LULC data and maps of 100 m resolution of Idukki and Ernakulam districts for the years 1985, 1995 and 2005 were sourced from National Aeronautics and Space Agency (NASA). For the years 2005 and 2015, the LULC data and maps[86] were obtained from Kerala State Remote Sensing and Environment Centre (KSREC). The common year 2005 for which data was available from both the sources was used to validate the two datasets against each other to enable a continuous LULC change analysis over the three decades from 1985-2015. The results of the analysis of LULC in the Periyar basin and in the test-checked districts of Idukki and Ernakulam are given below. Further, this chapter includes findings on illegal constructions on Cheruthoni riverbed, diversion canal for Chengalthodu inadequate to prevent inundation and obstruction to flood discharge through Thottappally spillway.

4.1. Result of LULC study in the Periyar basin

The Periyar basin has an area of 5,159.71 sq. km, out of which about 97 *per cent* is in Kerala and about three *per cent* is in Tamil Nadu. Within Kerala, the basin has 3,011.65 sq. km in Idukki district (~58 *per cent*), 1,724.34 sq.km in Ernakulam district (~33 *per cent*) and 282.34 sq. km in Thrissur district (~six *per cent*). The LULC analysis for the entire Periyar basin including the test-checked Idukki and Ernakulam districts revealed that the built-up area increased by nearly 450 *per cent* during 1985-2015 (from 60 sq. km in 1985 to 330 sq. km in 2015). During the same period, the water bodies decreased by nearly 17 *per cent* (from 267 sq. km in 1985 to 221.44 sq. km in 2015). During the last decade 2005 to 2015 alone, the built-up area increased by nearly 139 *per cent* (from 138 sq. km in 2005 to 330 sq. km in 2015) and the water bodies

[86] The LULC maps on a scale of 1:50,000 were procured from KSREC (converted to raster of 30 m resolution)

decreased by 1.26 *per cent* (from 224.26 sq. km in 2005 to 221.44 sq. km in 2015) in the Periyar basin.

During the course of the audit, instances of encroachment of water bodies, river banks were noticed in the test-checked districts. Encroachment of water bodies accentuates risk and exacerbates the State's vulnerability to natural disasters[87]. The Kerala Land Conservancy Act 1957, contained provisions for removal of any encroachment or obstruction in river bank or *kadavu* and it was the responsibility of the Village Officer to report to the District Collector promptly all cases of encroachments on lands which are the property of Government. However, Audit observed 913 encroachments on four rivers/ water bodies in the districts of Thrissur, Idukki and Alappuzha which obstructed the free flow of the river and consequent inundation of adjacent areas during the 2018 flood. Issues such as lack of timely action in preventing encroachments, failure of revenue authorities to remove encroachment, non-conducting of survey to determine the boundaries of a river etc. contributed to shrinkage in areas covered by water bodies as indicated in **Appendix 2.1**.

4.1.1. Land Use and Land Cover in Idukki district

As stated above, 3,011.65 sq.km of land in Idukki district is situated in the Periyar Basin. The LULC analysis revealed that in Idukki district, a very significant increase of around 658 *per cent* (**Appendix 4.1**) in built-up area has occurred during the decade of 2005-2015. Such an increase in the built-up area adversely affects the flood runoff, exacerbating the inundation during heavy rain events. A study of the transition of land use[88] (in percentage) from one type to another in Idukki district from 2005 to 2015 revealed that 7.30 *per cent*[89] of agricultural land, 1.04 *per cent*[90] of forest land and 1.34 *per cent*[91] of water bodies in 2005, were converted to built-up land by 2015. Thus, in Idukki, the increase in built-up land from 2005 to 2015 was mainly the result of conversion of agricultural land, forest land and water bodies etc.

4.1.2. Land Use and Land Cover in Ernakulam district

Periyar Basin also comprises of 1,724.34 sq.km in Ernakulam district. Analysis of data for Ernakulam district revealed (**Appendix 4.2**) a very significant increase in built-up area of around 212 *per cent* during the three decades 1985-2015 and an increase of around 73 *per cent* in built-up area in the decade of 2005-2015. Also, the extent of water bodies in the district decreased by nearly 14 *per cent* during 1985-2015. Such an increase in the built-up area, accompanied by a decrease in water bodies adversely affects the flood runoff, intensifying the inundation during heavy rain. As in the case of

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87 Rebuild Kerala Development Programme, Chapter 1, Encroachment of water bodies as an example of poor maintenance of existing assets

88 Transition of land use is change from one type of land use to another, which may be human induced or naturally occurring, over the years. *(Source: IISc Bangalore's Report on Kerala Floods 2018)*

89 103.40 sq. km out of total agricultural land of 1,416.15 sq. km in 2005

90 22.84 sq. km out of total forest land of 2,196.35 sq. km in 2005

91 1.46 sq. km out of total water bodies of 109.02 sq. km in 2005

Idukki district, a study of the transition of land use in Ernakulam district revealed that 12 *per cent*[92] of agricultural land in 2005 was converted to built-up area during the period 2005-2015. Audit also observed that 1.10 *per cent*[93] of water bodies were converted to built-up area during 2005-2015.

4.1.3. Land Use and Land Cover in flood prone region of Ernakulam district

The floods of 2018 severely impacted areas downstream of the Neeleswaram gauge station till the Arabian Sea covering the towns of Kalady, Perumbavoor, Aluva, North Paravur and parts of Ernakulam city and Cochin International Airport (flood affected region) with a total area of about 791 sq. km (about 46 *per cent* of Ernakulam district). Audit examined the LULC over the last three decades of the flood affected region to assess the impact of floods because of change in LULC. This is necessary to understand whether the increase in built-up area in the Ernakulam district and the reduction in extent of water bodies resulted in the enormous damage to the region during 2018 floods.

In the flood-affected region, 86.76 sq. km of agricultural land (of total agricultural land of 566.34 sq. km in 2005) and 1.09 sq. km of water bodies (of total area of water bodies 69.62 sq. km in 2005) was converted to built-up area between 2005 and 2015 (**Appendix 4.3**).

The change in land use during the past three decades (1985-2015) resulted in a notable impact on the floods of 2018. Significant increase in built-up area and notable decrease in water bodies in recent years have rendered the Periyar basin vulnerable to floods. The results of Hydrologic modelling[94] also revealed that had the same rainfall and spills of 2018 occurred with 1985 land use conditions, the flood depth at Neeleswaram gauge station would have reduced from 12.32 m to 10.03 m and the flood inundated area would have reduced from 520.04 sq. km to 414.76 sq. km.

In response to the audit observations on LULC, the Revenue and Disaster Management Department stated (November 2020) that Kerala has witnessed rapid urbanisation in the last two decades with 47.10 *per cent* of the population living in urban areas and the rise in number of urban settlements expected to continue. The State Disaster Management Authority, on identifying land use as a major determinant factor of vulnerability in the State, had identified and succeeded in ensuring risk sensitive land use restrictions[95] in the State through the State Disaster Management Plan besides a disaster

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92 208.5 sq. km out of total agricultural land of 1,737.86 sq. km in 2005

93 2.09 sq. km out of total water bodies of 190.70 sq. km in 2005

94 IISc used a two-dimensional (2D) HEC-RAS model for this purpose

95 No permission for blasting type quarrying in high hazard zones of Kerala, Restriction on construction types in Wayanad district owing to hazard proneness based on KSDMA's advice, Limiting extraction of groundwater to 25 *per cent* of the permitted amount in the light of drought, Prevention of obstruction of streams and natural drains through amendment in the Kerala Municipality/ Panchayat Building Rules in 2019, Report of the Technical Committee suggesting amendments to the techno-legal regime issued to the Local Self-Government Department to amend the Kerala Municipal/ Panchayat Building Rules by the State Executive Committee of KSDMA.

vulnerability linked relocation scheme. Enactment of a new integrated, risk sensitive and terrain specific legislation as highlighted in the Rebuild Kerala Development Programme (seeking to explore solutions to Kerala's urbanisation problems) was the only means of reducing disaster vulnerabilities of the State. Hence audit observation only reiterated known facts and the State has already started local and customised solutions.

The exercise undertaken in audit brought to light the extent of drastic change in land use in the Periyar basin during the past three decades (1985-2015), which resulted in a notable impact on the floods of 2018. The study underscores the need for urgent and coordinated efforts of stakeholders in arresting the rapid conversion of Land cover, to mitigate the severity of future flood scenarios in the State. Whereas urbanisation is essential to cater to the needs of growing population, unplanned and imprudent increase in built up area would trigger further depletion of pervious land cover. Besides the steps already undertaken, the State needs to review the need for a legislation on flood plain zones/ initiate steps to prioritise the identification and demarcation of flood plain zones.

Audit notes that the Rebuild Kerala Development Programme of Rebuild Kerala Initiative draws attention to the fact that rapid urbanisation influenced habitations into uncontrolled expansion on both banks of the rivers/ water bodies thereby encroaching into water channels/ bodies and constricting the flood plains. Arresting further unplanned increase in coverage of built-up area of land cover is the critical need of the hour.

Recommendation 4.1: In view of the drastic change in land use over the past few decades with its impact on the recent floods, Government may initiate urgent steps to review the adequacy of the measures initiated to reduce the risk of vulnerability to floods, attributable to changes in land use.

Government may also initiate steps for an integrated and comprehensive legislation and a land use policy after reviewing the existing land management related Acts/ rules/ regulations/ policies etc. to reduce disaster vulnerabilities, as highlighted in the Rebuild Kerala Development Programme.

4.2. Illegal constructions on Cheruthoni riverbed in Idukki district

Cheruthoni river is located in Idukki district. The water from Cheruthoni dam along with that of two other dams at Idukki and Kulamavu, is used by KSEBL for production of electricity at the Moolamattom Power house. The spillway of Idukki Hydro Electric Project in the Cheruthoni Dam, when opened, releases water from the dam into Cheruthoni river.

The Disaster Management Plan 2016 had warned that consequent upon encroachment of the riverbed downstream of this dam, opening the shutters of the dam would result in damage to property. However, lack of continuous monitoring and timely action to evict encroachers led to the obstruction of free

flow of the river and consequent damages in 2018 floods. Audit observed that the Idukki Township Area Development Scheme, 1980, classified 238.72 hectares of land, situated downstream of Cheruthoni Dam in between the road from Cheruthoni town to Neriyamangalam and Cheruthoni river, as Construction Free Zone (CFZ). This area falls under Maximum Flood Level (MFL) demarcated by KSEBL. No construction could be done in this area as the opening of dam shutters would damage buildings and habitations in this area. But disregarding the apparent danger, buildings were constructed along the course of the Cheruthoni River within CFZ/ MFL. It is evident from a letter written (March 1993) by Chairman, KSEBL to GoK that KSEBL had constraints in opening the dam spillway fearing the adverse effects on life and property downstream of the river.

Consequent to a mass petition filed by residents of Idukki (March 2008) before Hon'ble Chief Minister regarding illegal constructions of multi-storied buildings in CFZ at Cheruthoni, a detailed enquiry by the LSGD and Power departments identified 62 buildings in the CFZ which would be inundated in the event of opening of dam shutters. Though GoK directed (November 2009) Secretary, Vazhathope Grama Panchayat to remove the buildings constructed in CFZ, no action was taken to comply with the direction resulting in many buildings and houses[96] being washed away and foundations of several buildings getting damaged consequent to the opening of shutters of Cheruthoni dam during the floods of August 2018. More importantly, the Tahsildar Idukki reported (April 2019) that new buildings were again coming up in the area where the buildings were washed away in 2018. The constructions were in violation of the orders (August 2016) of the District Collector in his capacity as Chairman of DDMA prohibiting construction in areas within the MFL of the Cheruthoni River. The Deputy Superintendent of Police, Idukki also reported (April 2019) that there was reconstruction of old buildings which were damaged in the floods of 2018, in violation of the order of District Collector. No action has also been

Figure 4.1: Reconstruction of hotel building washed away in flood of 2018.
20 December 2019, Cheruthoni riverbed, Idukki District,
Photo taken by Audit party, attested by Tahsildar, Idukki Taluk

[96] Palace Hotel, Central Bakery, Kerala Bakery, Newspaper shop, Sreenilayam stores, Akshaya Kendra, Muthoot shop, KTM veg store, comfort stations, other vegetable shops etc. and eight numbers of houses

taken to remove or relocate 155 encroachments identified by a joint verification team[97] constituted (November 2019) by the District Collector. Complaints on encroachments received by the Revenue Department were also not acted upon by the department. The Tahsildar (Land Records), Idukki affirmed to Audit (November 2019) that none of the 34 complaints received upto 2019 by the Taluk Surveyor/ Village Officer relating to encroachment of rivers/ canals were acted upon.

Lack of continuous monitoring and timely action to evict the encroachers led to the obstruction of free flow of the river and consequent damages in 2018 floods. Further, the encroachment caused operational bottlenecks for spillway opening as the people occupying these illegally constructed buildings were to be given sufficient time for evacuation before the gates were opened.

Principal Secretary, Revenue and Disaster Management Department stated (January 2021) that a joint inspection under the leadership of Town Planner, Idukki has reported that there are approximately 285 constructions in the CFZ and directions were given to Vazhathope GP for taking action against illegal construction. In the Exit Conference (January 2021), Commissioner, Disaster Management stated that the District Collector had been insisting on removal of structures in the CFZ and MFL region and orders were issued by District Collector in 2016. However, due to court cases both in High Court and National Green Tribunal, progress in eviction was slow. The Commissioner assured that the matter was being pursued nevertheless.

Recommendation 4.2: The Government needs to prioritise speedy resolution of the issues relating to removal of unauthorised constructions from the construction free zone in Cheruthoni as also to ensure no new construction is allowed to come up in future within the demarcated zone.

4.3. Diversion canal for Chengalthodu inadequate to prevent inundation

The Land Use and Land Cover analysis of the Periyar Basin as conducted by IISc revealed significant increase in built-up area and reduction in the extent of water bodies. Several towns downstream of Neeleswaram gauge station including parts of Ernakulam city and areas in and around Cochin International Airport experienced aggressive flooding in August 2018. The severity of floods in 2018 caused Cochin International Airport Limited (CIAL) to shut down the airport for 15 days. Audit, therefore, sought to validate the LULC analysis with field verification and scrutiny of records at various offices.

Scrutiny of records revealed that 1,253 acres of land were acquired for constructing the airport, which included wetlands utilised for paddy cultivation

[97] Dam Safety Officer, KSEB, Vazhathope, Town Planning Officer, Idukki, Tahsildar (LR), Idukki, Secretary Grama Panchayat, Vazhathope, Village Officer, Idukki and Taluk Surveyor, Taluk Office, Idukki.

with canals and a portion of the Chengalthodu[98] flowing through. Government of India accorded (March 1995) environmental clearance for construction of the airport, subject to the fulfilment of the condition that 'for diversion of Chengalthodu, appropriate measures such as construction of bund/ diversion canal etc. to regulate the flow of water from Periyar river into the existing Chengalthodu must be adopted, to ensure that the overall hydrology of the area does not change.'

Audit sought the dimensions of Chengalthodu which originally flowed through the area acquired by CIAL before construction of the airport, from Taluk/ Land Acquisition offices in Aluva. The said details were not available either in the office of the Special Tahsildar (Land Acquisition)[99], Nedumbassery or the Taluk office, Aluva. Consequently, as requested by Audit, the survey wing in Taluk office Aluva conducted a comprehensive survey[100] of the original flow route of Chengalthodu prior to construction of airport, after accessing basic records, lithomaps etc. and survey plans from District Survey Office and taluk/ village offices. The survey revealed that while the existing stretch of Chengalthodu originating from the Periyar and flowing till the northern boundary wall of CIAL was approximately 3.5 km long and 60 m wide, the total length of the flow route within CIAL area before construction of airport was estimated to be 2.06 km with approximate width of 52 m. Audit observed[101] that the stretch within the acquired area was filled up by CIAL, thereby disrupting the natural flow route of the water body causing stagnation of water and severe inundation during monsoons.

While conceding that the river had been blocked at the point where it touches the northern boundary wall of the airport, CIAL informed (December 2020) that the stretch of Chengalthodu which flowed through the middle portion of the runway area was diverted in the process of converting the acquired area into airport, more specifically the runway and taxiway. It was also stated that CIAL had created a diversion canal approximately 3.5 km long and 38 m[102] wide in 1999 itself and that the length of the canal remained unaltered even today. However, the minutes of post 2018 flood meetings attended by Revenue and Disaster Management and Irrigation Departments/ CIAL/ LSGI authorities mentioned that the said channel remained without having been deepened and cleaned, obstructing the smooth flow of water in monsoons, leading to local protests.

Audit observed from records that consequent upon an aggravated flood situation in August 2013, areas in the vicinity of CIAL were inundated, forcing suspension of normal operation of the airport for a day. Subsequently,

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98 A rivulet collecting excess water from Periyar river, starting in Kanjoor village and having natural course through Chengal, Thuravankara, Manjali, Chowara and finally merging with Periyar at Kuzhippallam. 'Thodu' is the Malayalam word for small river/ creek/ canal.

99 The office was severely affected by floods in 2018 and 2019, with many of its records getting dampened and termite-infested

100 The survey was conducted from December 2019 to January 2020

101 Chengalthodu Report of the Irrigation Division, Ernakulam post 2018 floods

102 The width stated by CIAL alongwith bund road; the survey sketch showed width of 20 m.

CIAL requested National Institute of Technology (NIT), Calicut to conduct a study to suggest remedial measures to prevent recurrence of such an event. NIT Calicut observed (2013) that as the diversion channel proposed by CIAL had very limited carrying capacity, it could not be expected to bring down the flood discharge and levels in Chengalthodu and adjoining areas considerably and eliminate the threat of submergence. As an additional safety measure, NIT recommended that CIAL may complete the diversion channel with maximum possible width, depth, and bed slope, taking sufficient precaution to prevent inundation of the land along its alignment. However, insufficiency of measures taken since then is evident from the report of Irrigation Department post the deluge in 2018 stating that the diversion canal constructed by CIAL was totally inadequate to drain off the excess influx from Periyar as well as rainwater from the areas in the vicinity, which resulted in acute flooding in the area.

Cochin International Airport Limited stated in the replies and during discussion (December 2020, January 2021) that the site for the airport was selected by the expert team from Airports Authority of India, and GoK vide Government Order dated 15 November 1996 approved diversion of Chengalthodu so as to carry out construction of runway and apron over Chengalthodu. It was also informed that the width of Chengalthodu varies from place to place and at places is 20 m as against 60 m indicated by Audit. Considering the 400 m wide operational area of airport and some meandering of the rivulet, the maximum length of the rivulet inside the operational area would be 600 m against the 2.06 km length stated by Audit. Audit should have relied upon the Survey of India Map of 1993 rather than follow a methodology of the superimposition of lithomap of Aluva taluk over satellite map of the area.

Cochin International Airport Limited further stated that historical data indicates that the maximum water flow from Chengalthodu to Periyar could be 41.53 cumecs. The unprecedented water flow in the Periyar during the 2018 flood calamity, near the Airport area was 6,500 cumecs due to very heavy rainfall and excess spillage from upstream dams. The water flow rather than the construction of the airport caused severe flooding in Periyar, its tributaries and flood arms. Areas downstream and upstream of Periyar were also badly flooded in 2018 floods.

Audit clarified (January 2021) that it had relied upon the actual measurements of the detailed survey conducted by the Survey wing of Taluk Office Aluva for over a month, to assess the extent of water body that has been filled to make way for the runway of the airport, from the point at which it was blocked at the northern boundary wall of CIAL till the point at which it continues to flow outside the airport boundary. The superimposition[103] of the lithomap over satellite map was only for reconfirmation, which also revealed the length of Chengalthodu within CIAL area to be over 2 km. CIAL requested to share the

[103] At Land Use Board Thiruvananthapuram

survey sketch with them, which was complied with by Audit. Minutes of the conference were approved (February 2021) by Audit and CIAL.

Audit observed that action to survey and demarcate the flood plains of Chengalthodu, as well as conserve and ensure unhindered flow route for the river had not been taken even after the flooding in 2013. Despite passage of 20 years since the commissioning of the airport and incidents of severe flooding in the area, the Irrigation/ Revenue and Disaster Management wings/ LSGIs concerned/ CIAL have not been able to ensure a diversion canal adequate to carry the Chengalthodu waters (in the event of heavy flooding) into the Periyar river to sustain the overall hydrology of the area and ward off the potential risks of riverine flooding to the resident population. Considering that the flood hydrograph in NIT Report had observed that the peak flood discharge near the mouth of Chengalthodu (entrance from Periyar river) at Neeleswaram on Periyar river was 472 cumecs in 2013 (the time taken by the flood wave to travel from Neeleswaram to the mouth of the Chengalthodu is just about 14 minutes[104]) and also the flood flow through Chengalthodu 6,500 cumecs in 2018, the Government needs to ensure adequacy of the dimensions of the diverted route of Chengalthodu as well as its maintenance, so as to lessen the impact of possible inundation in the airport and surrounding areas during the monsoons.

CIAL stated (December 2020) that GoK had accorded sanction (February 2019) to a comprehensive flood mitigation plan for safeguarding the areas in the vicinity of airport from future floods. Of the 26 works taken up as part of the flood mitigation plan at a cost of ₹129.30 crore, 13 works were stated as completed and the remaining works were still in progress. CIAL informed (January 2021) that the works relating to the diversion canal were expected to be completed before the upcoming monsoon. Government of Kerala informed (January 2021) that reply to the matter has been furnished (December 2020) to Audit by CIAL.

Recommendation 4.3: Government may a) ensure the adequacy of planned/ ongoing works under the comprehensive flood mitigation plan for safeguarding CIAL and its surrounding areas and b) review the pace of progress vis-à-vis the targets so that risk of loss to life and property in case of extreme rainfall/ flooding is minimised.

4.4. Obstruction to flood discharge through Thottappally Spillway

The Thottappally Spillway[105] (TSW) situated 20 km south of Alappuzha was commissioned in 1955 as an easy and only direct outlet for the combined flood discharge of Pamba, Achencovil and Manimala rivers into the sea before it reaches lower Kuttanad area, preventing heavy damages to the life and

[104] NIT Report 2013

[105] The TSW included a regulator cum bridge 360 metres long having 40 vents and a leading channel 1,310 m long and 365 m wide, starting from the confluence point of Pamba and Achencovil rivers at Veeyapuram.

property of people in Kuttanad. TSW was to include a regulator cum bridge 365 m long having 40 vents and a leading channel 1,310 m long and 365 m wide, starting from the confluence point of Pamba and Achencovil rivers at Veeyapuram. Audit scrutiny of records revealed that in the upstream side of the spillway, the width of the leading channel was only about 80 m from Veeyapuram to Thottappally, which reduced the discharge capacity of TSW to 700 cumecs against the envisaged capacity of 1800 cumecs.

Consequently, water discharged through the spillway to the sea was severely restricted, during the flood of 2018, resulting in heavy flooding[106] and casualties in Kuttanad and other regions in Alappuzha and parts of Pathanamthitta.

The Chief Engineer (Mechanical), Irrigation Department confirmed (July 2020) that against the targeted dredging of the east side of Thottappally (lake side) for a length of 500 m with a width of 320 m, works were executed only in a stretch of 380 m length and 160 m width[107]. Audit notes that dredging works in the leading channel which remained to be completed imply reduced carrying capacity.

Scrutiny of records at Office of the Chief Engineer, Kuttanad[108] indicated that there was gradual accretion of sand on the south side of a breakwater which was constructed (2004) to facilitate opening of Thottappally Fishing Harbour about 100 m north of spillway mouth. The width and carrying capacity of the spillway mouth was further reduced to one third of its original state, after the Social Forestry Department, without seeking permission from Irrigation Department, planted (2010) casuarina trees on this sand base, right inside the spillway mouth. Incomplete dredging and widening of leading channel of Thottapally spillway and delay in removal of the trees planted inside the spillway mouth resulted in reduction of capacity of the spillway, thus contributing to the flood situation in Alappuzha in August 2018.

[106] Source: Letter from CE Kuttanad to Additional Chief Secretary, Water Resources Department (June 2019)

[107] Excluding a stretch of 80 metre length and 50 metre width

[108] Chief Engineer, Inland Navigation and Kuttanad package under Water Resources Department, Government of Kerala

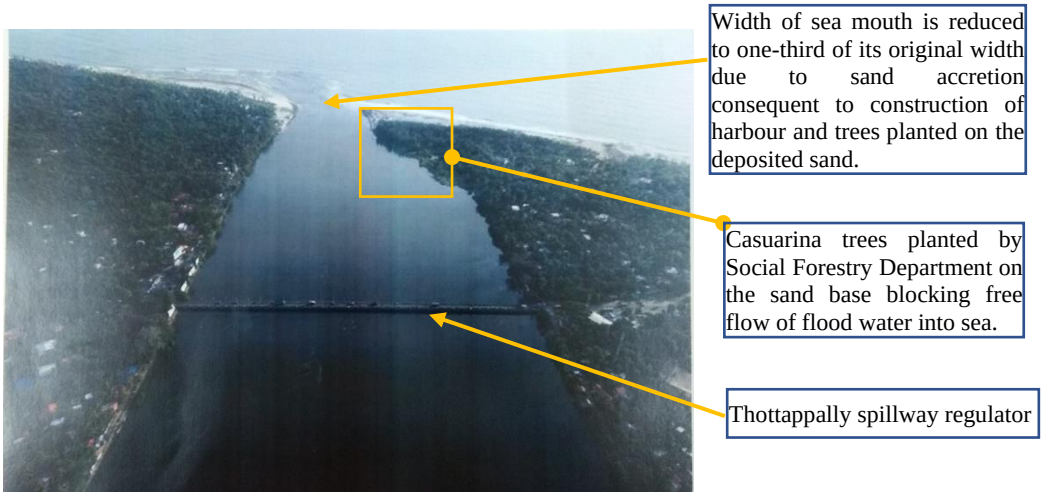

Figure 4.2: Thottappally spillway aerial view, July 2018, Alappuzha District
Source: Mechanical Division, Irrigation Department, Alappuzha

In the aftermath of the August 2018 floods, the Principal Chief Conservator of Forests (PCCF) issued instructions (May 2019) to cut down the trees in view of the risk of an impending disaster. However, the Social Forestry wing of the district, citing environmental reasons, did not comply with the order. Orders of the District Collector invoking the provisions of Disaster Management Act 2005 (June 2019), for taking immediate action to cut down these trees which were obstructing natural flow through the spillway mouth were also not complied with.

Chief Engineer, Kuttanad informed Audit during the joint site verification (04 October 2019) that though attempts were made to cut down the trees on the basis of District Collector's order, only four trees could be removed as the local people had vehemently resisted the move, stating that these trees acted as a protective shield against wind.

Water Resources Department confirmed (November 2020) that discharge envisaged through the spillway had been reduced from 1800 cumecs due to the siltation in the leading channel. Further, any change in width of the upstream channel requires rehabilitation of people from the heavily populated banks. Additional Chief Secretary, Water Resources Department informed (November 2020 and April 2021) Audit that 550 casuarina trees planted within the 380m width of the downstream, and reckoned to be obstructing the flow of floodwaters were cut down by the District Administration, Alappuzha on 22 May 2020, by which the width at the spillway mouth was extended by 230m thereby reaching the required width of 380m.

It was also informed that with a view to deepen and widen the estuary, Irrigation Department started removal of mineral sand from spillway mouth and downstream of the spillway on 20 May 2020. Accordingly, an estimated quantity of 2,42,831 cu.m sand was dredged; out of which a quantity of 1,75,319 cu.m sand was removed. Within a few months after completing the dredging, a sand bar has been formed at the spillway mouth, occupying a width of 75 m. The present accumulation of mineral sand at the downstream is

estimated to be 2,49,000 cu.m (April 2021). Steps were being taken to remove the since accumulated mineral sand from the downstream of the spillway mouth in order to ensure smooth flow of flood waters during the upcoming monsoon season.

Audit observes that Water Resources Department and District Administration Alappuzha would further need to ensure regular monitoring and deepening of the leading channel upstream of TSW and timely breaking of developing sand bar if any, which are crucial in ensuring unhindered flow of flood waters to the sea. Had the above authorities proactively intervened, to remove the trees obstructing the spillway mouth prior to 2018 monsoon, the flood situation in Alappuzha could have been mitigated to a considerable extent.

Recommendation 4.4: Government may, prioritise works such as deepening of the leading channel upstream of TSW and timely breaking of developing sand bar, if any, at the sea mouth so as to ensure unhindered flow of flood waters to the sea, giving due consideration to extant environment related instructions while so doing.