BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL
(SOUTHERN ZONE, CHENNAI)

Original Application No.75 of 2020 (SZ)

Tribunal on its own motion SUO MOTU
based on the News Item in Hindu
Newspaper dated 30.05.2020,"Kerala Forest
"Department told to permit sand removal from pampa".

.... Applicant

Vs

The Chief Secretary of Kerala,
Thiruvananthapupram, Kerala and others.

... Respondents

Report of Member Secretary, Kerala State Disaster Management Authority filed by the Counsel for Respondent Nos. 1 to 7

It is submitted that a Joint Committee has been constituted by this Hon'ble Tribunal vide order dated 02.06.2020, to enquire into the issue and submit a factual and action take report, in the above Original Application. Accordingly, The Joint Committee has been constituted and we are filing the independent Report of the Member Secretary, Kerala State Disaster Management Authority, for compliance before this Hon'ble Tribunal in the above Original Application.

To that effect this memo is filed and the same may be recorded.

E.K.KUMARESAN

STANDING COUNSEL FOR STATE OF KERALA

Counsel for Respondent Nos. 1 to 7

Debris Removal from Pamba

Order of National Green Tribunal in OA No. 75/2020

Report of Member Secretary

Kerala State Disaster Management Authority

Investigation Series 1/2020

Dated 8-10-2020

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1. Introduction

At the outset the following preliminary objections of lack of jurisdiction of the National Green Tribunal over the provisions of the Disaster Management Act, 2005 as per Section 14 of the NGT Act of 2010 and as per the Section 71 of the Disaster Management Act, 2005 is laid here under.

It is humbly submitted that as per Section 14 of the NGT Act of 2010 the Tribunal only has jurisdiction over disputes arising violating the provisions of the enactments mentioned in Schedule 1 of the Act. The Disaster Management Act of 2005 does not find mention in Schedule 1.

It is humbly submitted that as per section 71 of the Disaster Management Act of 2005, "No court (except the Supreme Court or a High Court) shall have jurisdiction to entertain any suit or proceedings in respect of anything done, action taken, orders made, direction, instruction or guidelines issued by the Central Government, National Authority, State Government, State Authority or District Authority in pursuance of any power conferred by or in relation to its functions, by this Act (Disaster Management Act 2005)".

The Division Bench of Hon'ble High Court Kerala in WA. No. 2745 of 2015 in WP (C) 26377/2015 in its judgement dated 5-4-2016 has upheld the overriding power of Disaster Management Act, 2005 against other legal instruments.

Further, under Section 74 of the Disaster Management Act, 2005 "Immunity from legal process - Officers and employees of the Central Government, National Authority, National Executive Committee, State Government, State Authority, State Executive Committee or District Authority shall be immune from legal process in regard to any warning in respect of any impending disaster communicated or disseminated by them in their official capacity or any action taken or direction issued by them in pursuance of such communication or dissemination".

The various actions, orders and directions of the District Disaster Management Authority (DDMA) Pathanamthitta as follows DM3-454/18 dated 18-5-2019 under Section 34 (d), DCPTA/454/DM3 dated 15-5-2020, DCPTA 454/2018/DM3 dated 30-5-2020, DCPTA/454/2018/DM3 dated 4-6-2020 and DCPTA/454/2018/DM3 dated 7-6-2020 are the ones under the consideration of the Hon'ble Tribunal.

As the provision of Sections 71 and 74 are as given above it is only Supreme Court or High Court which can entertain any suit or proceedings in respect to the Disaster Management actions, orders issued and directions of the DDMA Pathanamthitta.

It is also informed that vide SO 1224 (E) dated 28-3-2020 the Ministry of Environment, Forest and Climate Change issued a notification in which it is clearly stated that *dredging and desilting of dams, reservoirs, weirs, barrages, river and canals for the purpose of their maintenance, upkeep and disaster management do not require any prior environmental clearance*.

In the Amicus Curiae report in W.P(C). No. 2651 of 2019 related to Kerala Floods 2018 before Hon'ble High Court of Kerala, it is stated that sedminents in the river systems of Kerala has increased the flood magnitude.

Under Section 30 (2) (iii) of the Disaster Management Act, 2005, the District Disaster Management Authority has to (iii) Ensure that the areas in the district vulnerable to disasters are identified and measures for the prevention of disasters and the mitigation of its effects are undertaken by the departments of the Government at the district level as well as by the local authorities".

Under Section 3 (2) (iii) of the Disaster Management Act, 2005 "The District Authority may by order require any officer or any Department at the district level or any local authority to take such measures for the prevention or mitigation of disaster, or to effectively respond to it, as may be necessary, and such officer or department shall be bound to carry out such order".

Under Section 34 of the Disaster Management Act, 2005 “Powers and functions of District Authority in the event of any threatening disaster situation or disaster - For the purpose of assisting, protecting or providing relief to the community, in response to any threatening disaster situation or disaster, the District Authority may-

(a) Give directions for the release and use of resources available with any Department of the Government and the local authority in the district;

(d) Remove debris, conduct search and carry out rescue operations;

(m) Take such other steps as may be required or warranted to be taken in such a situation.

Section 65 (1) (a) of the Disaster Management Act, 2005 "Resources includes men and material resources".

Further, vide Section 64 of the Disaster Management Act, 2005, “Making or amending rules, etc., in certain circumstances.- Subject to the provisions of this Act, if it appears to the National Executive Committee, State Executive Committee or the District Authority, as the case may be, that provisions of any rule, regulation, notification, guideline, instruction, order, scheme or bye-laws, as the case may be, are required to be made or amended for the purposes of prevention of disasters or the mitigation thereof, it may require the amendment of such rules, regulation, notification, guidelines, instruction, order, scheme or bye-laws, as the case may be, for that purpose, and the appropriate department or authority shall take necessary action to comply with the requirements”.

Vide the above illustrated sections of the Disaster Management Act, 2005, the following are evident:

- The District Disaster Management Authority (DDMA) Pathanamthitta has satisfied itself by means that it deemed appropriate identified an area as vunerable as no study is pragamatically possible to be conducted immediately prior to the emergence of a threatening disaster situation. It is also not a statutory requirement for Disaster Management Authorities to conduct such studies for removal of debris.
- The DDMA Pathanamthitta has reported that they have conducted site specific study which included technically competent experts such as Assistant Executive Engineer, Irrigation, District Geologist and Assistant Executive Engineer Dewasom Board and Divisional Forest Officer (Ranni). This is deemed sufficient by the DDMA Pathanamthitta to undertake such an activity in light of the threatening disaster situation. Amicus Curiae report furnished in the High Court of Kerala in W.P (C) No. 2651 of 2019 related to floods has also highlighted the need for desilting.
- There is no violation in removing debris from river Pamba to avoid disaster. It is evident that DDMA has examined and have satisfied itself as to the need and amount of debris to be removed.
- India Meteorological Department (IMD) issued the first long range forecast pertaining to monsoon on 15.04.2020 indicating 100% rainfall during the south west monsoon season of 2020. This was a prediction higher than that was predicted in 2018 and 2019. In 2018, the predicted monsoon rainfall was 97% of the long period average, while the

actual received was 196%. In 2019, the predicted monsoon rainfall was 96% of the long period average, while the actual received was 113%. Therefore, there was cognizable evidence from IMD that there is a probability of heavy rainfall and therefore the possibility of floods was evident.

- Further, in the Minutes of the Meeting held on 20-5-2020, 11 am at the Durbar Hall, Government Secretariat, Thiruvananthapuram under the chairmanship of the State Relief Commissioner for Monsoon Preparedness 2020 the possibility of floods was highlighted by the Principal Secretary, Science and Technology of Government of Kerala, Prof. Dr. Sudheer, who is also a renowned scientific expert in the field of flood prediction studies in the country from IIT, Madras. He informed the meeting "that even though the IMD's seasonal forecast predicts a normal rainfall, by observing a pattern change in the previous years, the scientific community believes that there may be extreme events to happen. So the state has to anticipate a flood scenario and prepare well for the season".
- It is also to be stated that the decision of the DDMA to remove debris that accummulated in 2018 and 2019 floods in public spaces such as rivers, rivulets and canals was inline with the statutory state wide applicable decision dated 18-5-2020 of State Executive Committee (SEC), a statutory committee of State Disaster Management Authority constituted under Section 20 (1) of the Disaster Management Act, 2005. Government order (Rt) No. 457/2020/DMD dated 19-5-2020 was also issued based on this decission of the SEC providing funds from State Disaster Response Fund for the conduct of debris removal from public spaces such as rivers, rivulets and canals in Pathanamthitta District.
- The State Executive Committee of KSDMA "placed on record its deep appreciation for the speedy debris removal activities being carried out by Pathanamthitta District Disaster Management Authority from Pamba and by Alappuzha District Disaster Management Authority from Thottappally" in its meeting held on 9-7-2020.
- It is also reported that the Division Bench of Hon'ble High Court Kerala in WP (C) No. 11394 of 2020 (S) dated 1-6-2020 in petition against removal of debris from the rivers of Kerala as a preparedness against floods of 2020 has already ruled that "Instant writ petition is filed with bald averments, criticizing the Government of Kerala alleging that there is no mechanism, lack of study on the aspect of removal of natural deposit of sand

and silt. The prayer to issue a mandamus for constituting a committee and thereafter to submit a report, is without any basis".

- Thus, the Hon'ble High Court examined the matter in detail and had disposed the very idea of any expert committee for studying debris removal from the rivers of Kerala as a this was a specific disaster management activity. Hence the very existance of any expert committee on the matter is against the directive of the Hon'ble High Court.

Without prejudice to the objections raised above the facts relating to the specific action is reported here under.

2. Visit of team from KSDMA with the Joint Committee

Based on the direction of the National Green Tribunal, a team of three experts visited Pamba Triveni on 15-9-2020 along with the members of the Joint Committee constituted vide OA No. 75/2020 dated 2-6-2020. The experts who vistied the sites are:

1. Dr. Sekhar L. Kuriakose, Member Secretary, KSDMA & Head, Kerala State Emergency Operations Centre
2. Mr. Ajin R.S, Hazard Analyst (Geology), Kerala State Emergency Operations Centre
3. Ms. Amrutha K, Hazard Analyst (Envi\ronmental Science), Kerala State Emergency Operations Centre

The following report is prepared and submitted based on the filed visit, apriori knowledge regarding the site conditions, the legal contexts and situational awareness related to the matter.

Figure 1: Site inspection at Pamba

Figure 2: Site inspection at Chakkupalam

3. Streams

In order to understand the specifics of how rivers behave geomorphologically, some introduction to the geomorphology of streams are required.

I. Classification of Streams

This classification is based on stream flow conditions and the connectivity between stream water and groundwater (Zaimes and Emanuel, 2006).

- Perennial streams have water flowing in the channel year around and the stream is in direct contact with water table.
- Intermittent streams have water flowing only part of the year, but the stream is still in direct contact with water table.
- Ephemeral streams flow with water only after precipitation events, and the stream are well above the water table. Some large, permanent gullies may be considered ephemeral streams.

The Pamba at Triveni is both pernennial and intermittent in nature as a part of it has perennial flow.

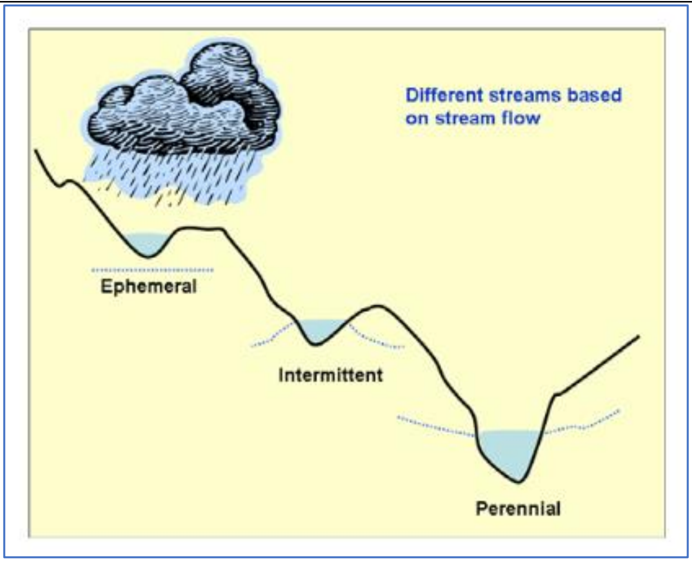

Figure 3: Streams based on stream flow (Zaimes and Emanuel, 2006)

II. Geometry and Dynamics of Stream Channels

The stream channel is the conduit for water being carried by the stream. The stream can continually adjust its channel shape and path as the amount of water passing through the channel changes. The volume of water passing any point on a stream is called the discharge. Discharge is measured in units of volume/time (m^3/sec).

Cross Sectional Shape - varies with position in the stream and discharge. The deepest parts of a channel occur where the stream velocity is the highest. Both width and depth increase downstream because discharge increases downstream. As discharge increases the cross-sectional shape will change, with the stream becoming deeper and wider.

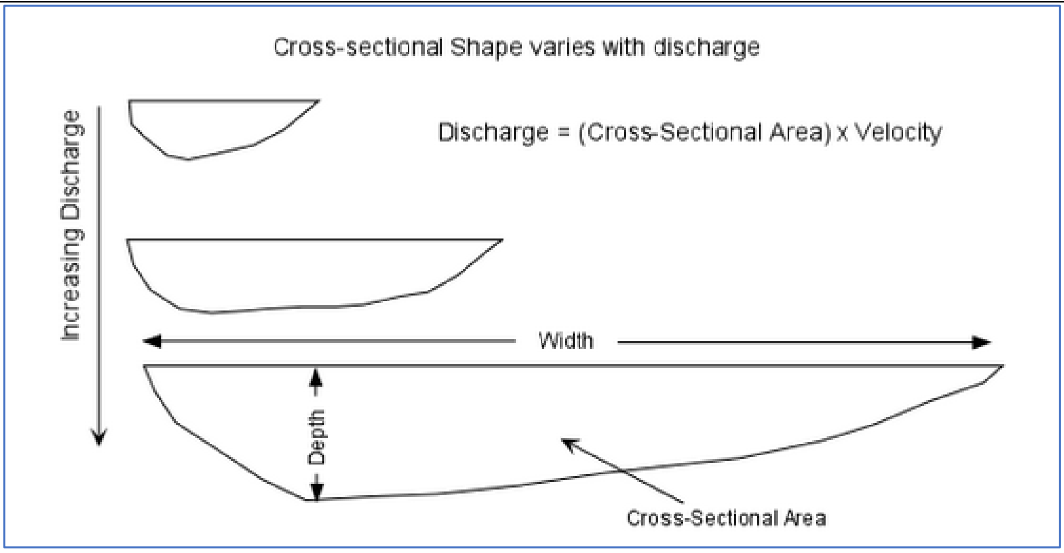

Figure 4: Cross sectional shape (Nelson, 2016)

Long Profile - Usually shows a steep gradient near the source of the stream and a gentle gradient as the stream approaches its mouth.

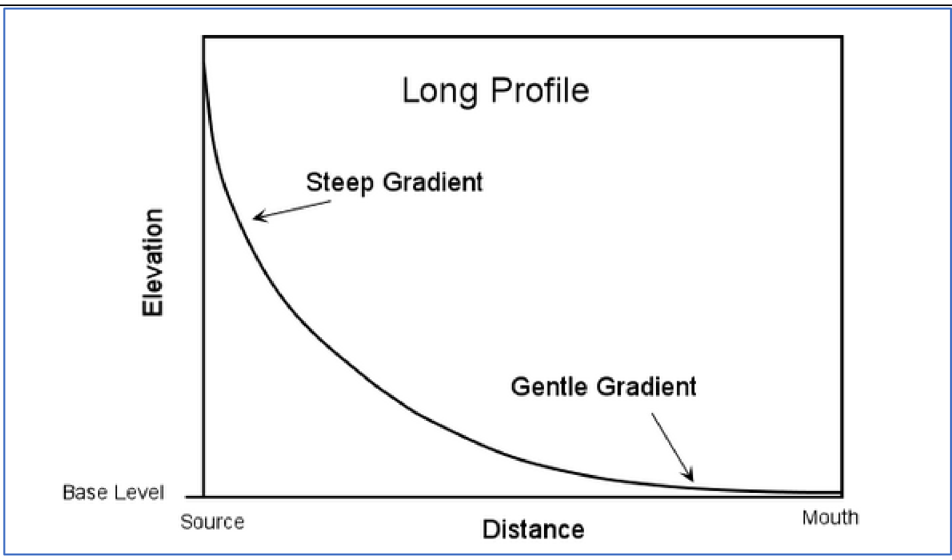

Figure 5: Long profile (Nelson, 2016)

Velocity - A stream's velocity depends on position in the stream channel, irregularities in the stream channel caused by resistant rock, and stream gradient.

Friction slows water along channel edges. Friction is greater in wider, shallower streams and less in narrower, deeper streams. In straight channels, highest velocity is in the center.

Deepest part of the channel is called the thalweg - meanders with curve the of the stream. Flow follows a spiral path. In curved channels - maximum velocity traces the outside curve where the channel is preferentially scoured and deepened. On the inside of the curve were the velocity is lower, deposition of debris occurs. Stream flow can be either laminar, in which all water molecules travel along similar parallel paths, or turbulent, in which individual particles take irregular paths. Turbulent flow can keep debris in suspension longer than laminar flow and aids in erosion of the stream bottom.

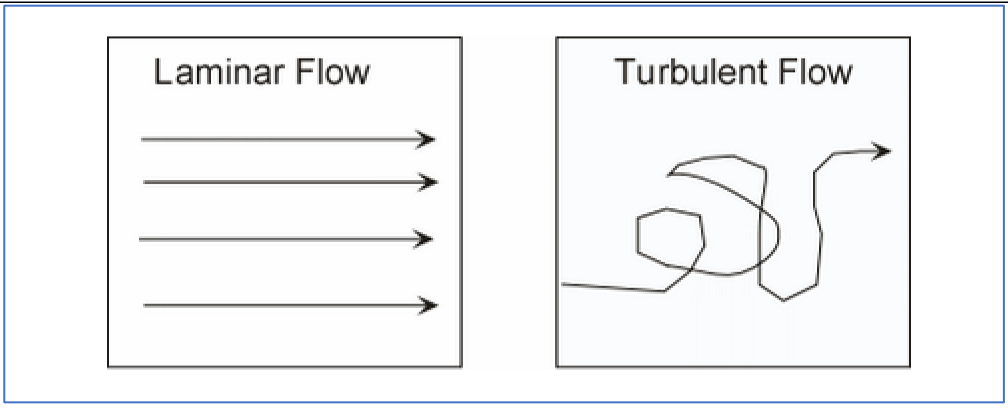

Figure 6: Type of stream flow (Nelson, 2016)

Load - The rock particles and dissolved ions carried by the stream are the called the stream's load. Stream load is divided into three parts:

- **Suspended load** - particles that are carried along with the water in the main part of the stream. The size of these particles depends on their density and the velocity of the stream. Higher velocity currents in the stream can carry larger and denser particles. The suspended load is what gives most streams their muddy looking appearance and brown or red color. When the velocity of the stream is decreased, that particles in the suspended load that can no longer be suspended are deposited.
- **Bed load** - coarser and denser particles that remain on the bed of the stream most of the time but move by a process of saltation (jumping) because of collisions between particles and turbulent eddies. Note that debris can move between bed load and suspended load as the velocity of the stream changes.
- **Dissolved load** - ions that have been introduced into the water by chemical weathering of rocks. This load is invisible because the ions are dissolved in the water. Dissolved load consists mostly of HCO^{-3} (bicarbonate ions), Ca^{+2}, SO_4^{-2}, Cl^-, Na^+, Mg^{+2}, and K^+. These ions are eventually carried to the oceans and give the oceans their salty character. Streams that have a deep underground source generally have higher dissolved load than those whose source is on the Earth's surface.

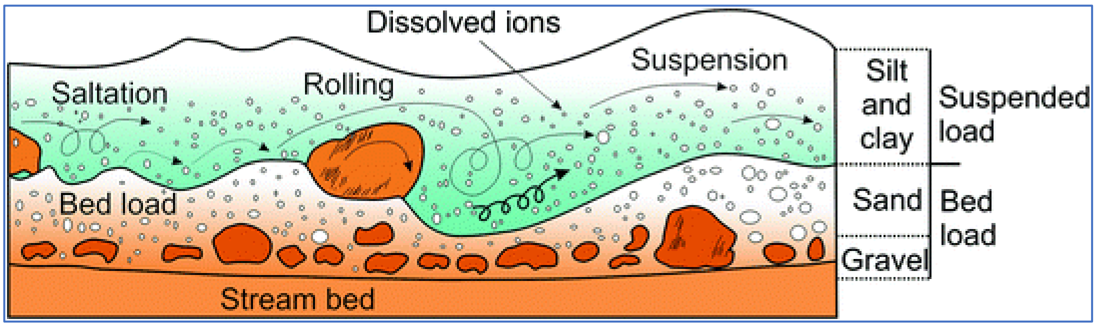

Figure 7: Stream load (Jain, 2014)

The maximum size of particles that can be carried as suspended load by the stream is called **stream competence**. The maximum load carried by the stream is called **stream capacity**.

Competence and capacity increase with increasing discharge. At high discharge boulder and cobble size material can move. At low discharge - larger fragments become stranded and only the smaller, sand, silt, and clay sized fragments move.

Changes Downstream - As one moves along a stream in the downstream direction:

- Discharge increases, as noted above, because water is added to the stream from tributary streams and groundwater.
- As discharge increases, the width, depth, and average velocity of the stream increase.
- The gradient of the stream, however, will decrease.
- The size of particles that make up the bed load of the stream tends to decrease.
- Even though the velocity of the stream increases downstream, the bed load particle size decreases mainly because the larger particles are left in the bed load at higher elevations and abrasion of particles tends to reduce their size.

The velocity increases in the downstream direction. This is because, the water in the mountain stream is likely flowing in a turbulent manner, due to the large boulders and cobbles which make up the streambed. If the flow is turbulent, then it takes longer for the water to travel the same linear distance, and thus the average velocity is lower.

Floods occur when the discharge of the stream becomes too high to be accommodated in the normal stream channel. When the discharge becomes too high, the stream widens its channel by overtopping its banks and flooding the low-lying areas surrounding the stream. The areas that become flooded are called **floodplains**.

Channel Patterns

- **Straight Channels** - Straight stream channels are rare. Where they do occur, the channel is usually controlled by a linear zone of weakness in the underlying rock, like a fault or joint system. Even in straight channel segments water flows in a sinuous fashion, with the deepest part of the channel changing from near one bank to near the other. Velocity is highest in the zone overlying the deepest part of the stream. In these areas, debris is transported readily resulting in pools. Where the velocity of the stream is low, debris is deposited to form bars. The bank closest to the zone of highest velocity is usually eroded and results in a cut bank.

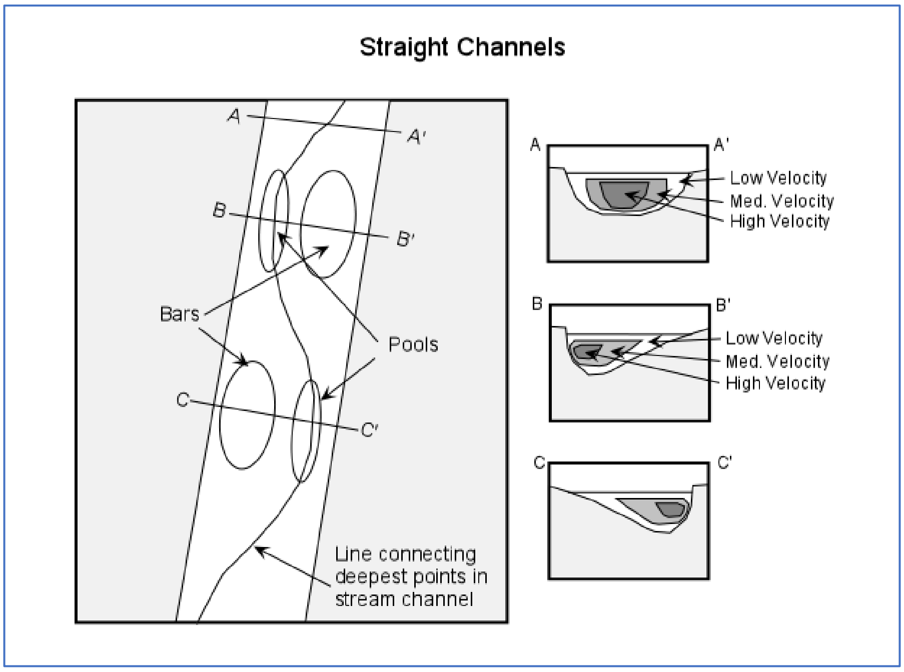

Figure 8: Straight channel (Nelson, 2016)

- **Meandering Channels** - Because of the velocity structure of a stream, and especially in streams flowing over low gradients with easily eroded banks, straight channels will eventually erode into meandering channels. Erosion will take place on the outer parts of the meander bends where the velocity of the stream is highest. Debris deposition will occur along the inner meander bends where the velocity is low. Such deposition of debris results in exposed bars, called point bars. Because meandering streams are continually eroding on the outer meander bends and depositing debris along the inner meander bends, meandering stream channels tend to migrate back and forth across their flood plain.

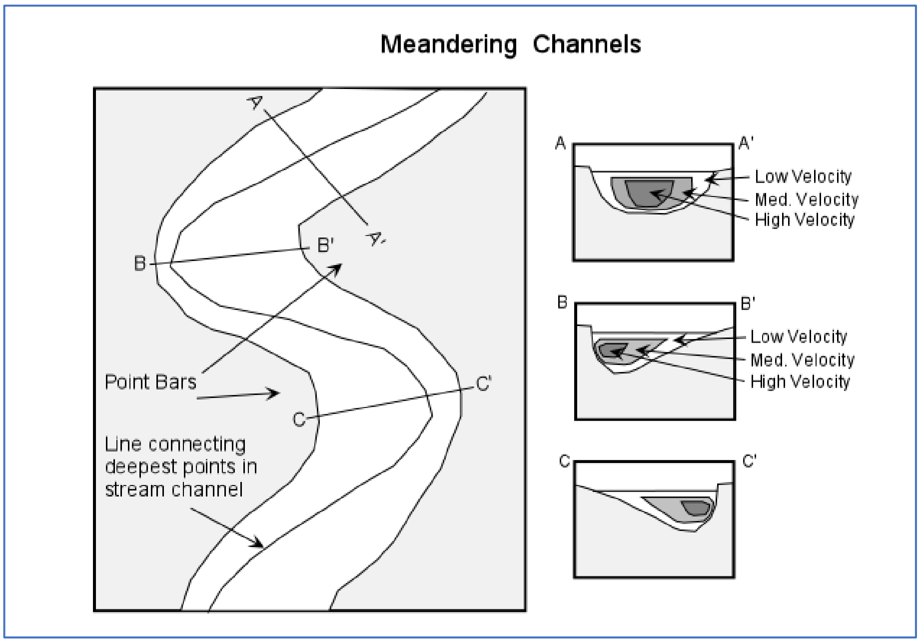

Figure 9: Meandering channel (Nelson, 2016)

If erosion on the outside meander bends continues to take place, eventually a meander bend can become cut off from the rest of the stream. When this occurs, the cut-off meander bend, because it is still a depression, will collect water and form a type of lake called an oxbow lake.

- **Braided Channels** - In streams having highly variable discharge and easily eroded banks, debris gets deposited to form bars and islands that are exposed during periods of low discharge. In such a stream the water flows in a braided pattern around the islands and bars, dividing and reuniting as it flows downstream. Such a channel is termed a braided channel. During periods of high discharge, the entire stream channel may contain water with the islands covered to become submerged bars. During such high discharge, some of the islands could erode, but the debris would be re-deposited as the discharge decreases, forming new islands or submerged bars. Islands may become resistant to erosion if they become inhabited by vegetation.

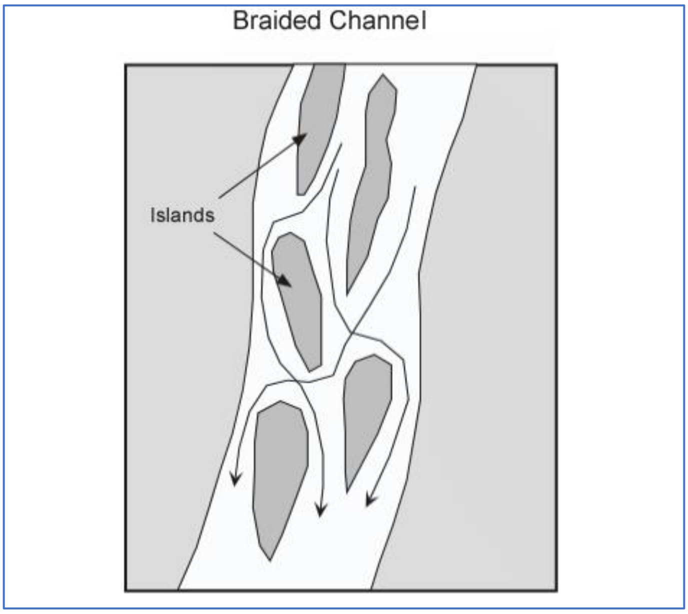

Figure 10: Braided channel (Nelson, 2016)

Stream Deposits

Sudden decreases in velocity can result in deposition by streams. The velocity of streams varies with position. If debris gets moved to the lower velocity part of the stream, the debris will come out of suspension and be deposited. Other sudden changes in velocity that affect the whole stream can also occur. For example, if the discharge is suddenly increased, as it might be during a flood, the stream will overtop its banks and flow onto the floodplain where the velocity will then suddenly decrease. This results in deposition of such features as **levees** and **floodplains**. If the gradient of the stream suddenly changes by emptying into a flat-floored basin, an ocean basin, or a lake, the velocity of the stream will suddenly decrease resulting in deposition of debris that can no longer be transported. This can result in deposition of such features as **alluvial fans** and **deltas**.

- Floodplains and Levees - As a stream overtops its banks during a flood, the velocity of the flood will first be high, but will decrease as the water flows out over the gentle gradient of the floodplain. Because of the sudden decrease in velocity, the coarser grained suspended debris is deposited along the riverbank, eventually building up a natural levee. Natural levees provide some protection from flooding because with each flood the levee is built higher and discharge must be higher for the next flood to occur.

- Terraces - Terraces are exposed former floodplain deposits that result when the stream begins down cutting into its floodplain.

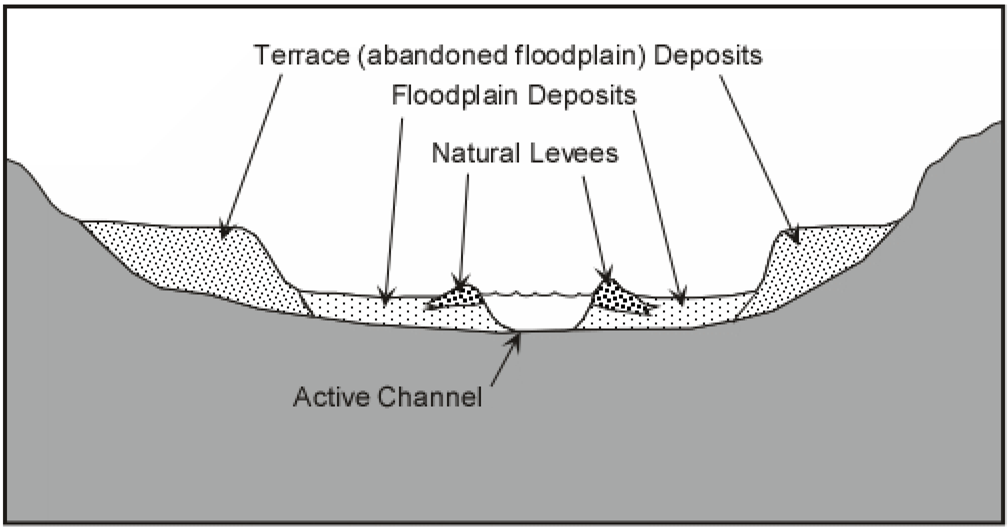

Figure 11: Stream deposit (Nelson, 2016)

The geomorphological alterations and debris moving in rivers impact flood frequency and can increases because of:

i. reduction of the channel capacity (Slater *et al.,* 2015)
ii. morphological adjustments in response to a variable debris supply from upstream (Lane and Thorne, 2007)
iii. bed aggradation and erosion due to damming and backwater effects (Walter and Merritts, 2008; Maselli *et al.*, 2018).

Previous studies based on historical data and geomorphic analyses found that an increase in flood risk can be correlated not only with an increase in flow discharge, but also with a reduction in the channel conveyance (James, 1999; Stover and Montgomery, 2001). High debris delivery ratio is one of the necessary drivers for increasing flood risk, due to the reduction in the cross sections after sedimentation (Korup et al., 2004; Pinter and Heine, 2005) or the alteration of the river pattern (Sinnakaudan et al., 2003).

III. Geometry and Dynamics of Stream Channels

The bank of this section of Pamba river is the halting place while visiting Sabarimala and is adjacent to the Triveni Sangamam. As the name depicts, Triveni Sangamam means the meeting point of three rivers. At this point, the Holy Pamba river confluences with the Manimala river basin in its north and the Achankovil river basin in the south (Fig. 12). This area was severely affected by the 2018 Kerala floods (Fig. 13-16) and which caused substantial damage to the infrastructures, floodplains, and to the biodiversity[1-6] (Fig. 17-30). Huge quantities of debris (sand, pebbles, and cobbles) were accumulated in this river channel and which obstructed the free flow of water.

Figure 12: River confluence

Figure 13: 2018 Floods – Pamba (Source: **District Administration, Pathanamthitta**)

Figure 14: 2018 Floods – Pamba 2 (Source: **District Administration, Pathanamthitta**)

Figure 15: 2018 Floods – Triveni Bridge (Source: **District Administration, Pathanamthitta**)

Figure 16: 2018 Floods – Triveni Bridge (2) (Source: **District Administration, Pathanamthitta**)

Figure 17: Effect on the vegetation

Figure 18: Damage caused to trees

Figure 19: Damage caused to trees (2) (Source: **District Administration, Pathanamthitta**)

Figure 20: Damage caused to infrastructures

Figure 21: Damage caused to infrastructures (2) (Source: **District Administration, Pathanamthitta**)

Figure 22: Damage caused to infrastructures (3) (Source: **District Administration, Pathanamthitta**)

Figure 23: Damage caused to infrastructures (4) (Source: **District Administration, Pathanamthitta**)

Figure 24: Damage caused to infrastructures (5) (Source: **District Administration, Pathanamthitta**)

Figure 25: Damage caused to infrastructures (6) (Source: **District Administration, Pathanamthitta**)

Figure 26: Damage caused to infrastructures (7) (Source: **District Administration, Pathanamthitta**)

Figure 27: Damage caused to infrastructures (8) (Source: **District Administration, Pathanamthitta**)

Figure 28: Damage caused to infrastructures (9) (Source: **District Administration, Pathanamthitta**)

Figure 29: Damage caused to infrastructures (10) (Source: **District Administration, Pathanamthitta**)

Figure 30: Damage caused to infrastructures (11) (Source: **District Administration, Pathanamthitta**)

This river is a perennial one and is in meandering stage. This portion of the river have an ‘U’ shaped valley and the bed load are smooth pebbles and cobbles, which is an indication of a mature stream (Fig. 31). The depositional pattern of debris along the river banks after flooding can be seen in Figure 32. After flooding, the granular debris will be deposited adjacent to the channel and finer debris away from the channel. This type depositional pattern has been observed in this portion of the channel (Fig. 33-36).

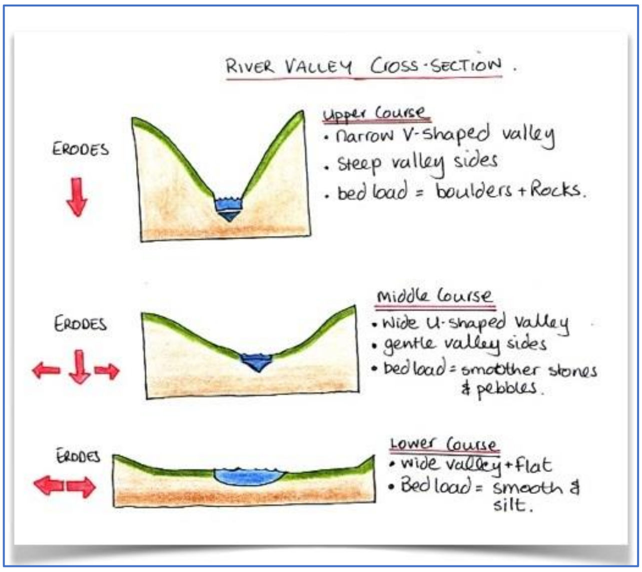

Figure 31: River valley cross-section (Source: https://garsidej.wordpress.com/year-7/rivers/)

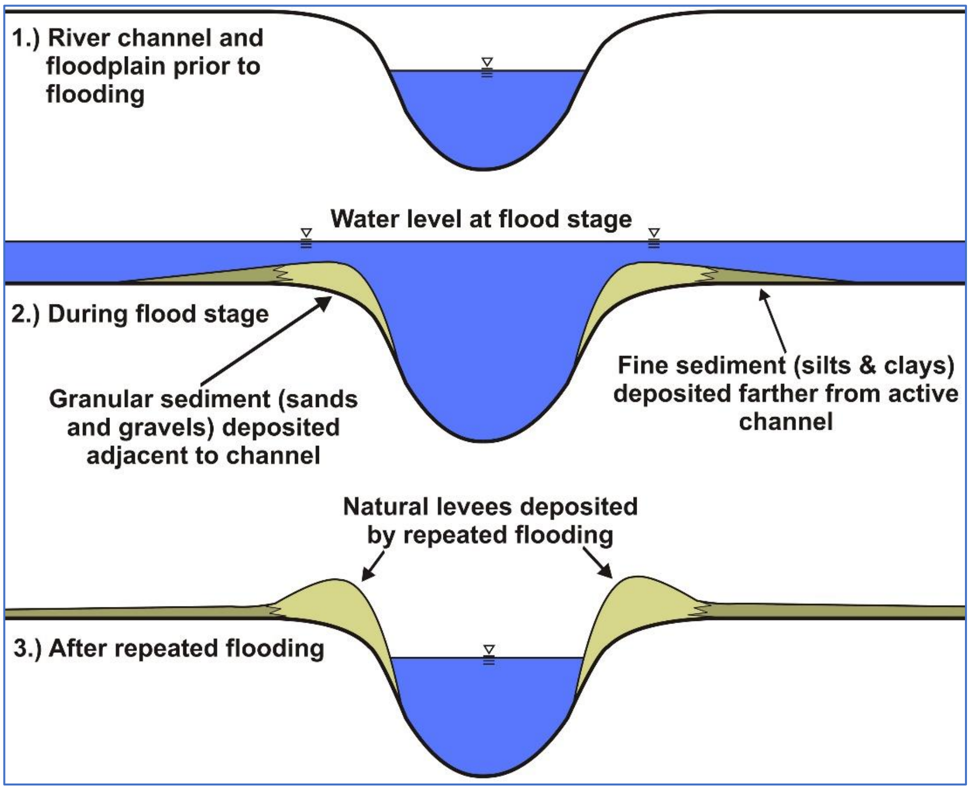

Figure 32: Depositional pattern of debris after flooding (Source: **Rogers, 2008**)

Figure 33: Granular debris deposition adjacent to the channel

Figure 34: Pebble and cobble accumulated along the bank (1)

Figure 35: Pebble and cobble accumulated along the bank (2)

Figure 36: Fine grained material accumulated away from the channel

IV. Findings

1. CHANGE IN RIVER COURSE (1977 – 2019) DUE TO ACCUMULATION OF DEBRIS – 2018 & 2019 FLOODS

Drainage congestion is one of the major causes of flooding (Ali et al., 2019; Bhattacharya et al., 2016; Dewan, 2015; Sahu, 2014). The IPCC Special Report on Extreme Events (SREX) (2012) estimated that in a normal year, river spills and drainage congestion cause inundation of 20–25% of the total area in Bangladesh (IPCC, 2012). The site falls in the Survey of India topographic map numbered 58 G/3. It is evident from the SoI topographic map that this river is a perennial one. The SoI topographic map (1977), September 2018 (Post-flood situation), and March 2019 have been used to assess the change in the river course. 7 transects have been created along the river channel and the widths of each transects have been noted using ArcGIS tools and Google Earth. It is evident that the floods of 2018 carried significant quantities of debris from upstream prestine hills which could not be carried further down in suspended state by the river beyond the Pamba Triveni confluence. This resulted in large quantities of debris being deposited in the areas that are used by pilgrims since time in memory as may be seen from the 1977 Survey of India Topographic Sheet.

This caused damage to the infrastructures and the floodplains and stream channel were completely covered by the debris. The change in the river channel width during this period shows drastic increase ranging between 66% - 247% from 1977 to 2018. The debris was partially cleared after the 2018 floods to ensure the flow of water (Fig. 37-43). In 2019 during the Floods of the year in the months of July and August, more debris was deposited in the confluence. Hence the stream channel does not have the capacity to drain the excess water and not in a condition as in the year 1977. 48-94% decrease was identified when compared with the width of channels as against the topographic map. The change in river course and the deposition of debris in the river channel can be observed in the Figures 44-47 and Table 1-2.

The accumulation of debris in the channel resulted in local flooding and this situation can cause flooding in the downstream also. This is because of the reduction of the stream channel capacity. When the stream channel in the upstream area is filled with debris, it obstructs the flow of water and this will lead to change in the course of river and results in levee breech. Such levee breach as observed in 2018 will further reduce and aggrevate the public & religious purposes for which Hon’ble Supreme Court has provided the land in Pamba Triveni area. Further, the reduction in the upstream containment capacity due to deposited debris transfers the flooding risk, to downstream more populated areas.

Figure 37: The Chairman, DDMA monitoring in the clearing of debris (Source: **District Administration, Pathanamthitta**)

Figure 38: Clearing of debris (1) (Source: **District Administration, Pathanamthitta**)

Figure 39: After the clearance of debris from the river channel (Source: **District Administration, Pathanamthitta**)

Figure 40: River channel (view from Triveni bridge) after the clearance of debris (Source: **District Administration, Pathanamthitta**)

Figure 41: The stream channel after the clearance of debris (Source: **District Administration, Pathanamthitta**)

Figure 42: Clearance of debris accumulated over the Triveni bridge using Earth movers (Source: **District Administration, Pathanamthitta**)

Figure 43: Triveni bridge (September 15, 2020)

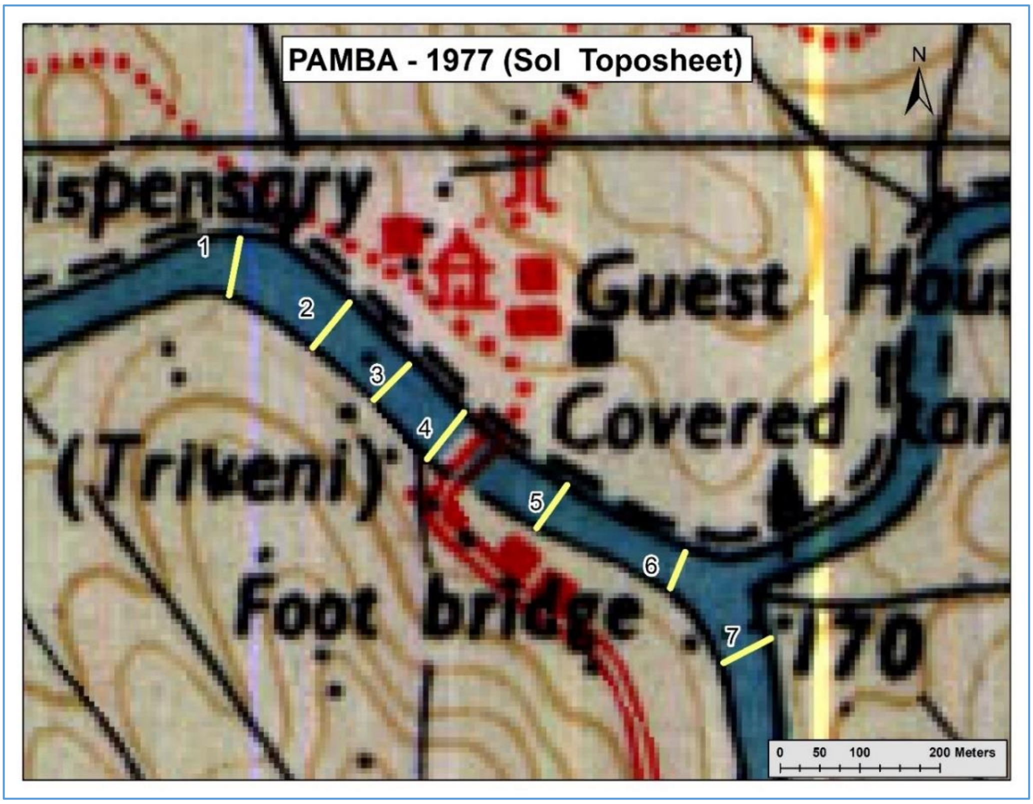

Figure 44: River course (Source: **Survey of India topographic map numbered 58G/3**)

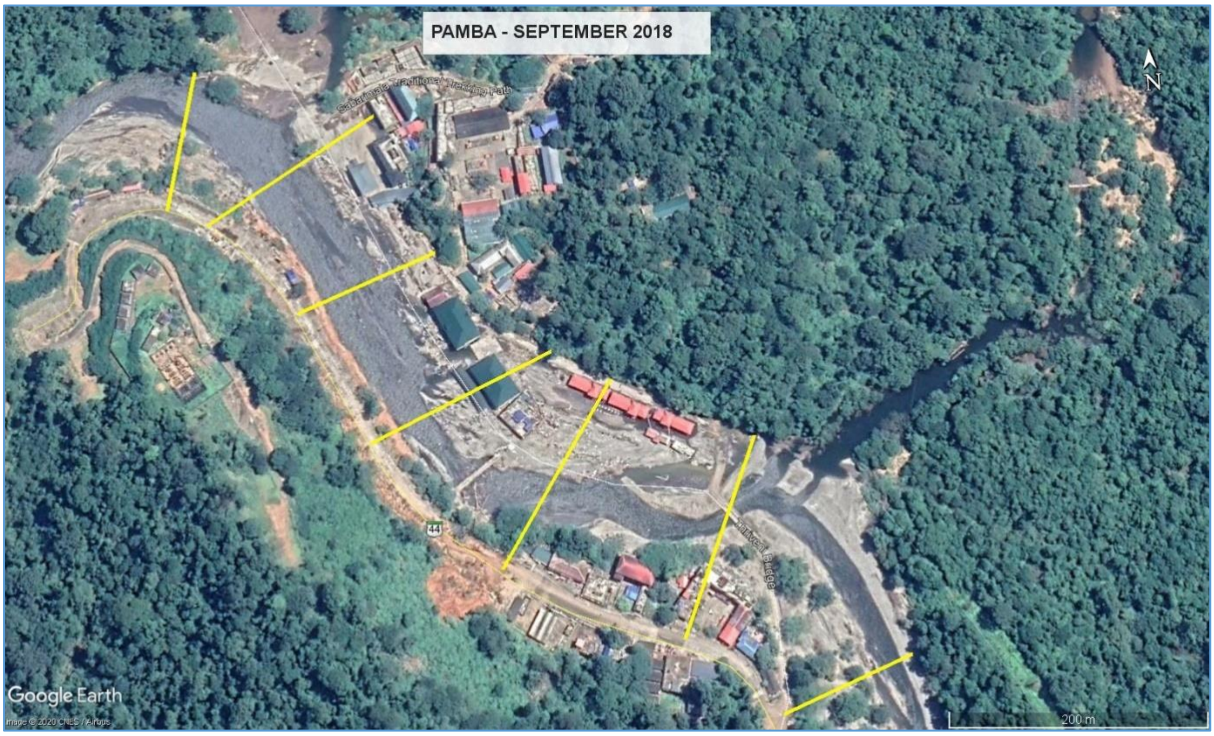

Figure 45: River course after the 2018 Floods (Source: **Google Earth**)

Figure 46: River course as on March 2019 (Source: **Google Earth**)

Figure 47: River course after partial clearance of the debris (Source: **Google Earth**)

	Transect 1 (M)	Transect 2 (M)	Transect 3 (M)	Transect 4 (M)	Transect 5 (M)	Transect 6 (M)	Transect 7 (M)
SoI Topographic map (1977)	72.3	72.8	61.8	74.46	65.97	48.69	66.81
Google Earth (Sept. 2018)	122	165	123	162	173	169	111
Google Earth (March 2019) – Width of Debris covered area	85.6	85.7	82.2	87.0	58.0	113	36.9
Google Earth (March 2019) – Width of wetted area of the channel	12.3	11.5	31.6	20.4	14.8	11.4	3.58

Table 1: Change in river width from 1977-2019

Change	Transect 1 (%)	Transect 2 (%)	Transect 3 (%)	Transect 4 (%)	Transect 5 (%)	Transect 6 (%)	Transect 7 (%)
1977 - 2018	**+68.74**	**+126.64**	**+99.02**	**+117.56**	**+162.24**	**+247.09**	**+66.14**
1977 - 2019	**-82.98**	**-84.20**	**-48.86**	**-72.60**	**-77.56**	**-76.58**	**-94.64**

Table 2: Change in river width (in percentage) with reference to the SoI topographic map

From the figures 44 to 47, it is evident that the floods of 2018 and 2019 deposited significant quantities of debris.

2. ISSUES RELATED TO DUMPING OF DEBRIS ON FOREST LAND

The debris removed from the river channels were deposited in the areas suggested by the Forest Department (Chakkupalam, Hill top) (Fig. 48-50). Forest department should find suitable sites (preferably areas devoid of vegetation) near to Pamba Triveni to deposit such transported debris as, such extreme flood events may increase in frequency of occurrence as evident from various climate change scenarios.

It is also ideal to conduct a Strategic Environment Impact Assessment (SEIA) at the selected sites to quickly acertain the impact. Further, it is also appropriate to identify and include such sites within forest lands in the Depeartmental Disaster Management Plan of Forest Department (which is a statutory requirement under Section 40 of the Disaster Management Act, 2005) for depositing such environmental debris resulting out of natural disasters so as to maintain the channel depth and width and thereby reduce the flood impacts downstream.

Figure 49: Chakkupalam (1)

Figure 50: Chakkupalam (2)

Figure 51: Top portion of the Chakkupalam site – Destruction of vegetative cover

3. EROSION OF DEPOSITED DEBRIS

Forest Departmnet has to put in measures in place to prevent the erosion of deposited debris from the site (Fig. 52-53). It is ideal to examine the usable sand quantity from the deposited debris and use for construction purposes as part of the Rebuild Kerala Development Programme (Post Flood Reconstruction Programme of Kerala) or other major development projects. Until such consences is arrived at, the Forest Department may attempt to cover the entire deposited debris with geotextile and stabilize it.

Under Section 39 (C) of the Disaster Management Act, 2005 it is the statutory obligation of Forest Department to allocate funds from its own sources for disaster mitigation. The Department should comply with this statutory direction and ensure that the debris does not drain back into the river.

Figure 52: Loss of debris due to erosion at Chakkupalam site

Figure 53: Erosion at Chakkupalam site

V. Technical Recommendations

- The Kerala Forest Department should immediately comply with Section 39 and Section 40 of the Disaster Management Act, 2005 and prepare the departmental disaster management plan and submit to KSDMA. The template for the same may be found here https://sdma.kerala.gov.in/templates/
- The Departmental Disaster Management Plan of Forest Department should include measures and funds for maintaining the depth and width of river channels within forest areas every year so as to ensure the minimum width of channel as given in the Survey of India Topographic Sheet. Such a plan and funds allocated under Section 39 (C) of Disaster Management Act, 2005 will ensure that such litigations do not arise in Forest areas such that when Disaster Management directions are issued by State/District Disaster Management Authorities, the Forest Department themselves will be able to undertake the required measures urgently without any delay.
- Forest Department should ascertain the usable sand content through College of Engineering, Thiruvananthapuram in the deposited debris and utilize it for construction purposes related to Rebuild Keralsa Initiative (Post flood reconstruction programme) and major Governmental Projects in the State. It is warned that leaving the debris as is will result in erosion problems and invite Audit remarks for wastage of valuable resources.

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