United Nations
Educational, Scientific and
Cultural Organization

WATER, MEGACITIES AND GLOBAL CHANGE

1- 4 December 2015, Paris, France

UPSTREAM-DOWNSTREAM CONTAMINATION GRADIENT OF THE FLUVIAL URBAN SYSTEM IN CHENNAI (Tamil Nadu, India)

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Centre For Water Resources
ANNA UNIVERSITY CHENNAI
PROGRESS THROUGH KNOWLEDGE

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PROGRESS THROUGH KNOWLEDGE

Water
Uncontrolled Growth
Urban Sewer System

Urban activity
(Ag, Cd, Cu, Pb, Sn, Zn)

Chemical Industries
(Ag, Cd, Cu, Hg, Ni, Pb, Sn, Zn)

Urban River
Visible pollution
Non-visible pollution

Anthropogenic Sources

Air
Fossil Fuel Combustion
Motor Vehicle Exhaust

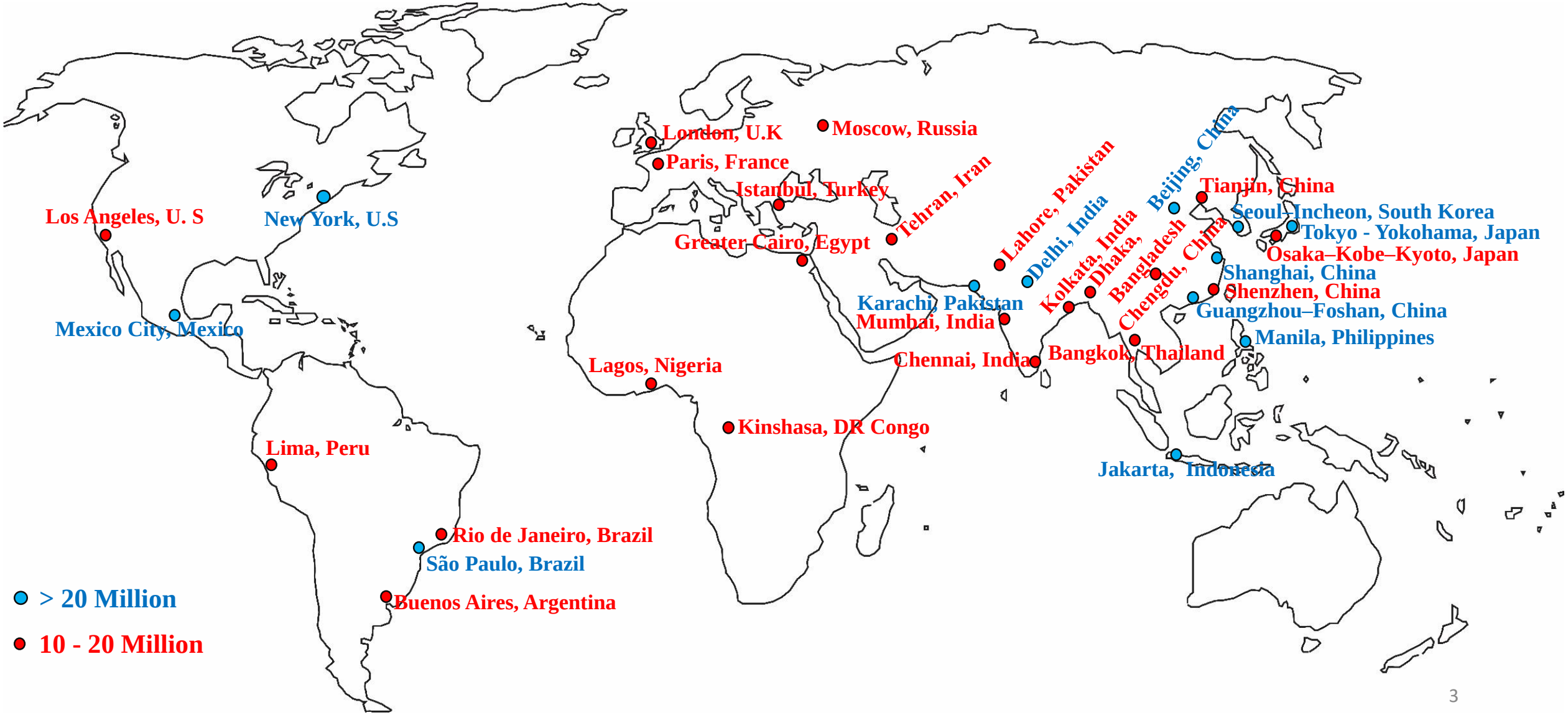
Soil
Metals & Metalloids
Elemental or Compound

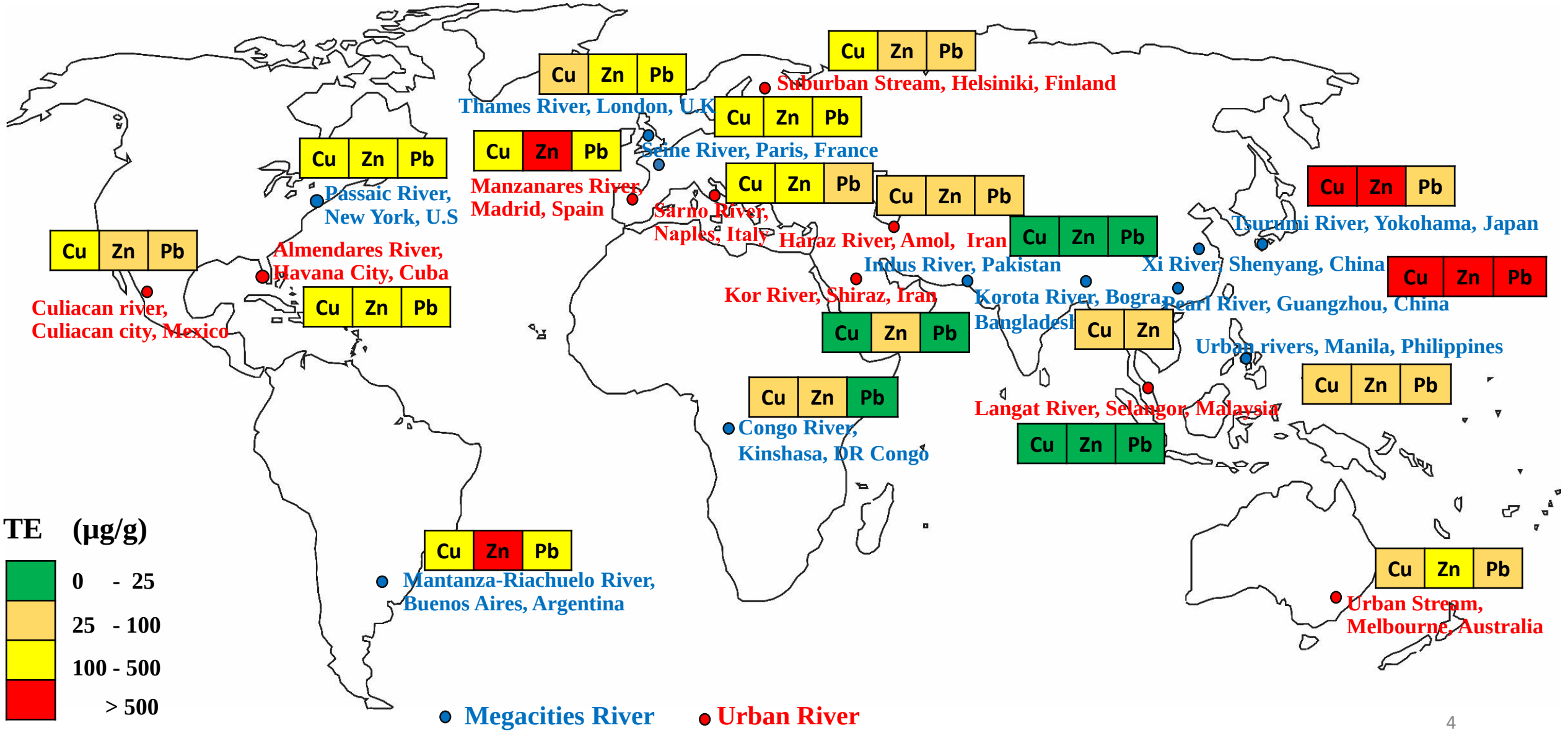
Urban River, Chennai, South India

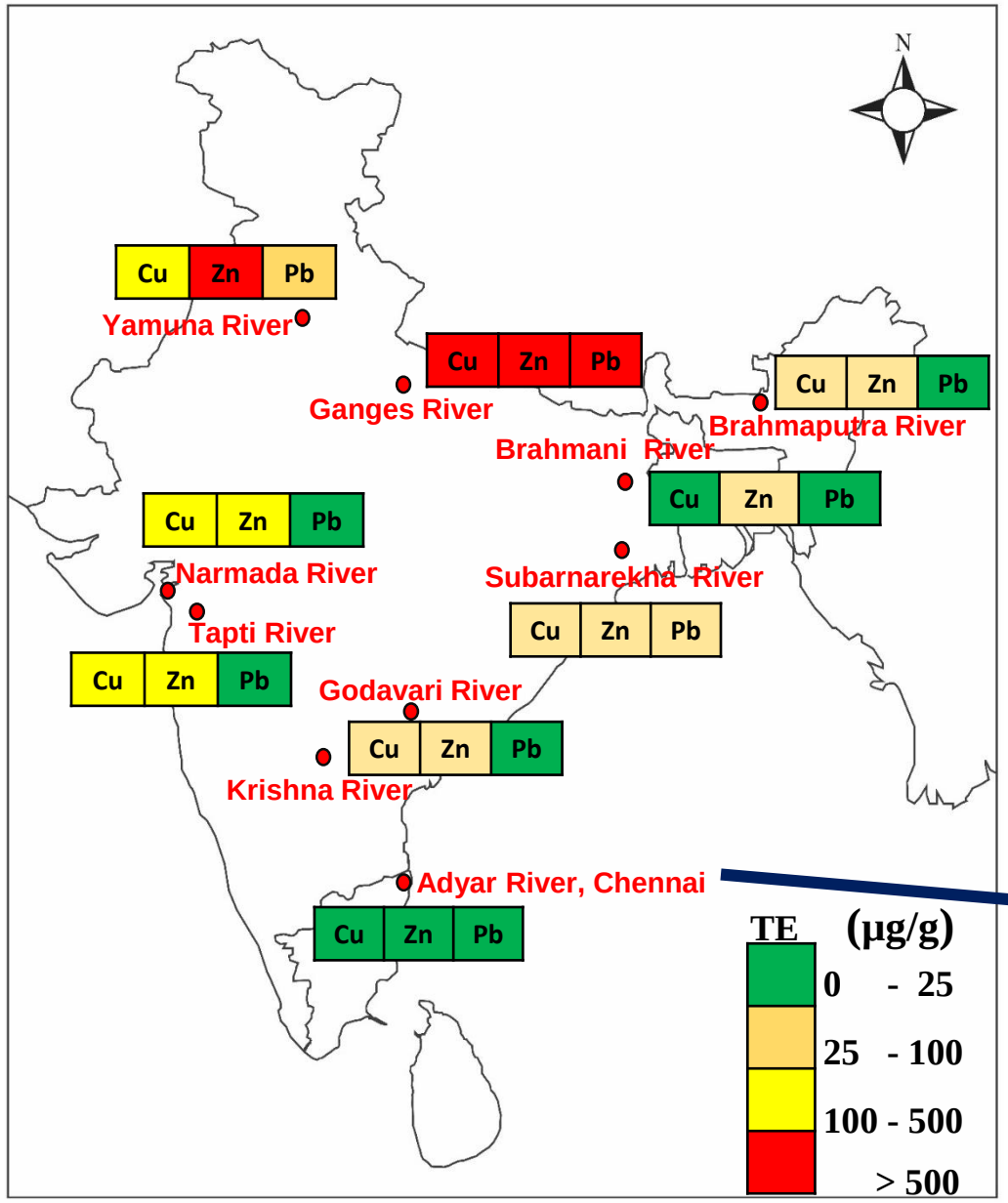
Electronic Industries
(As, Cd, Cu, Hg, Ni, Sb)

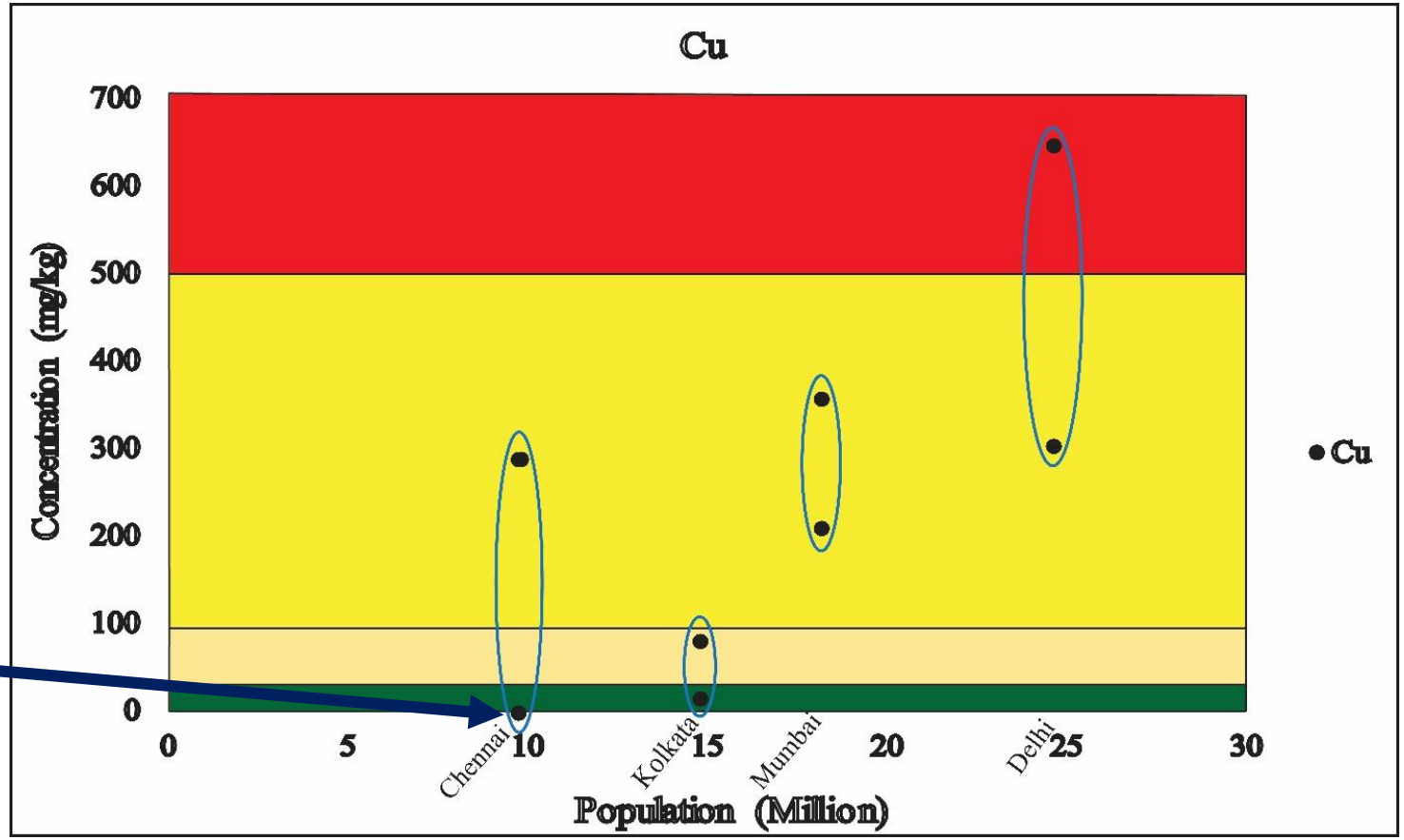
Mechanical Industries
(Cr, Cu, Ni, Sn, Zn)

MEGACITIES

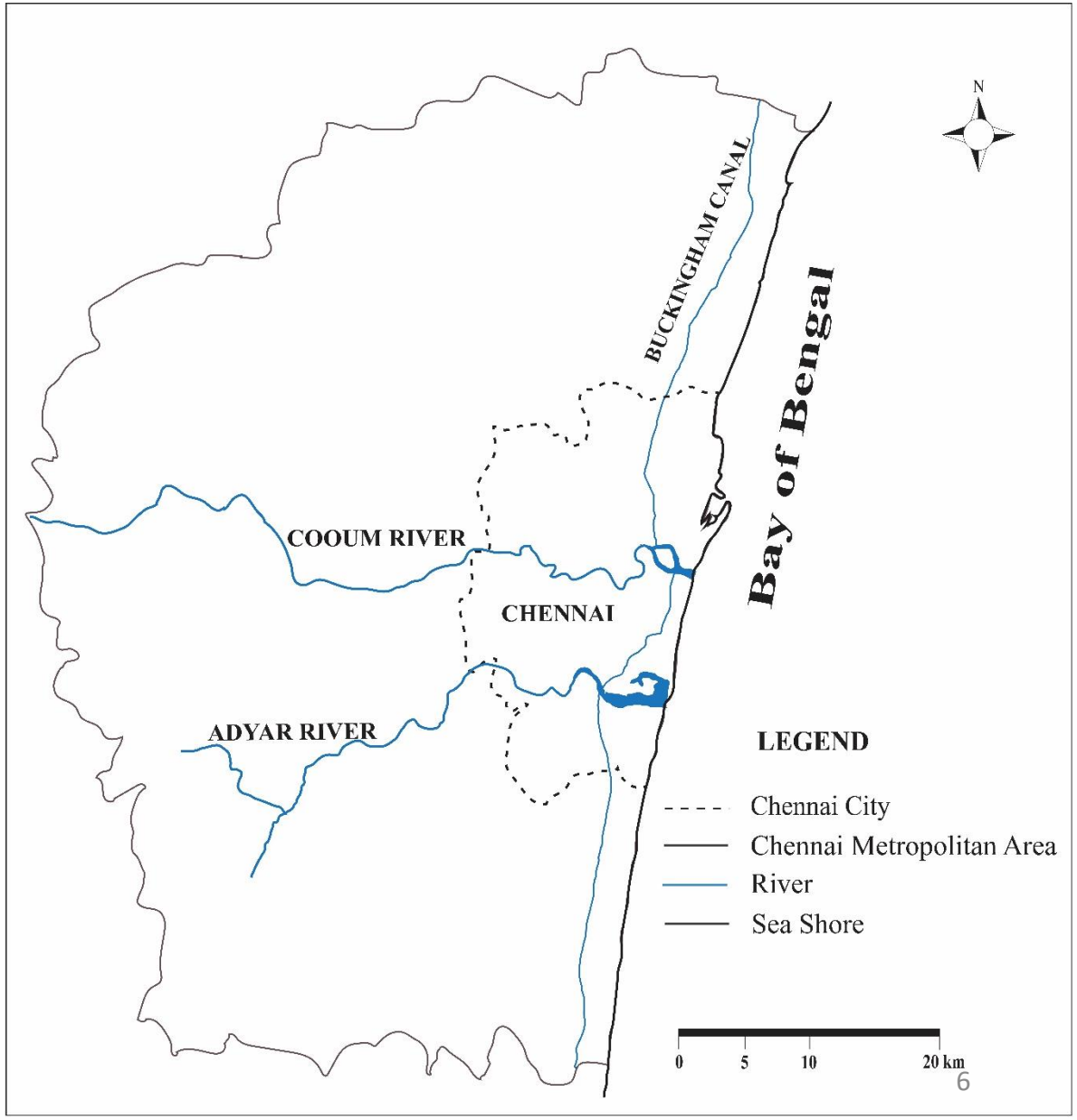

London, U.K
Moscow, Russia
Paris, France
Istanbul, Turkey
Tehran, Iran
Greater Cairo, Egypt
Lahore, Pakistan
Delhi, India
Kolkata, India
Dhaka, Bangladesh
Beijing, China
Tianjin, China
Seoul–Incheon, South Korea
Tokyo - Yokohama, Japan
Osaka–Kobe–Kyoto, Japan
Chengdu, China
Shanghai, China
Shenzhen, China
Guangzhou–Foshan, China
Manila, Philippines
Bangkok, Thailand
Karachi, Pakistan
Mumbai, India
Chennai, India
Jakarta, Indonesia
Los Angeles, U. S
New York, U.S
Mexico City, Mexico
Lagos, Nigeria
Kinshasa, DR Congo
Lima, Peru
Rio de Janeiro, Brazil
São Paulo, Brazil
Buenos Aires, Argentina
> 20 Million
10 - 20 Million


Cu Zn Pb
Suburban Stream, Helsiniki, Finland
Thames River, London, U.K
Seine River, Paris, France
Manzanares River, Madrid, Spain
Sarno River, Naples, Italy
Haraz River, Amol, Iran
Indus River, Pakistan
Kor River, Shiraz, Iran
Korota River, Bogra, Bangladesh
Congo River, Kinshasa, DR Congo
Langat River, Selangor, Malaysia
Tsurumi River, Yokohama, Japan
Xi River, Shenyang, China
Pearl River, Guangzhou, China
Urban rivers, Manila, Philippines
Urban Stream, Melbourne, Australia
Passaic River, New York, U.S
Almendares River, Havana City, Cuba
Culiacan river, Culiacan city, Mexico
Mantanza-Riachuelo River, Buenos Aires, Argentina
TE (µg/g)
0 - 25
25 - 100
100 - 500
> 500
Megacities River
Urban River


N
Cu Zn Pb
Yamuna River
Ganges River
Brahmaputra River
Brahmani River
Narmada River
Subarnarekha River
Tapti River
Godavari River
Krishna River
Adyar River, Chennai
TE (µg/g)
0 - 25
25 - 100
100 - 500
> 500


Cu
Concentration (mg/kg)
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Chennai
Kolkata
Mumbai
Delhi
Population (Million)
Cu

Study area : Urban Rivers in Chennai City



Chennai flooding- November 2015

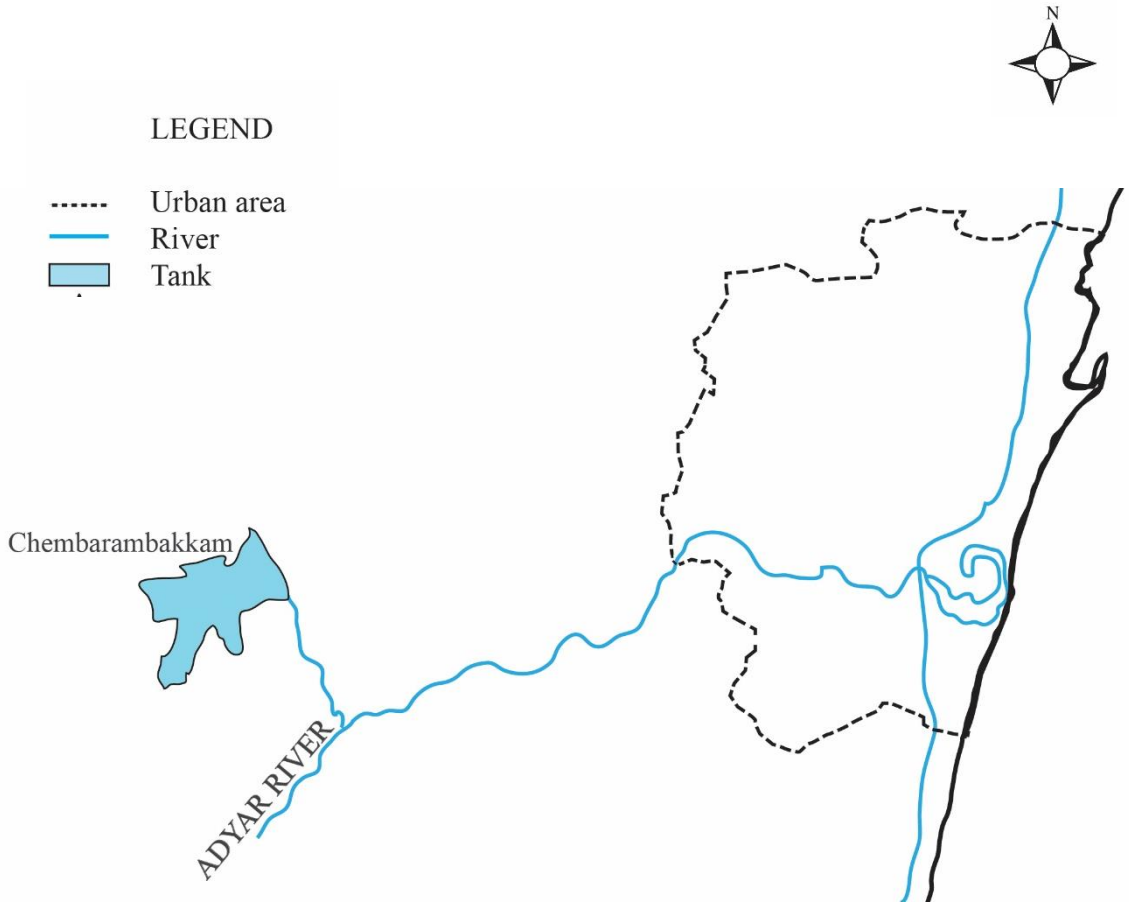
நாள். 01.12.2015

அவசரச் செய்தி

செம்பரம்பாக்கம் ஏரியிலிருந்து உபரி நீர் தற்பொழுது வினாடிக்கு 5000 கனஅடி வெளியேற்றப்பட்டு வருகிறது. ஏரிக்கு வரும் நீர் வரத்து அதிகரிப்பதால் உபரி திறந்துவிடும் அளவு 7500 கனஅடி வரை அதிகரிக்க வாய்ப்புள்ளதால், அடையாறு ஆற்றின் கரையோரம் வசிக்கும் மக்கள் பாதுகாப்பான இடங்களுக்குச் செல்ல அறிவுறுத்தப்படுகிறார்கள்.

01/12/2015

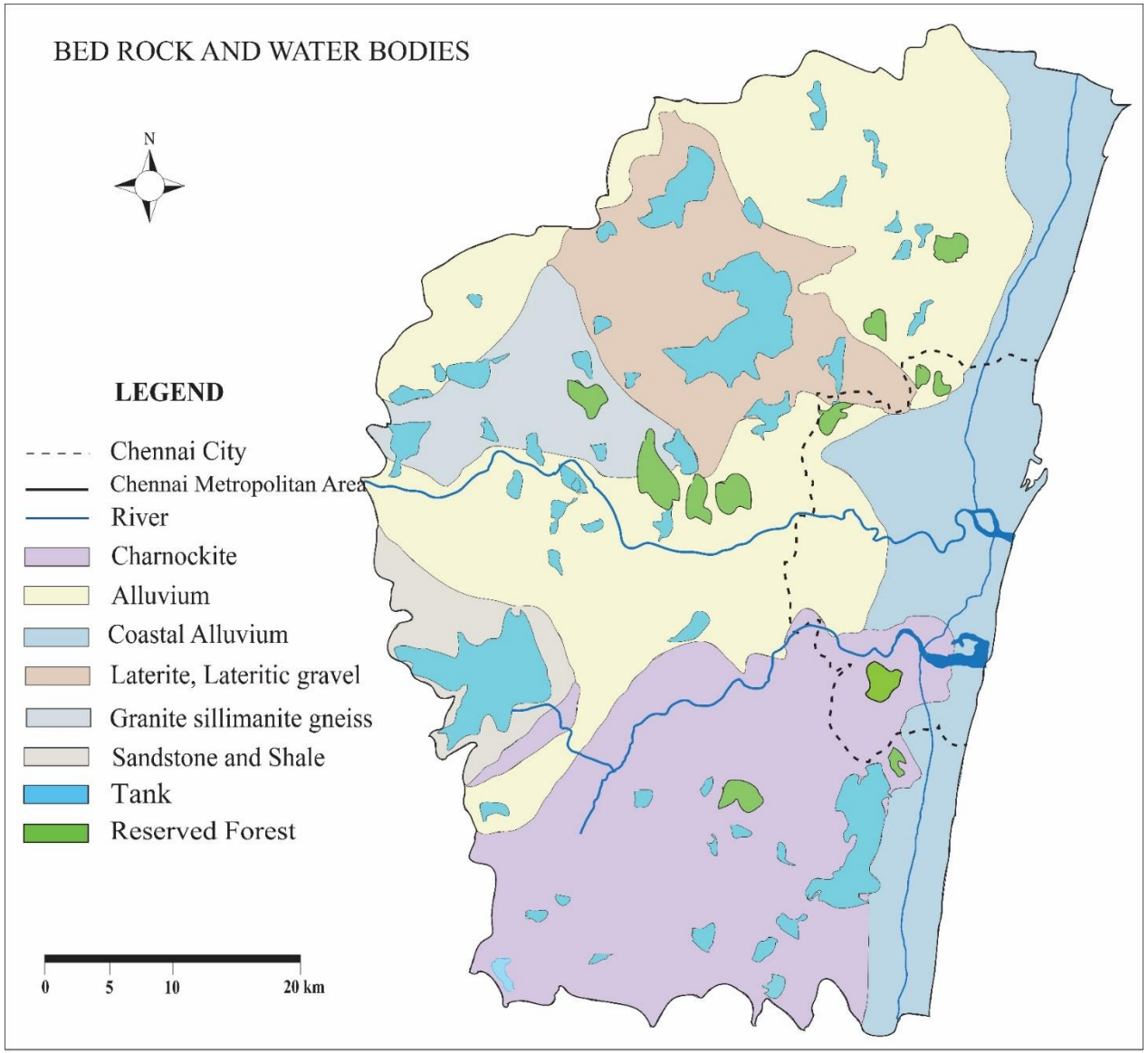
திருமதி. எ.சுந்தரவல்லி, இ.ஆ.ப.,
மாவட்ட ஆட்சியர்,
சென்னை மாவட்டம்.

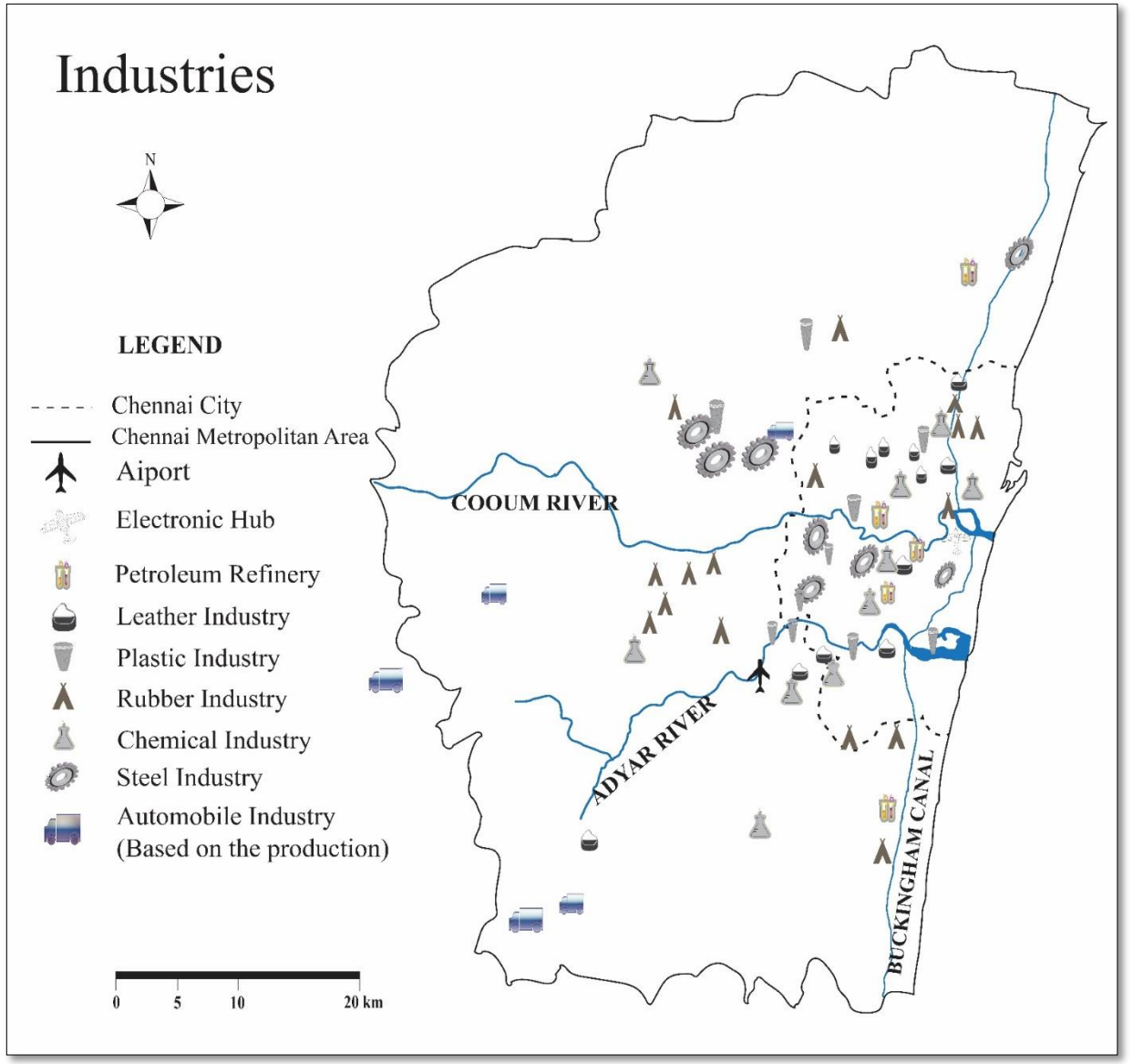


Chennai flooding alert – 1 December 2015

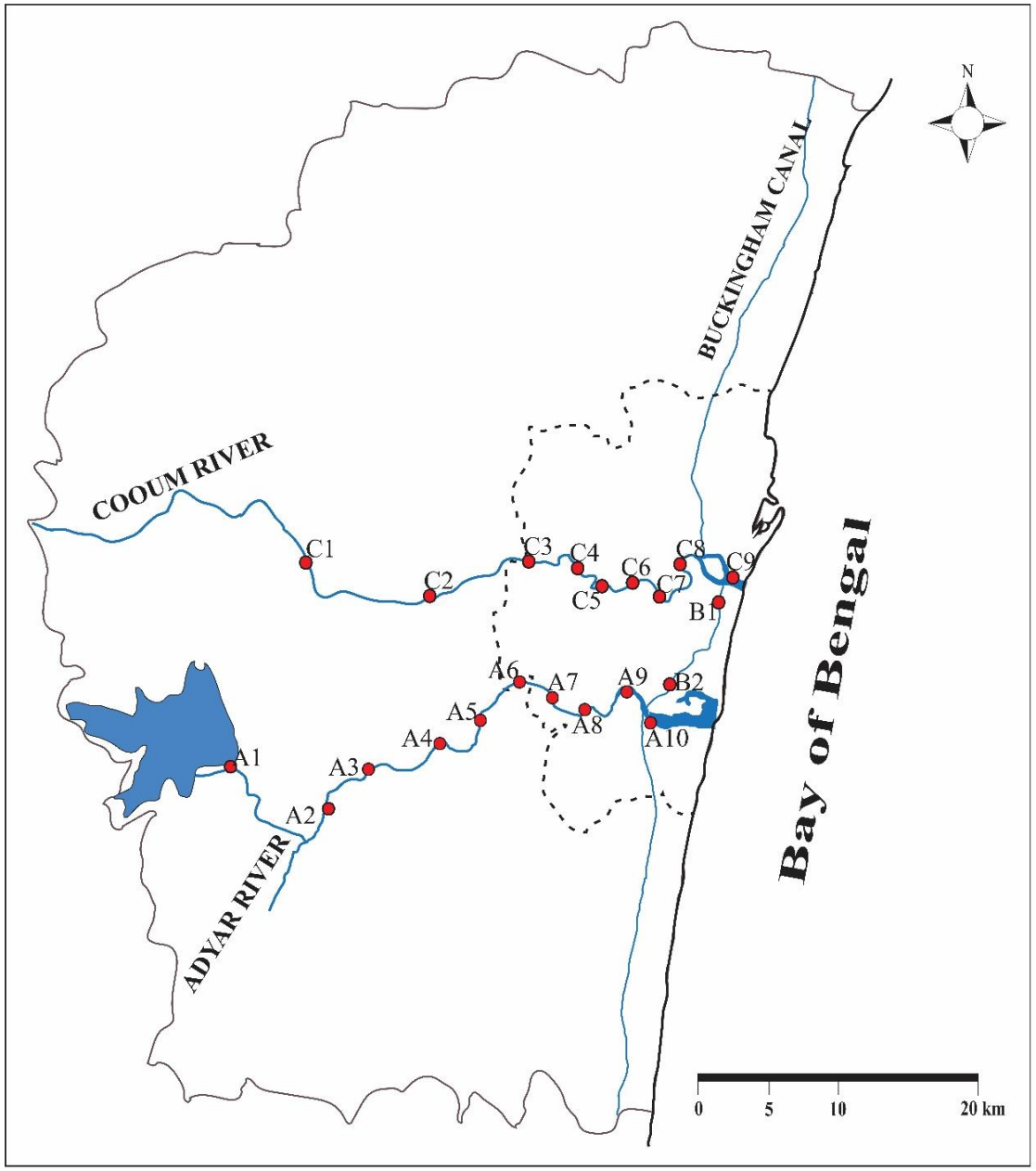
Objectives

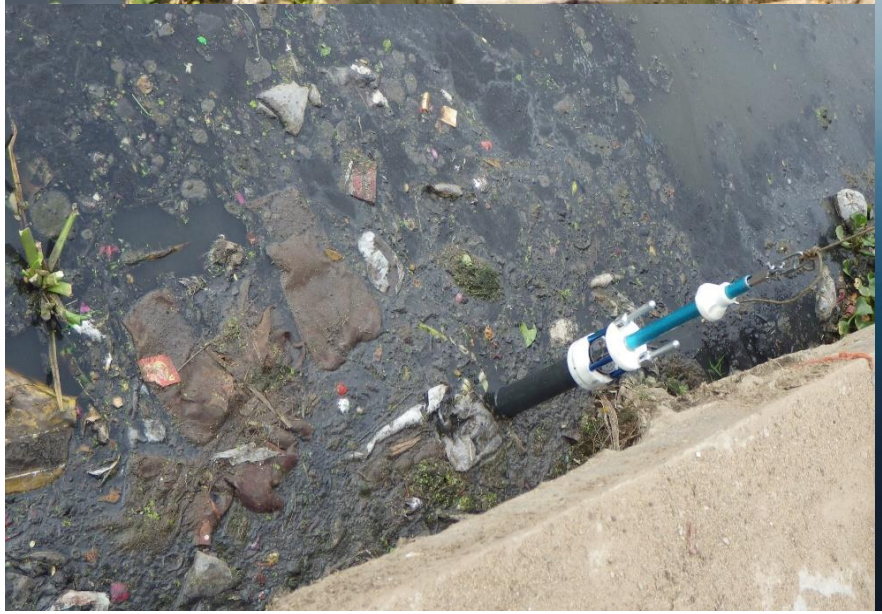
- To identify potential agricultural, industrial and urban sources of incoming pollutants
- To establish upstream-downstream characterization of the fluvial system
- To correlate the state of sediment contamination to the industrial, waste areas and urban planning


BED ROCK AND WATER BODIES
N
LEGEND
Chennai City
Chennai Metropolitan Area
River
Charnockite
Alluvium
Coastal Alluvium
Laterite, Lateritic gravel
Granite sillimanite gneiss
Sandstone and Shale
Tank
Reserved Forest
0 5 10 20 km


Industries
N
LEGEND
Chennai City
Chennai Metropolitan Area
Aiport
Electronic Hub
Petroleum Refinery
Leather Industry
Plastic Industry
Rubber Industry
Chemical Industry
Steel Industry
Automobile Industry
(Based on the production)
COOUM RIVER
ADYAR RIVER
BUCKINGHAM CANAL
0 5 10 20 km

Sediment Sampling

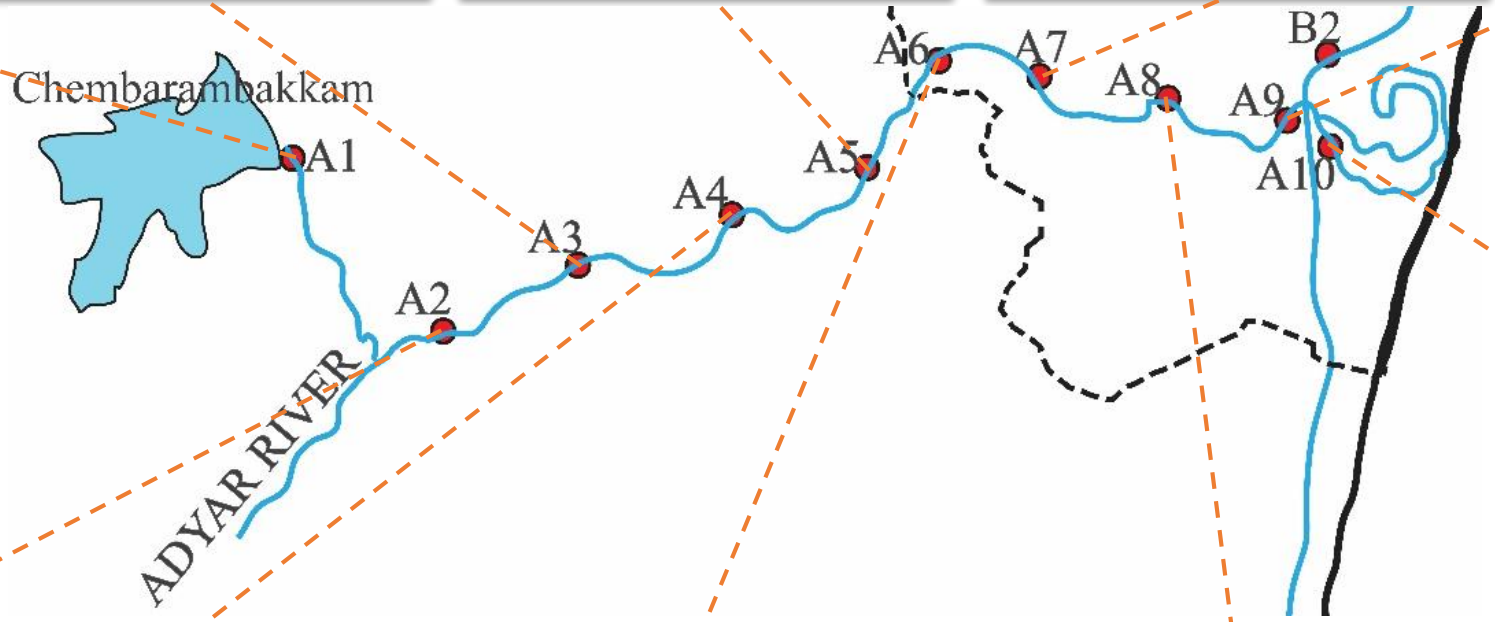




Uwitec Coring Device

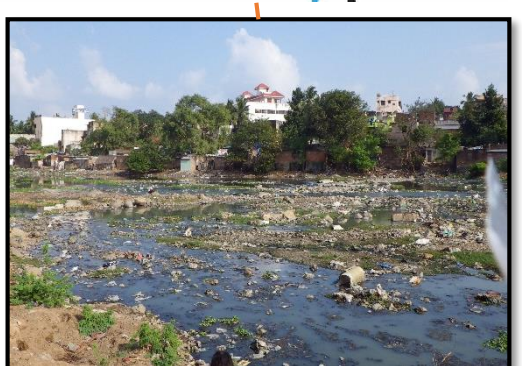


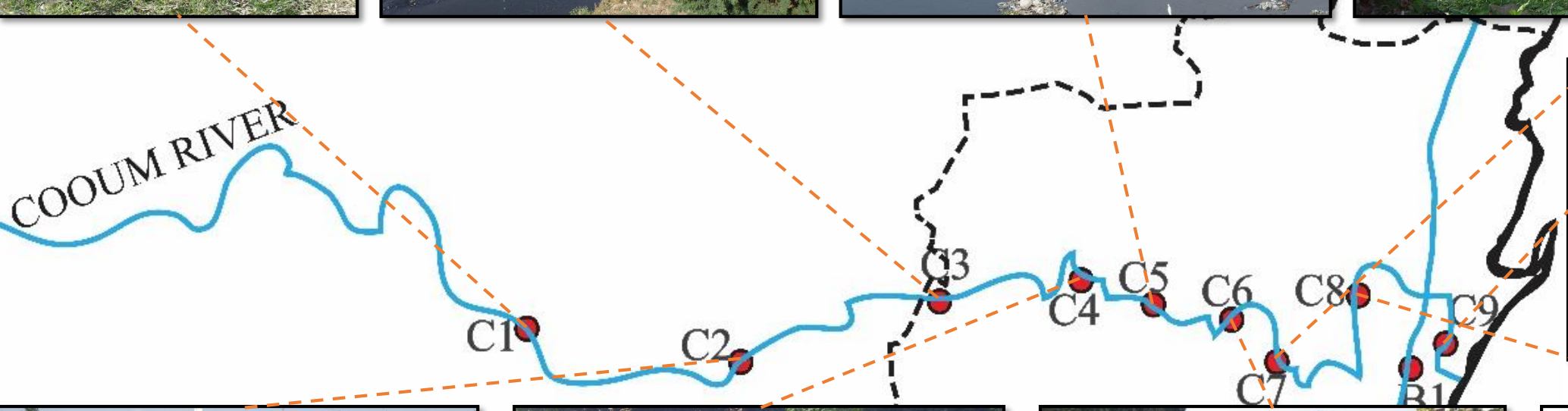


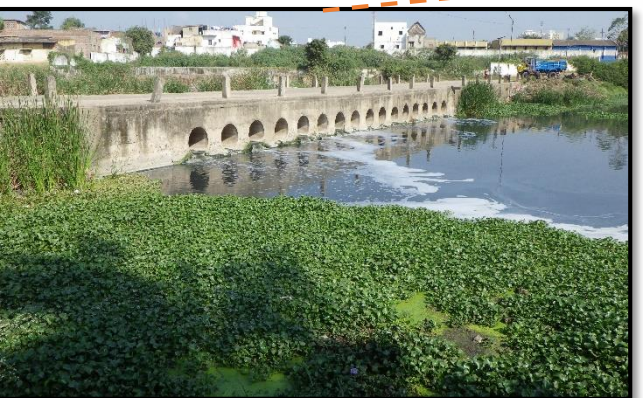

Chembarambakkam
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
B2
ADYAR RIVER

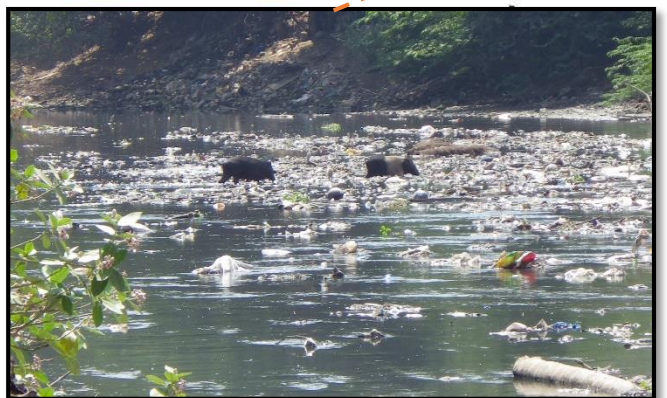


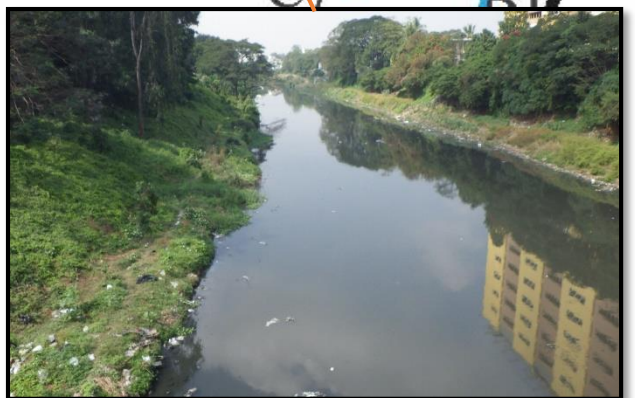


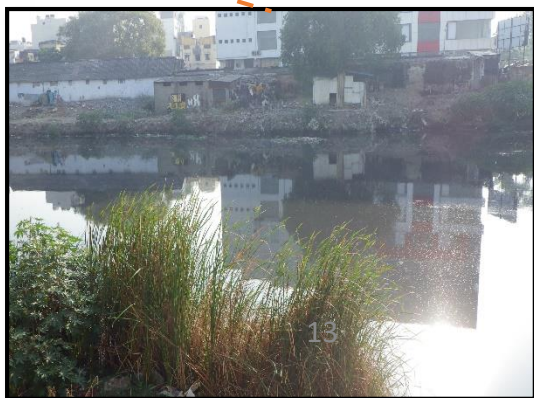


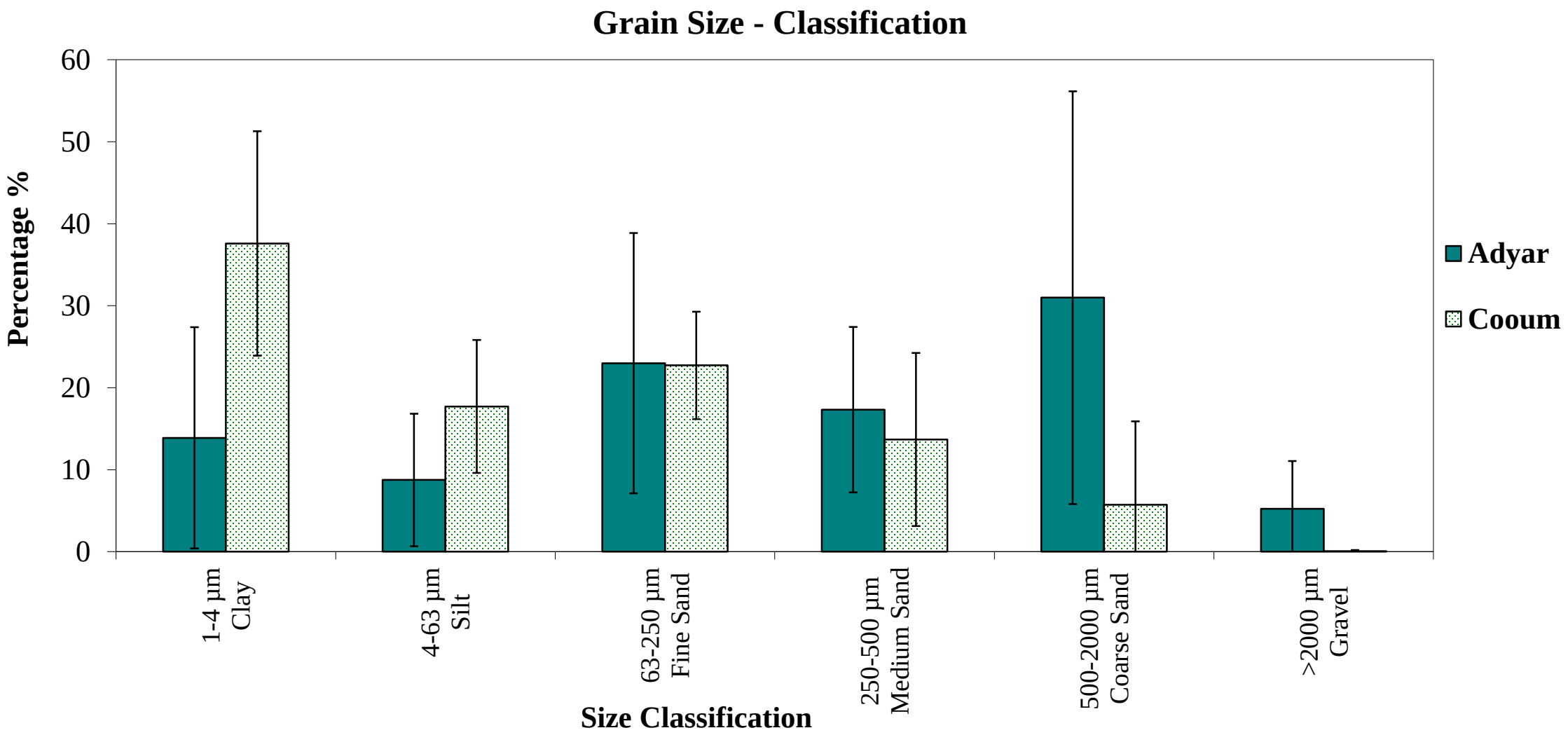

COOUM RIVER
C1
C2
C3
C4
C5
C6
C7
C8
C9
B1





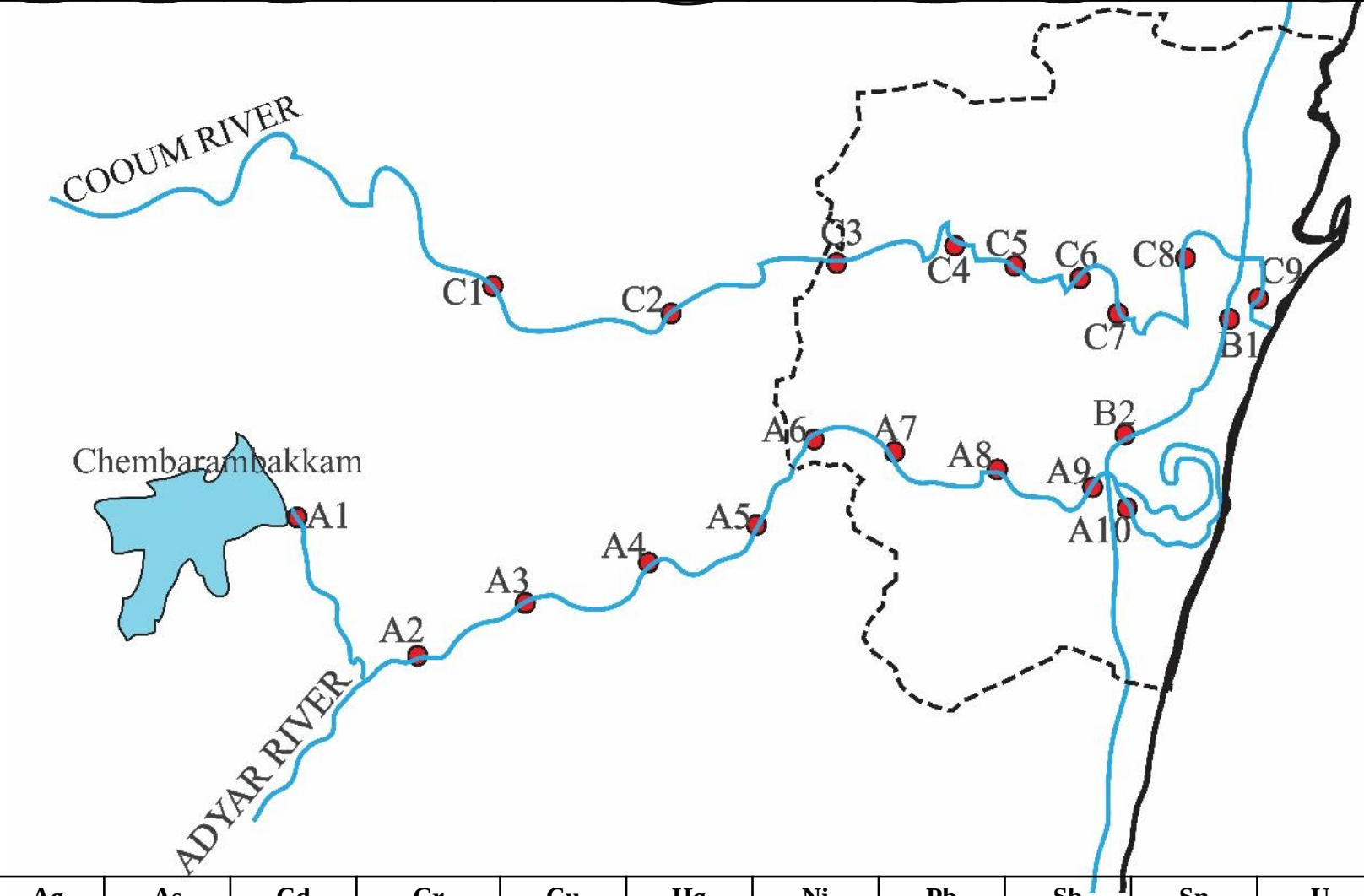




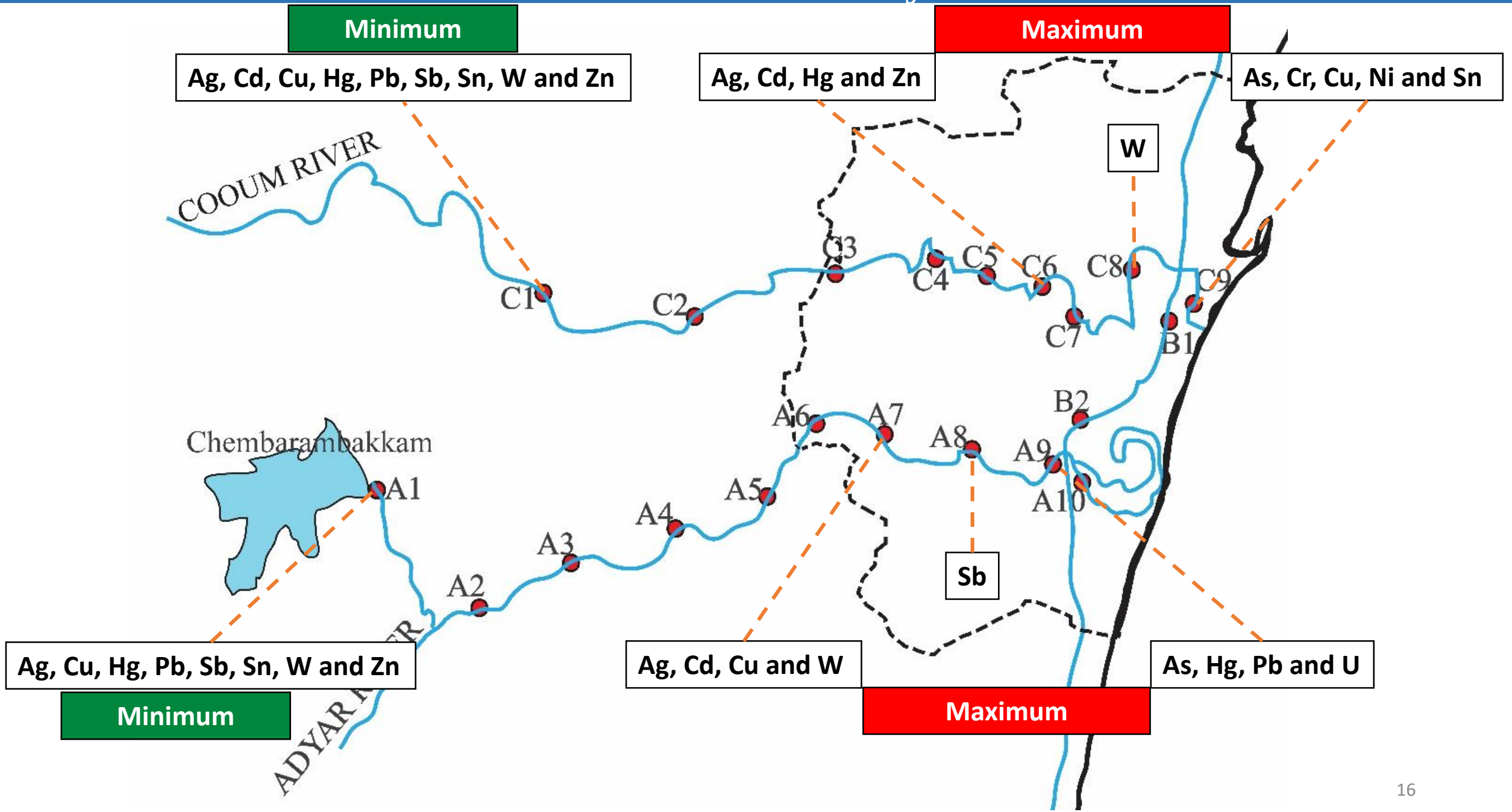


This analysis is considered as random and no trace element signal trend should be attributed to texture variation of the sediment deposits

River	Range	Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Sn	U	W	Zn
Cooum River	Minimum (mg/kg)	1.23	3.54	0.43	95.34	60.81	0.07	36.26	38.08	0.50	5.16	3.41	1.63	147.50
	Maximum (mg/kg)	31.00	10.84	17.41	225.90	302.00	6.57	49.41	339.72	10.18	32.16	5.83	5.91	595.10



River	Range (mg/kg)	Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Sn	U	W	Zn
Adyar River	Minimum (mg/kg)	0.10	1.78	0.23	74.22	45.12	0.01	17.85	17.43	0.00	1.68	1.28	0.90	65.19
	Maximum (mg/kg)	18.80	4.12	4.78	1517.00	325.00	1.83	76.44	65.23	2.85	304.00	3.37	9.64	1392.00


Minimum
Ag, Cd, Cu, Hg, Pb, Sb, Sn, W and Zn
Maximum
Ag, Cd, Hg and Zn
As, Cr, Cu, Ni and Sn
COOUM RIVER
W
C1
C2
C3
C4
C5
C6
C7
C8
C9
B1
B2
A6
A7
A8
A9
A10
Chembarambakkam
A1
A2
A3
A4
A5
Sb
Ag, Cu, Hg, Pb, Sb, Sn, W and Zn
Minimum
Ag, Cd, Cu and W
Maximum
As, Hg, Pb and U

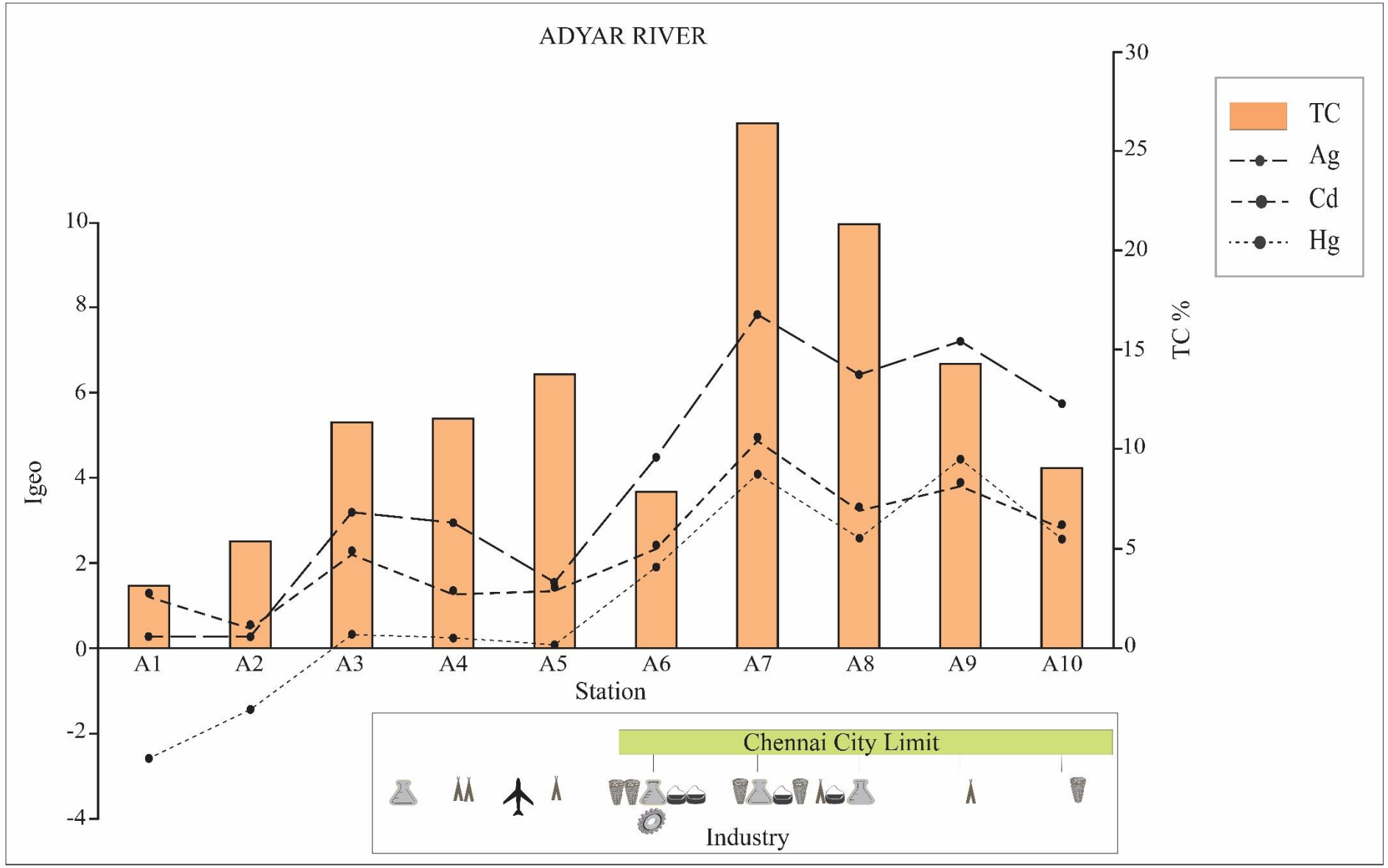
Its common approach to estimate the enrichment of metal concentrations is to calculating the Geoaccumulation Index (*I*geo) as proposed by Muller (1969)

$$I_{geo} = \mathrm{Log}_2 (C_n / 1.5 \times B_n)$$

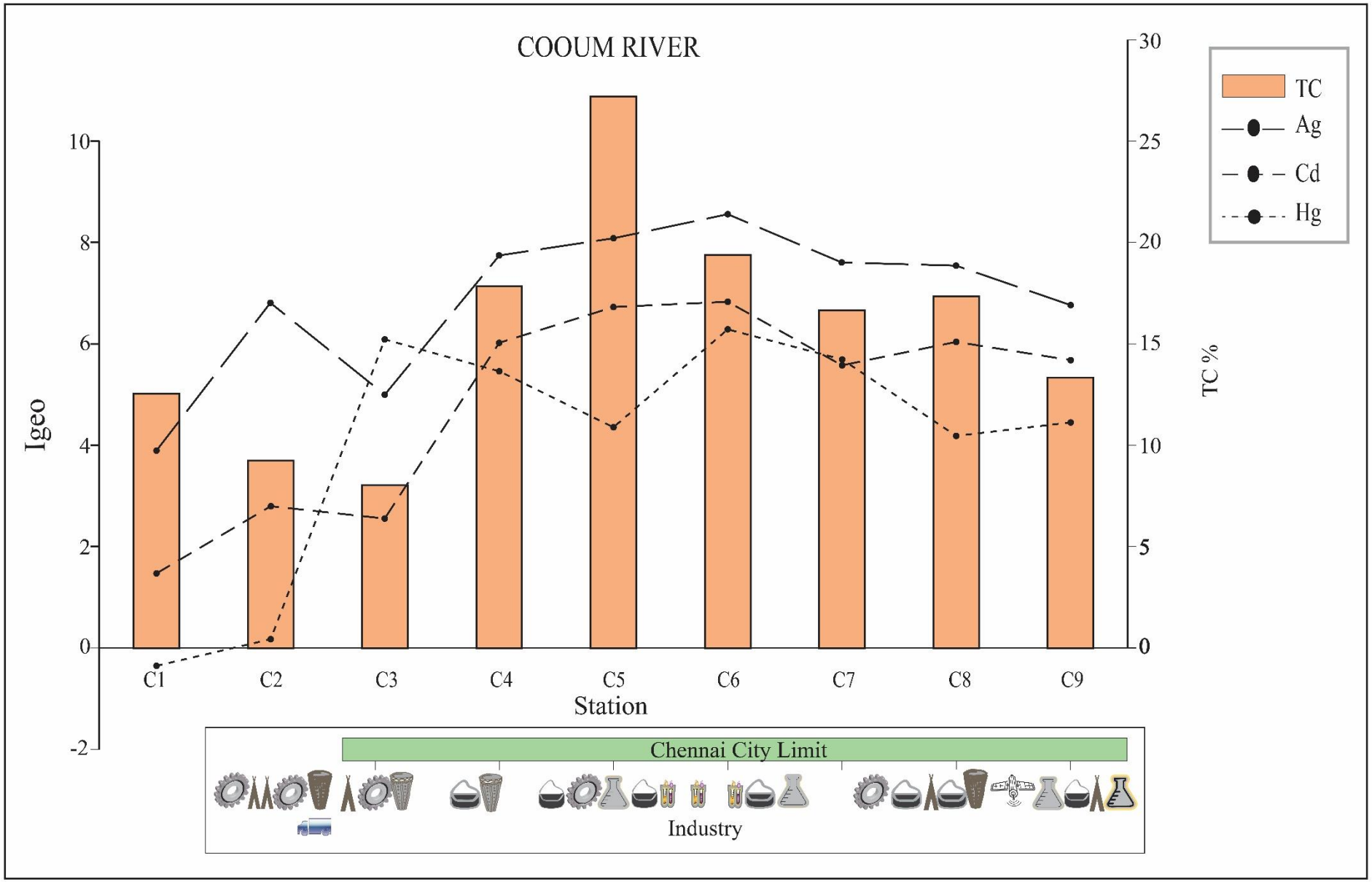
*I*geo value	Polluted level	Adyar River	Cooum River
<1	From unpolluted to moderately polluted	As, U	Ni, U, W
1-2	Moderately polluted	Ni (50%), Pb(40%)	As(10%)
2-3	From moderately polluted to strongly polluted	Sb(10%), W(10%)	Cr(10%), Zn(77%)
3-4	Strongly polluted	Cu (40%)	Cu(67%), Pb(10%), Sn(10%)
4-5	From strongly polluted to extremely polluted	**Cd(10%), Cr(20%), Hg(20%), Zn(10%)**	**Sb(10%)**
>5	Extremely polluted	**Ag(40%), Sn(10%)**	**Ag(88%), Cd(67%),Hg(45%)**

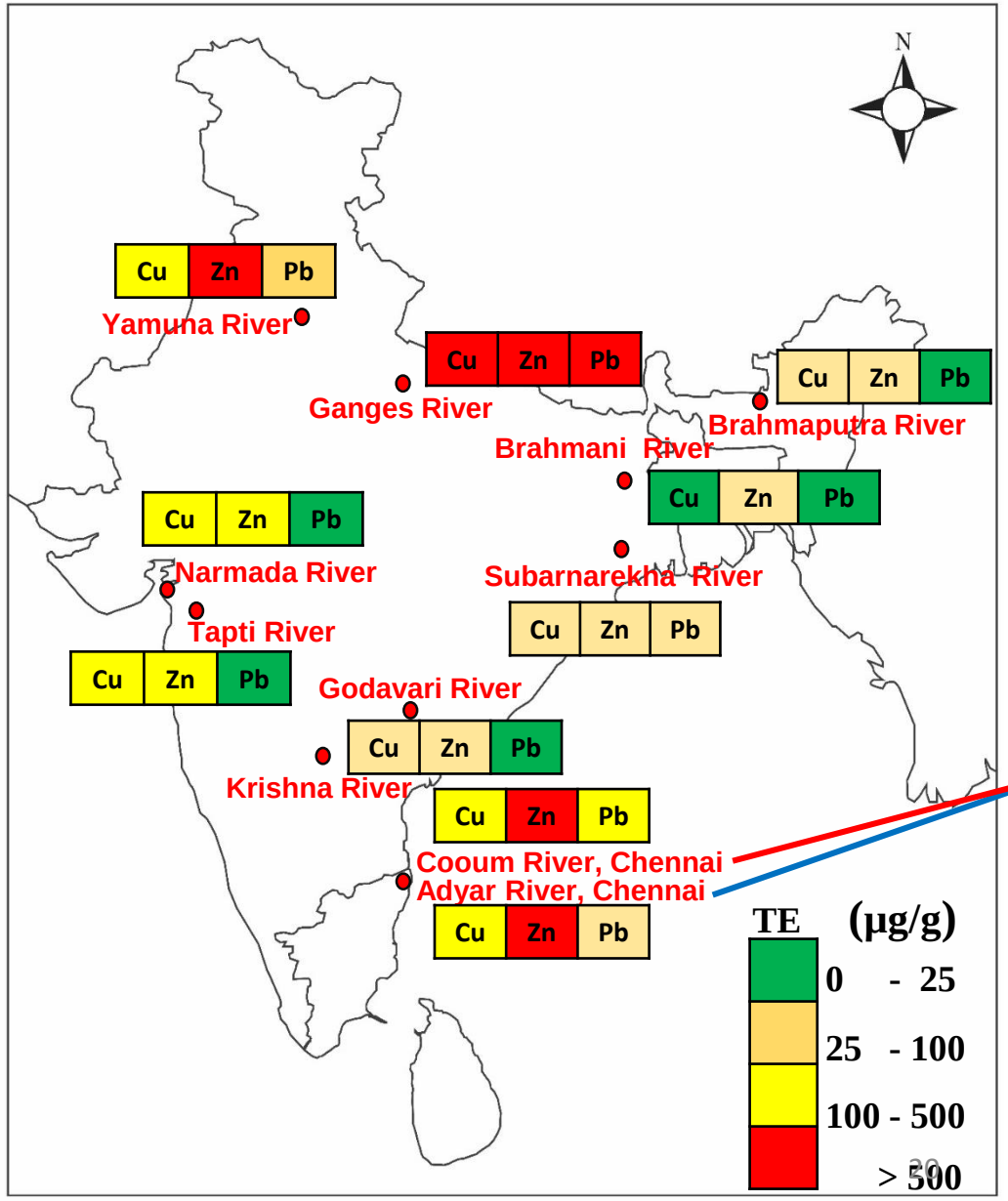
Description of sediment quality according to I_{geo} (Muller, 1969)

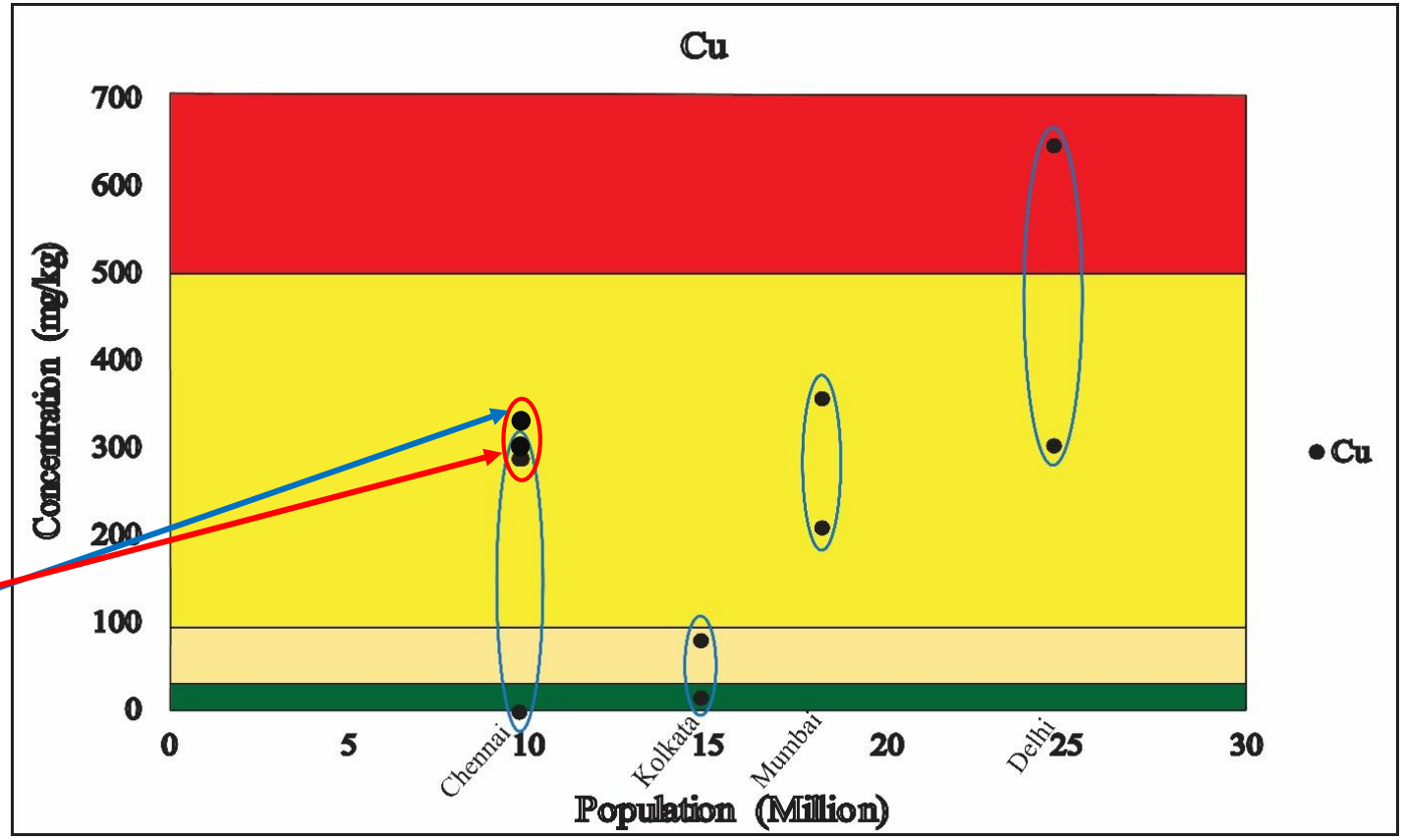
Results : Upstream - Downstream geoaccumulation Index (I_{geo}) of Ag, Cd and Hg associated to total carbon (%) and urban activities in Adyar River sediments



Results : Upstream - Downstream geoaccumulation Index (I_{geo}) of Ag, Cd and Hg associated to total carbon (%) and urban activities in Cooum River sediments



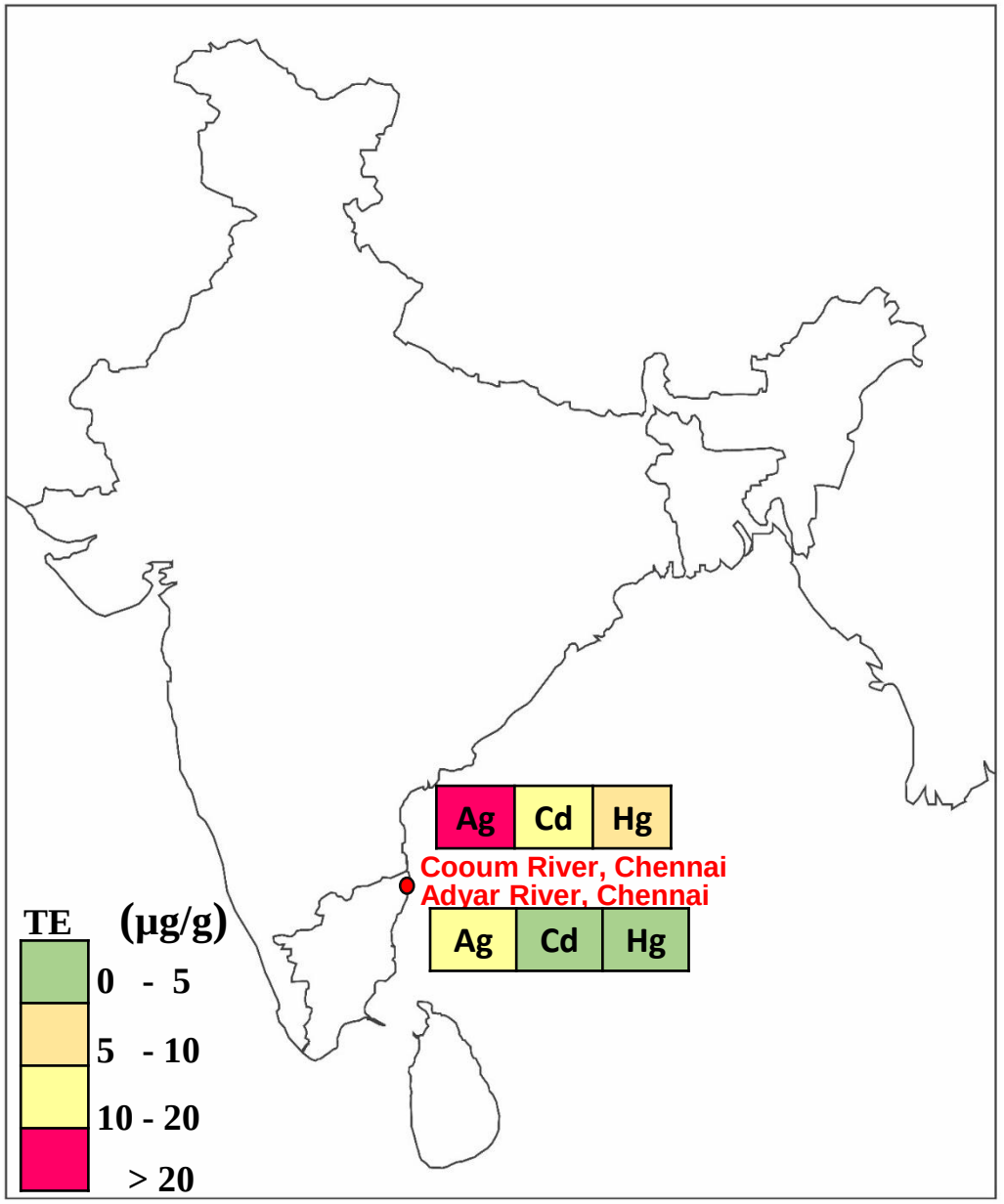

N
Cu Zn Pb
Yamuna River
Ganges River
Brahmaputra River
Brahmani River
Narmada River
Subarnarekha River
Tapti River
Godavari River
Krishna River
Cooum River, Chennai
Adyar River, Chennai
TE (µg/g)
0 - 25
25 - 100
100 - 500
> 500


Cu
Concentration (mg/kg)
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Chennai
Kolkata
Mumbai
Delhi
Population (Million)
Cu

- Ag, Cd and Hg are used as urban tracers. This may be ascertained to the various pollutants discharge via diffuse urban and punctual industrial sources operating in and around the river bed.

- Concentration of trace elements (Cr, Cu, Pb, Sb, Sn, W and Zn) are strongly influenced by the local industrial input

- The results of this study indicates that monitoring and immediate managerial measures must be taken to avoid further potentially toxic metal pollution of river sediment



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ANNA UNIVERSITY CHENNAI
PROGRESS THROUGH KNOWLEDGE