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2019-FLASHFLOOD IMPACTS OF KAPILA RIVER ON TEMPLE TOWN OF NANJANGUD, KARNATAKA, INDIA

Manjunatha M.C[1], Basavarajappa H.T[2]

DBT-Builder, JSS-AHER, Sri Shivarathreeshwara Nagara, Mysuru-570 015[1]

Department of Studies in Earth Science, Centre for Advanced Studies in Precambrian Geology,

University of Mysore, Manasagangothri, Mysuru-570 006[2]

Abstract: India is extremely liable to floods and out of the overall region of 329 mha, over 40 mha is flood prone. Floods are recurrent phenomenon, which cause huge loss of lives and damage to livelihood system, loss of domestic animals, property, infrastructure and public utilities. It is a cause for great concern that the increasing trends are noticed to be high in connection with flood damages. This can be attributed to many reasons including rapid increase in population & urbanization coupled with growing developmental and economic activities in the floodplains and global warming. Continuing and large scale loss of lives and damage to public and private property due to floods indicate that it still need to develop an effective response to floods. The present study aims to strengthen the existing criteria for flood preparedness and to minimize the risk analysis in Kapila River floodplains of Nanjangud. Limited field visits are carried out during & after flood impacts and field photographs has been effectively collected. Survey of India (SoI) topomap, IRS-1D, PAN+LISS-III and ASTER G-DEM satellite data are processed through GIS environment. It is hoped that this humble effort will prove useful to decision makers in formulating effective Flood Management Plans in the future for similar geological terrains.

Keywords: Flash Flood; Nanjangud; Structural lineaments; Risk Management.

1. INTRODUCTION

Flooding in the cities and the towns is a recent phenomenon caused by increasing incidence of heavy rainfall in a short period of time, indiscriminate encroachment of waterways, inadequate capacity of drains and lack of maintenance of the drainage infrastructure (NDMA, 2008). Keeping in view the fact that the problem is becoming more severe and losses are mounting every year (NDMA, 2008). 80 percent of the precipitation takes place in the monsoon months from June to September in which the major rivers bring heavy sediments load from those catchment areas (NDMA, 2008). These coupled with inadequate carrying capacity of the rivers are responsible for causing floods, drainage congestion and erosion of river-banks (NDMA, 2008). Floods being the foremost common natural disaster, people have, out of experience, devised many ways of handling them. However, encroachments into the flood plains over the years has aggravated the flood problem and a need to take effective and sustained Flood Management (FM) measures (NDMA, 2008).

Flood like situation has erupted at temple town of Nanjangud as heavy cusecs of water has been released to Kapila River from Kabini reservoir of H.D Kote taluk. Following heavy rains for the continuous two days on 8th and 9th Aug 2019 in Wayanad of Kerala state, Kabini reservoir received a huge inflow of over 1.25 lakh cusecs with the water level just 2 ft away from its optimum dam level. Water outflow from three dams such as Kabini, Taraka and Nugu to Kapila River has increased to 1.25 lakh cusecs on 10th Aug 2019. With the river overflowing, Nanjangud is under the threat of flashfloods every year. The study area lies in between 76^{0}31' to 76^{0}44' and 12^{0}04' to 12^{0}10' with an aerial extent of 135.59 km^2 (Fig.1) and general elevation of 779 mts above MSL (Manjunatha and Basavarajappa, 2020). The average annual temperature ranges from 15^{0}C to 34^{0}C and may rise up to 38^{0}C in extreme summers. Major part of rain is received during monsoon period with moisture laden winds and invariably associated with violent thunderstorms and lightening. Nanjangud lies on the banks of the river Kapila (Kabini) and 23 km from the city of Mysuru. Nanjangud is famous for Srikanteshwara Temple also called as "Dakshina Kashi" (Southern Kashi) and also famous for a variety of Banana grown in the region, the Nanjanagoodu rasabale.

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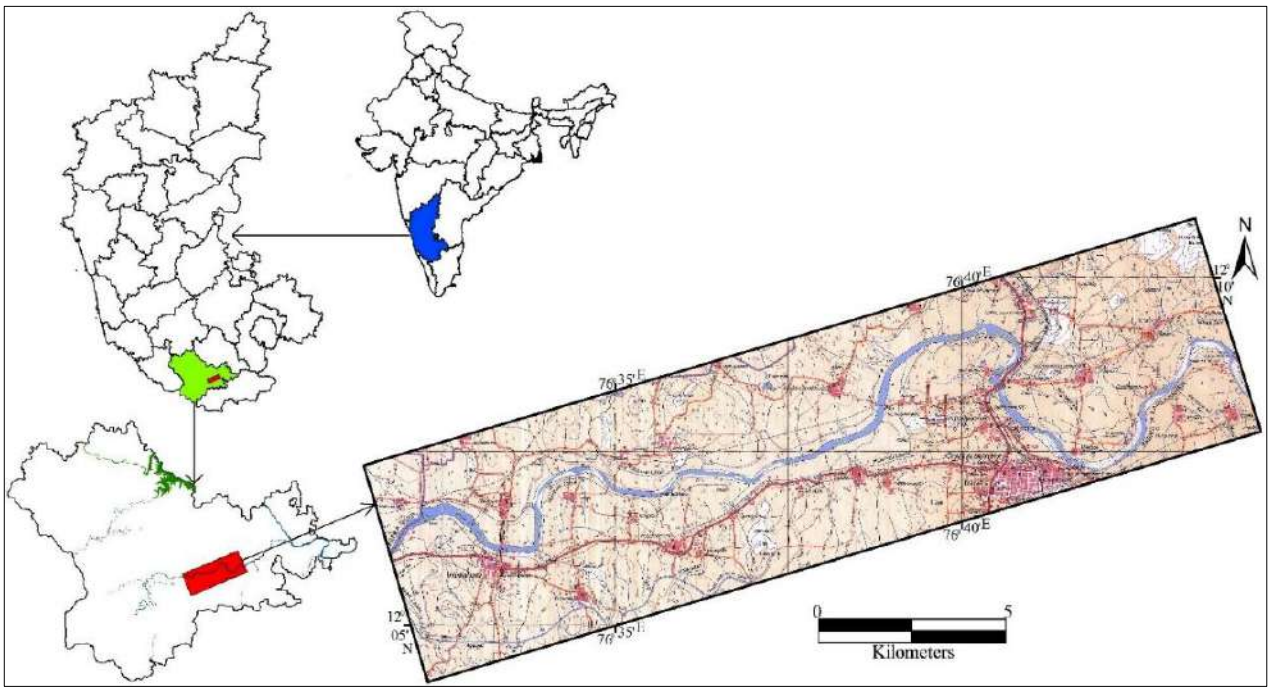

Fig.1 Topomap & location of the study area

2. METHODOLOGY

Survey of India toposheet of 1:50,000 (Fig.1) scale are effectively utilized in digitization and extraction of the base maps through Visual Image Interpretation Techniques (VIIT); whereas Digital Image Processing (DIP) have generated using PAN+LISS-III and ASTER G-DEM (Global Digital Elevation Model) satellite images through ArcGIS software (Manjunatha et al, 2015). Lithology map is derived from Quadrangle map of GSI number 48P and 57D of 1:250,000 scale; whereas structural lineaments map are extracted from PAN+LISS-III image of 5.8m resolution (Fig.2) (Manjunatha and Basavarajappa, 2017) and slope map is derived digitally from ASTER GDEM image (Fig.3) (Love Kumar., 2017). Wastelands were identified using SoI toposheets; while loamy soil type digitized from satellite Images (NBSS & LUP, 2013) (Fig.7). Structural lineament/ faults along with geological formations were studied during field survey and overlaid as a thematic map (Fig.6) (Love Kumar, 2017).

2.1 Materials used

i. **Survey of India toposheets:** 57D/12 and 57D/16 of 1:50,000 scale, Survey of India, Bangalore region, Bengaluru.
ii. **Satellite Imagery:** IRS-1D, PAN+LISS-III image of 5.8m Resolution (dated: 12th Jan 2002) and ASTER G-DEM with 30m resolution (dated: 17th Oct 2011), NRSC-ISRO, Hyderabad; USGS, Earth Explorer website.
iii. **Thematic layers:** Lithology, Lineament, Soil type, Slope and Wasteland type.
iv. **GIS Software's:** ArcGIS v10 and PCI Geomatica v16.

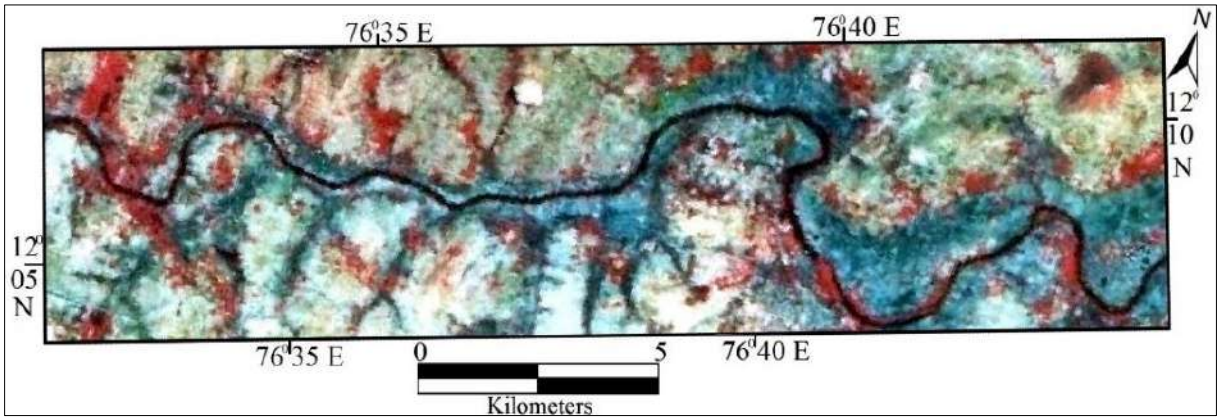

Fig.2 IRS-1D, LISS-III Satellite image of the study area

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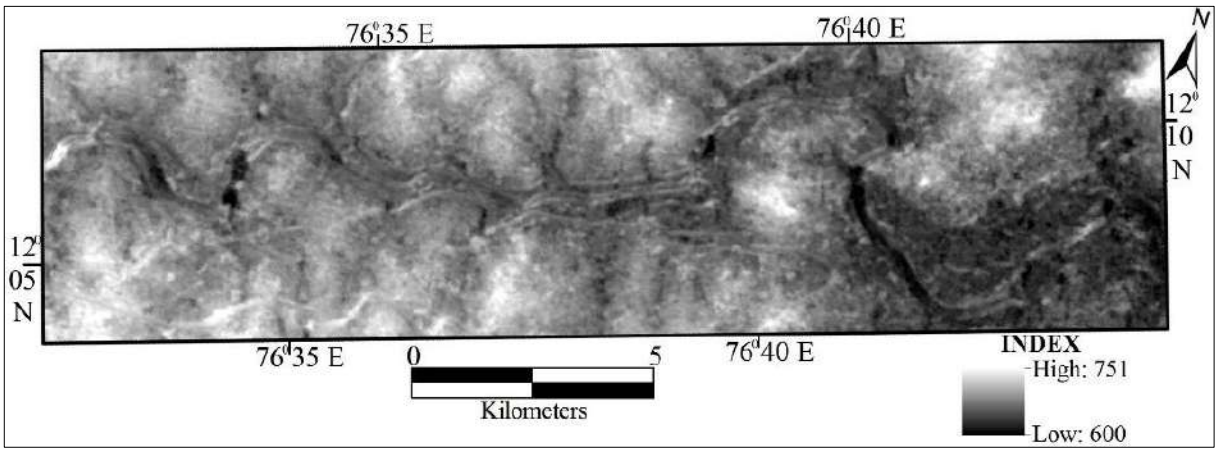

Fig.3 ASTER G-DEM image of the study area

3. 2019-FLASHFLOOD IN THE STUDY AREA

The revival of southwest monsoon since the last three days (8th, 9th & 10th Aug 2019), after a brief full has led to heavy rain in Wayanad district of Kerala which has augmented the inflow and outflow from Kabini Dam in H.D. Kote taluk. The overflow of Kapila River had led to water release from Kabini Dam for the third time during the monsoon of 2019. While the release of 80,000 cusecs of water from Kabini Dam on 9th Aug caused the 'flash flood' by blocking the Mysuru-Nanjangud National Highway (NH-766) due to waterlogging (Plate-II: 13a, 14a & 16a). Vehicles moving from Mysuru to Nanjangud and from Gundlupet to Mysuru were diverted via Kadakola Industrial area and were let to enter the temple town through Basavanapura (Fig.4). Civic authorities have alerted flood warning in low-lying areas of the temple town and have asked the residents to move to safer locations along with their belongings and livestock (Plate-II: 11a & 12a). Police personnel stopped the vehicles on the highway for a while with water level rising throughout the day (Plate-II: 14a). Meanwhile, overnight rains on 10th Aug 2019 which continued on 11th Aug 2019 (Friday) morning hit normalcy in the temple town. With Friday being the Varamahalakshmi festival, most of the devotees were left disappointed as they could not reach the temples (Plate-II: 17a).

3.1 Damage Assessment: Discharge of 1.25 lakh cusecs of water from the Kabini, Taraka and Nugu reservoirs has inundated the temple town of Nanjangud which resembled an island on Friday (11th Aug 2019). The Irrigation Department had assessed the affected areas of flood damage in the taluk. The drone photos clearly captures the areas submerged including the Sutturu Mutt in the taluk turning into an island (Plate-I; Plate-II; Plate-III). Most of the prominent temples, including the famous Srikanteshwara temple (Plate-I: 1a; 2a), Ayyappa Temple, Parashuram Temple (Plate-III: 21a), Chamundeshwari Temple, Chikkamma ChikkaDevi Temple were flooded due to high rise in Kapila River as incessant rain occurred in Wayanad district of Kerala state. Meanwhile, a person was killed in house collapse at Veeranahosahalli. Madapura, Bidirahalli and Hommaragalli bridges had submerged in high flowing river water. Water has gushed into houses at Kurubageri, Halladakeri, Gowri Ghatta Beedhi, Chamarajanagar bypass roads are also inundated (Plate-II: 11a & 12a).

The Karnataka-Kerala main road has been blocked as the road at Mallanamule Mutt is marooned (Plate-I: 7a; Plate-II: 17a & 18a; Fig.4). Meanwhile the river is roaring and iconic 16 Kaalu Mantapa (16 Pillar Pavilion) has submerged in the river and only tomb on the top is visible (Plate-I: 3a, 4a; Plate-II: 10a). The water level at the river is touching the stairs of bathing ghat (Snanaghatta and mudikatte) triggering danger (Plate-I: 5a). As a precautionary measure, devotees are restrained from visiting Parashurama temple (Plate-III: 21a). The river level has also touched the Kabini bridge near Basavanapura on Mysuru-Nanjangud (Plate-I: 6a). District administration has alerted villagers in the downstream to take necessary arrangements for safety and warnings had issued against venturing near the river. Most of the areas in Nanjangud have turned into islands due to the overflowing of Kabini River resulted in damages to 379 houses, 3 cattle shed and farmers have suffered crop loss due to flash flooding. Halladakeri, adjacent to Srikanteshwara Temple is flooded and residents have been moved to safety (Plate-II: 11a, 12a). The district administration has opened a several relief centers in the town and shifted peoples safely. Drinking water supply showed the pollution of industrial effluents, agricultural runoff, domestic and municipal sewage contributions (Azadeh and Basavarajappa, 2012).

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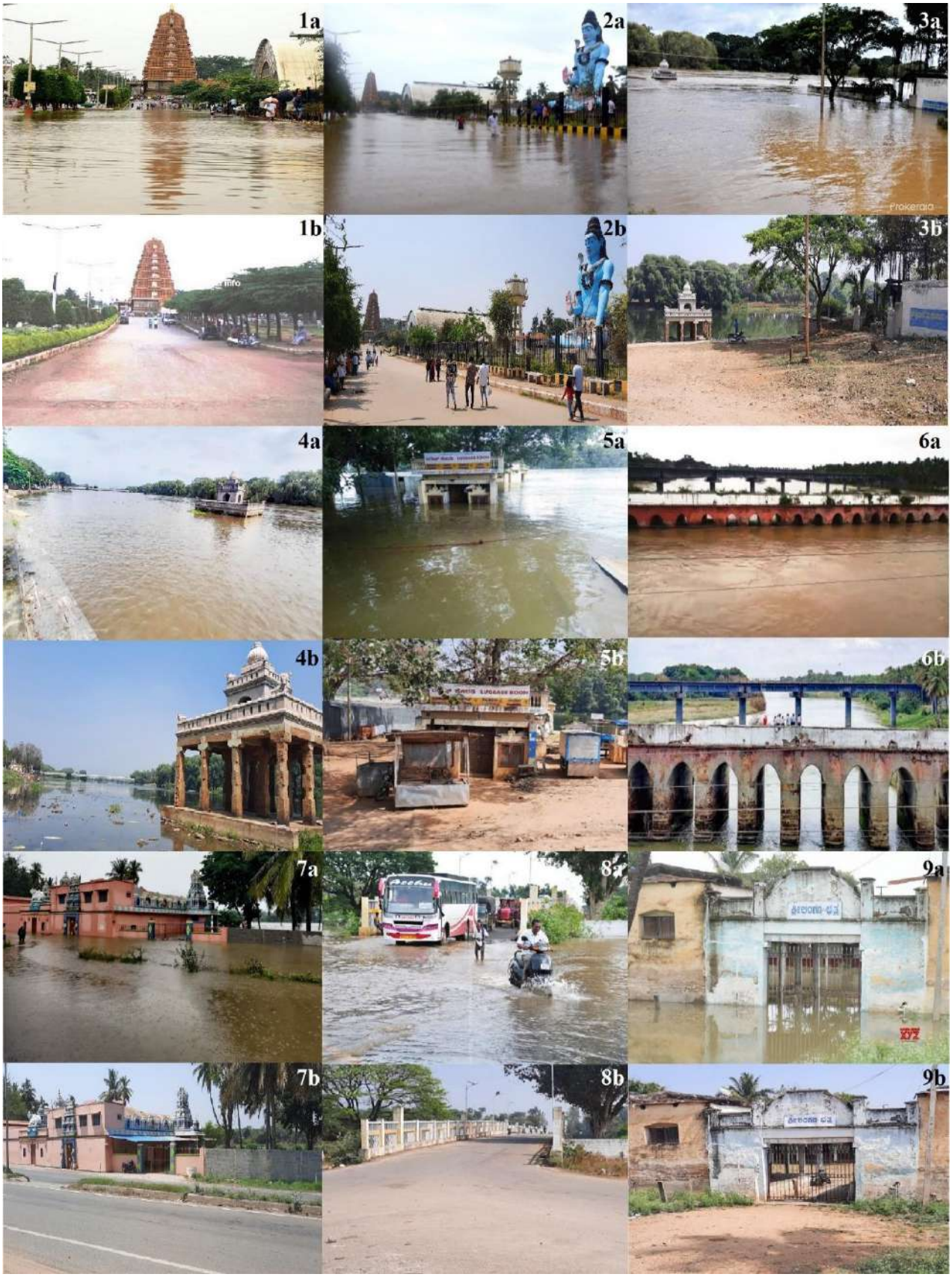

Plate-I: (a) During and **(b)** After the Flashflood impacts of Kapila River on **1 & 2.** Srikanteshwara Swamy Temple; **3 & 4.** 16 Pillar pavilion; **5.** Bathing ghat; **6.** Rising water levels near Nanjangud-Mysore connecting bridge; **7.** Mallanamoole Mutt; **8.** Bridge connecting Nanjangud temple to Hejjige village; **9.** Sri Linganna choultry

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Plate-II: (a) During and **(b)** After the Flashflood impacts of Kapila River on **10.** 16 Pillar tomb; **11 & 12.** Streets near Main temple; **13.** NH-712 near Mallanamoole Mutt; **(i)** Nanjangud Water works; **(k & l)** Road block of NH-766 from Mallanamoole Mutt till Mysore Paper Mills Kapila river water submergence **(a, b, c d & e)** Blocking the road between Mallanamoole Mutt to Mysore Paper Mills on NH-766; **(f)** Submergence of Parashurama Temple

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Plate-III: (a) During and **(b)** After the Flashflood impacts of Kapila River on **19.** Submergence of Sutturu Math turning into an island; **20.** Overflowing on bridge connecting between Mysuru-Hosakote and Sutturu Math; **21.** Submergence of Parashurama temple turning into an island too

3.2 Impact on agricultural activities: More than hundred acres of standing crops, agricultural plantation & others were damaged due to flood. After the water release from Kabini last month (July-2019), farmers had tilled their lands and had sowed paddy and even transplanted them into fields and hoping for a better crop yield with enough water supply. More than 100 acres of agricultural lands were damaged by high flowing water levels during 2019-flashflood. This adversely affected the crop production due to heavy rainfall and long duration of waterlogging.

3.3 Relief centers: Most of the bridge connectivity between Karnataka, Tamil Nadu and Kerala witnessed huge traffic and also at several other places. The District Administration Authority had opened 11 relief centres and 2 cow care centers to provide shelter for 1,277 people and 75 animals respectively. Two low-lying localities in Nanjangud have been partially submerged and four families were relocated to Girija Kalyana Mantapa. One more relief center (Ganji Kendra) was opened as a temporary shelter for 8 families at Dasoha Bhavan in Srikanteshwara Swamy Temple.

3.4 Traffic Diversion: A stretch of Mysuru-Nanjangud highway, which is part of National Highway 766, that connects Bengaluru with Ooty, remained out of bounds for the third day on 11th Aug 2019 (Sunday) with flood water overflowing on the highway (Plate-II: 13a, 14a, 16a). As the NH 766 connects to Tamil Nadu and Kerala, the travelers have been inconvenienced with the traffic being diverted. Due to heavy outflow, several roads were blocked and a few bridges have washed away due to meandering of the Kapila River near Mallanamoole Mutt which widens up in its width (Fig.4 & 5). The road between Mallanamoole Mutt and South India Paper Mill has been blocked and there is over three to four feet of water on the road (Plate-I: 7a, Plate-II: 16a, 17a, 18a).

Table:1 Length-Wise Measurement of Regular and Traffic Diverted Roads

Sl. No	Existing Regular and Traffic Diverted Routes		Colour indicated in Map	Road length
1.	Regular Route	NH-766 from Kadakola to Nanjangud bridge	Red	7.23 km
	Existing Traffic Diverted Route	Diverted route from Kadakola along Adakanahalli Industrial Area, Thandavapura, Kempisidanahundi and Basavanapura to reach Nanjangud bridge	Yellow	10.04 km
Proposed Traffic Diversion Route Map				
2.	Regular Route	NH-766 from South Indian Paper Mills to Nanjangud bridge	Red	2.21 km
	Traffic Diversion Route	Diversion along Thandya Industrial Area (Sree LPG) road, Kempisidanahundi and Basavanapura to reach Nanjangud bridge	Light green	5.35 km

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Traffic between Mysuru-Nanjangud road near Mallanamoole Mutt, has been closed and diverted via Adakanahalli Industrial Area, Thandavapura and Kempesiddanahundi to reach Nanjangud which is a detour of about 10.04 km on the village narrow road (Fig.4; Table.1). While vehicles coming from Gundlupet are diverted towards Hullahalli Circle to reach Mysuru. Hejjige (Plate-I: 8a) and Ramapura bridges have been closed. Hommaragalli bridge connecting Nanjangud with H.D. Kote was inundated after heavy water discharge from Kabini dam. The bridge across Kapila near Sutturu village was submerged cutting off the link between Mysuru-Hosakote and Sutturu (Plate-III: 20a). Nearly 40 villages had lost proper connectivity due to overflowing of water. Crowds continued to throng places and clicking photos along high flowing of Kapila River of tourist interest caused more traffic conjunctions.

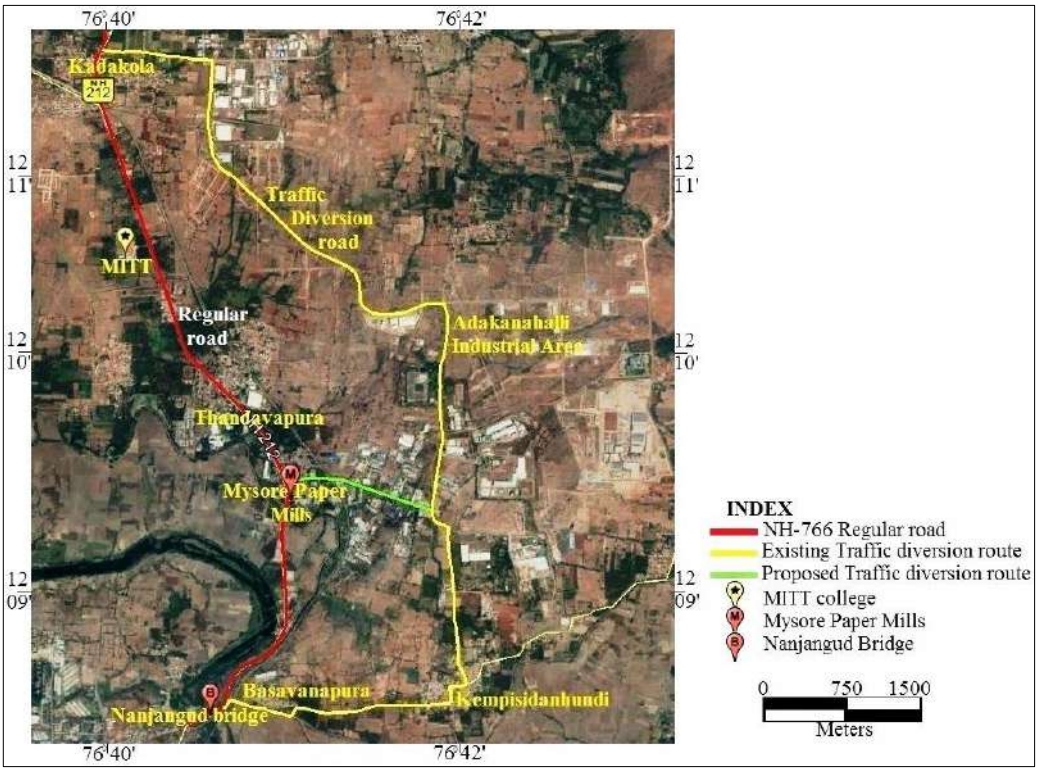

Fig.4 Existing Traffic Diversion Route and Proposed Diversion Route map

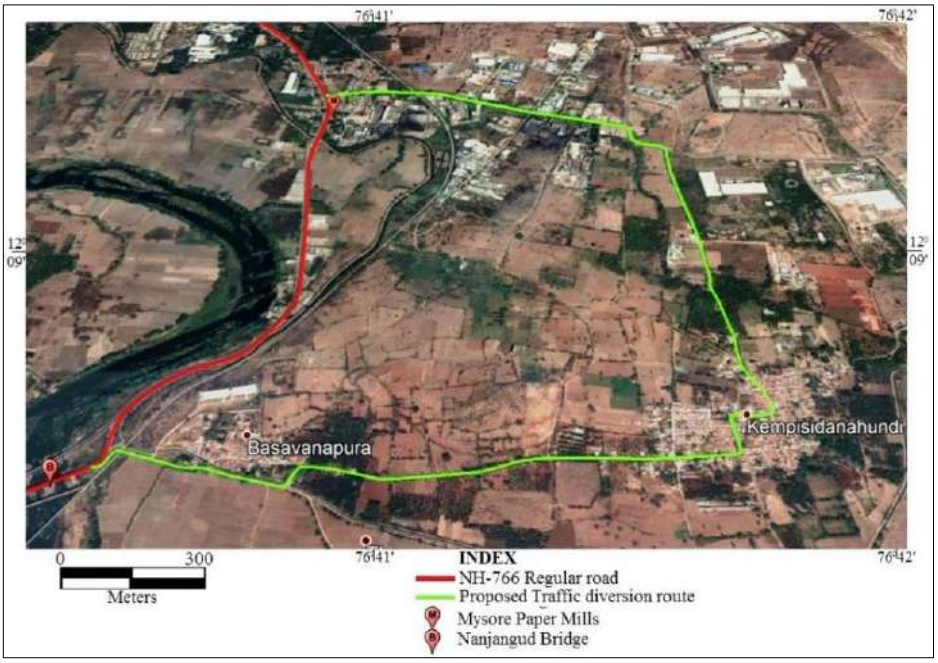

Fig.5 Proposed Traffic Diversion route map on for NH-766 during Flashflood impacts

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4 DISCUSSION

2019-Flashflood impacts of Kapila River resulted in economic impacts of industrial businesses, agricultural loss and socio-environmental damages that included evacuation, displacement & lose of life, damages of houses, and ultimate impacts on river ecosystem in the study area. East-West running lineaments in Karnataka state transports surplus groundwater from Western Ghats region to the eastern parts of the state (Naganna, 1979). Several structural lineaments/ joints/ fractures were identified near the villages of Hullahalli, Ramapura, Sarguru, Hosakote & Sutturu during limited field visits (Fig.6). Constructions of recharge trenches along interconnected major & minor lineaments/ fractures/ joints and suitable weathered zones arrest the flowing water and recharges to sub-surface zones. Check dams at regular intervals along the Kapila river flowing area would reduce the flow of sediments that needs to be extracted regularly every year before monsoon season arrival. This construction also recharges the groundwater on regional scales which minimizes its contribution to surface water flow.

Floodwater may be diverted to nearby abandoned Karya (Fig.9) and Sindhuvalli mining areas from left bank canal of river Kapila during high flow. Construction of percolation tanks, deeper recharge pits/ shafts on nearby identified wastelands (Fig.7) are the cost effective structures that recharge directly to sub-surface through less permeable zones. Mapping of old & abandoned dug, driven and drilled bore well locations need to be mapped along with their slope information (Fig.8) which may play great importance in storm water management. The dug wells penetrating through fractured zones are most preferred to be deepened for further injection of flood water. Growing crops of wheat, paddy and sugarcane which require more water supply on either sides of the Kapila River during monsoon season may be helpful. Increasing the number of nallas and streams on structural lineaments (Fig.6) may help in reducing the flash flood impacts. Proposed traffic diversion route map (Fig.5) may be helpful in better diverting the vehicles with reduced time, cost and distance.

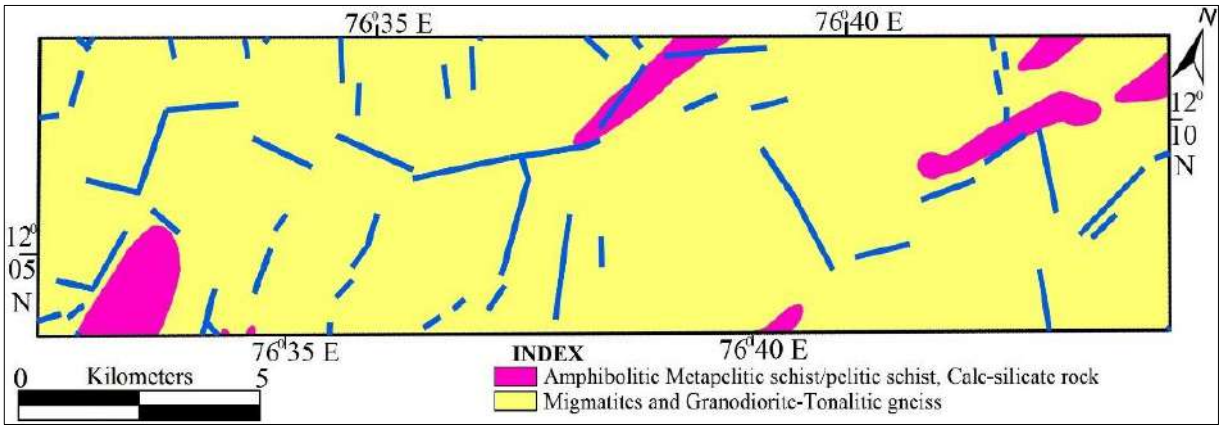

Fig.6 Lithology map of the study area

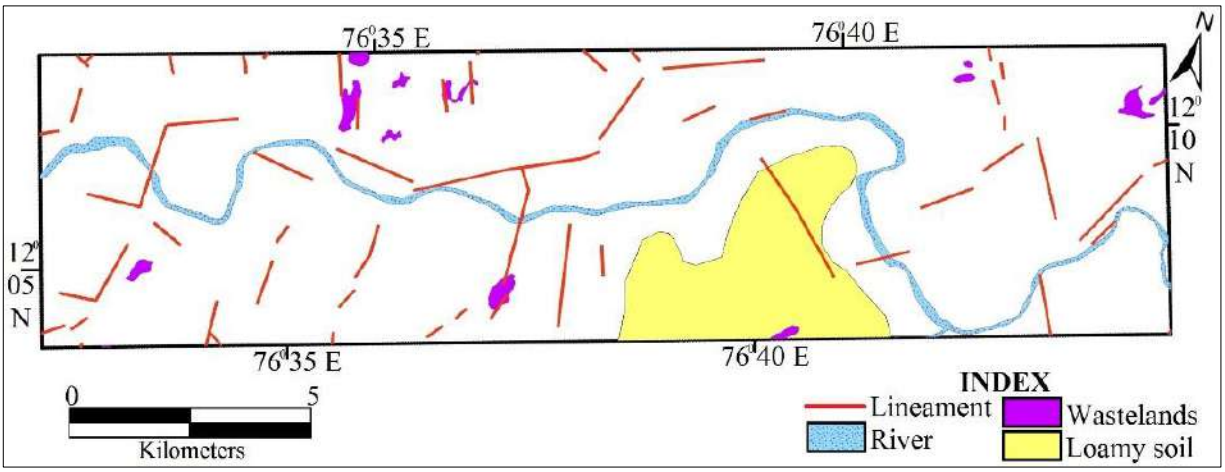

Fig.7 Lineaments overlaid Wastelands and Loamy Soil of the study area

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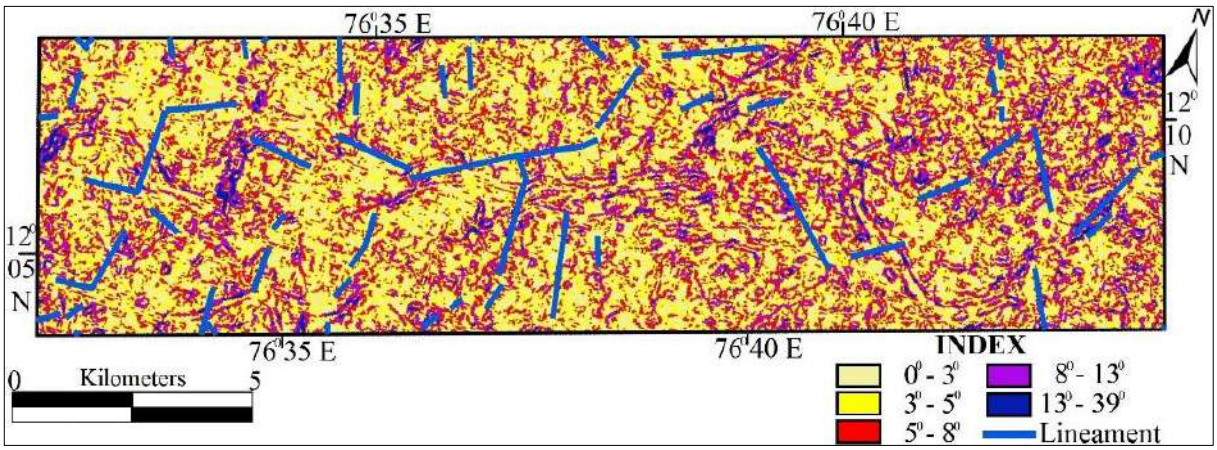

Fig.8 Slope map of the study area

Fig.9 (i) Field photograph and (ii) Google Earth Image of Karya Magnesite Mines, Kadakola town

5 CONCLUSION

2019-Flashflood impacts showed most adverse impacts causing more damage to life, property and economic in the study area. Frequent flood impacts of Kapila River had noticed during the month of August since from 2017 till 2021 in temple town of Nanjangud. It is necessary to map the flood risk hazard maps and optimal flood management strategies involving long term prevention before the next flashflood impacts (probably August-2022) the town. The quality of the drinking water supply had impacted with industrial & municipal untreated wastes and other organic pollutants. Public information and awareness programs are very much necessary to locate themselves along with livestock to the safest places before flashflood impacts.

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Conflicts of interest: The authors declare no conflicts of interest.

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BIOGRAPHIES

Dr. M.C. Manjunatha, is working as Assistant Professor in DBT-Builder Project, JSS-AHER, Mysuru, Karnataka, India completing 5 years of Teaching Experience and 9 years of Research Experience. He has published more **77** research papers in National/International peer reviewed journals/ Proceedings & **1 Chapter** in Springer. He has presented over **40** Research outcomes in National/ International Seminars and Conferences in the country and abroad and participated over 29 training programs in different states of India. Currently he is serving as **Editorial/ Review board Member** for 26 National and 8 International journals. He is also serving as **Lifetime Member** in Professional bodies of MSI & DoSGAA Mysuru; ISCA, Kolkata and IAEME, Chennai. His Google Scholar Citations score has reached **591** with **12** h-index. He had nominated for several Prestigious Awards & Professional Posts such as **Bharath Ratna Mother Theresa Gold Medal Award, Highest Honor of Prestigious Award, Bharath Shiksha Ratan Award, Super Honorary Doctoral Degree with Gold Medal Award** and **Editor-in-Chief** Post for International Journal of Remote Sensing & Letters, Taylor & Francis, UK.

Dr. H.T. Basavarajappa, is a Senior Professor of Geology in Department of Studies in Earth Science, Centre for Advanced Studies in Precambrian Geology, University of Mysore, Mysuru. He is also serving as Dean Faculty of Science and Technology in University of Mysore. He has received the **Young Scientist Award** from the **Karnataka Advanced Applied Science Association (KAAS)** in 1998 and **Vijayashree Award** by India International Friendship Society, New Delhi in 2005, in recognition of his merit and contribution to Earth Science. He has successfully guided **14** research students for their PhD degree, and also actively representing several scientific bodies on the Earth Science in our country. Presently serving as the **Coordinator** of the UGC-SAP CAS-I; **Chairman** of ISG-Mysore Chapter since from 2004; **Treasurer** of Mineralogical Society of India (MSI) from 2003 and **President** of DOSGAA since from 2008. He has successfully completed **6** Major Research Project under **UGC-MRP, UGC-CAS, ISRO-NRSC, DST** and **University of Mysore**. He has visited **France** (Paris) and **Germany** (Bonn University) during 1991 to participate in several international training programs on EPMA and Geochemical analysis. He has over **143** research publications to his credit. He has attended and presented about more than **106** research articles in conferences and seminars. He has also conducted successfully about **31** National and International Seminars/ Conferences/ Workshops/ Field Trainings in the department. He has edited **9** abstract Volumes/ proceedings. He has successfully adjudicated around **42** PhD thesis all over the country including the Technical Universities and has successfully guided around **45** Post Graduate Students during their dissertation work. He has been specialized in most of the analytical instruments in Geological aspects. He has successfully developed **2** scientific laboratory using advanced high-tech tools such as Remote Sensing and GIS.