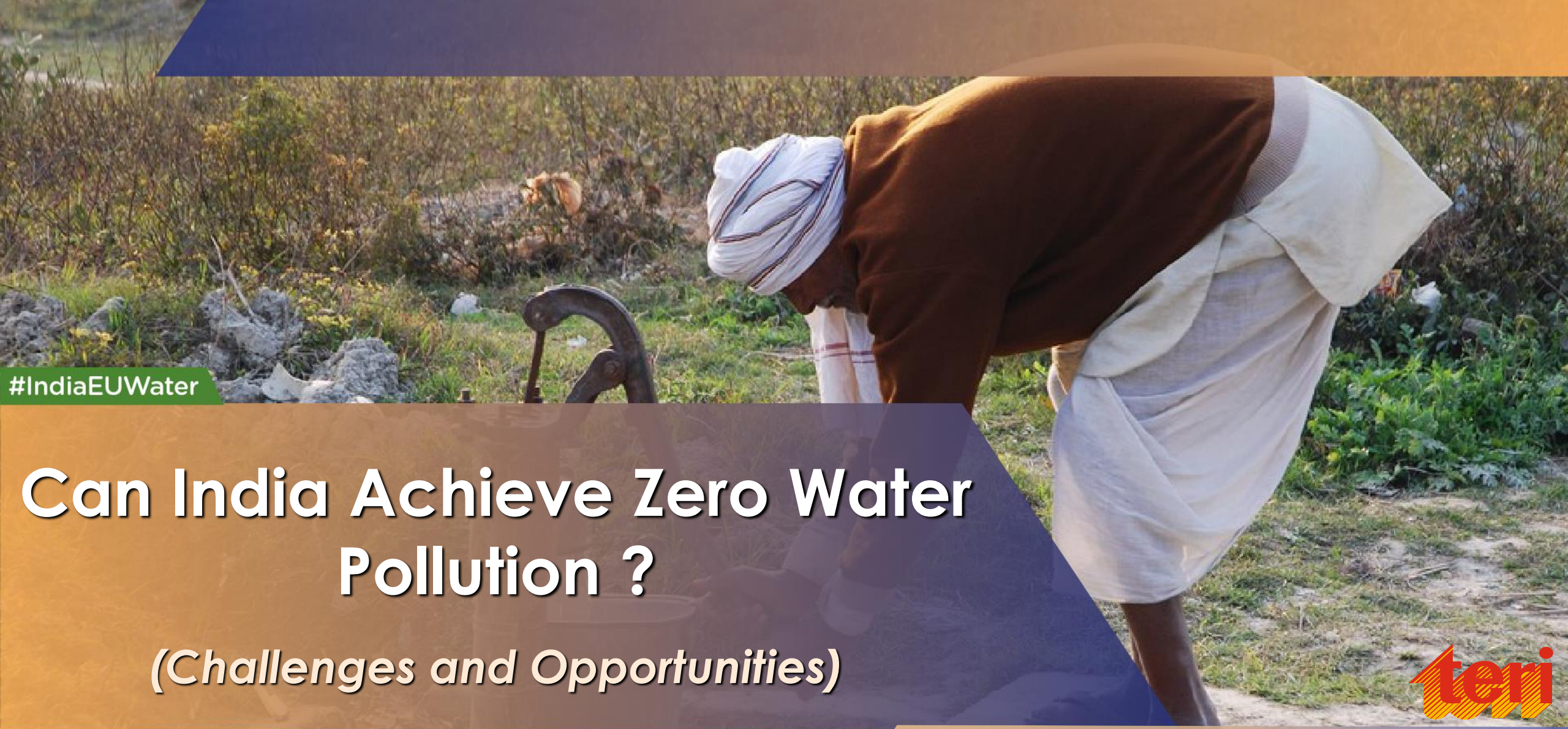


#IndiaEUWater

Can India Achieve Zero Water Pollution ?

(Challenges and Opportunities)

Anshuman

Associate Director, Water Resources Division

The Energy and Resources Institute (TERI)

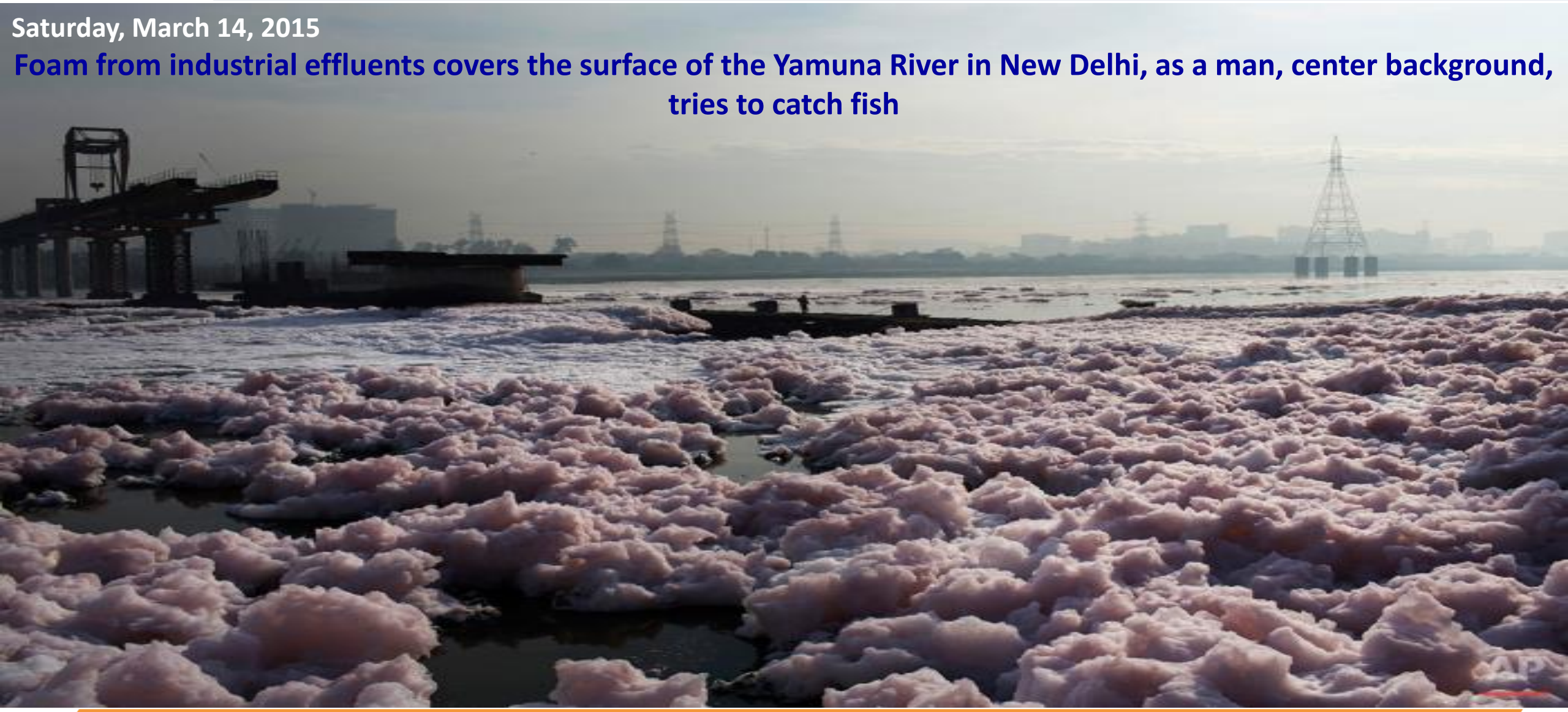
State of Water Resources

March 21, 2010: A man wraps a cloth around himself after a ritual dip in the polluted Yamuna river in New Delhi

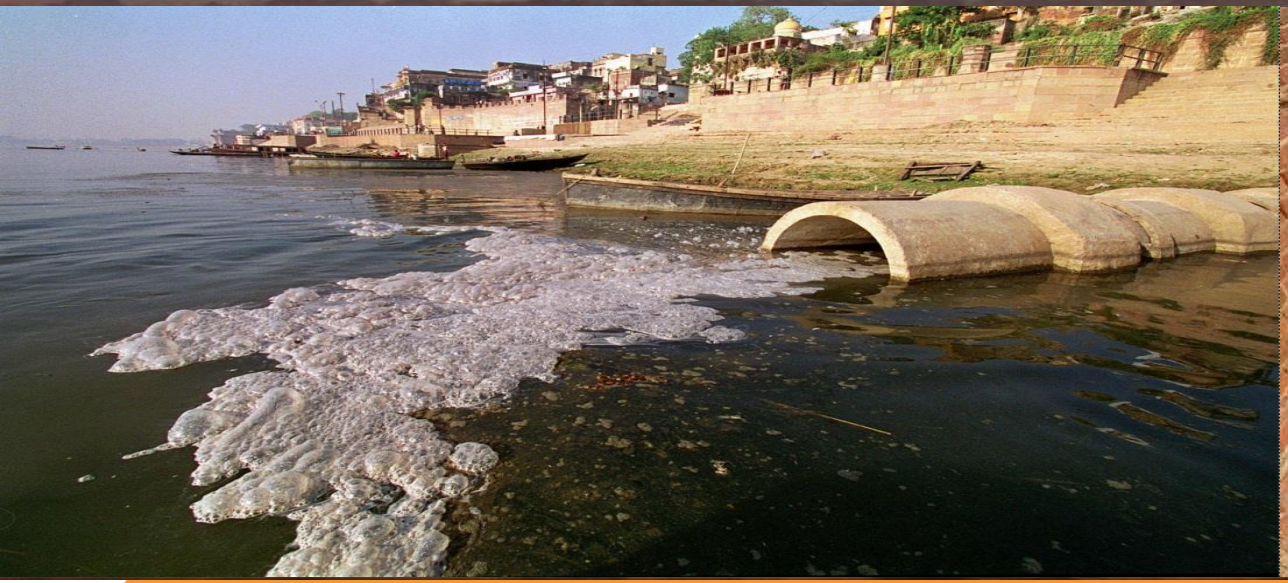
(Danish Siddiqui/Reuters)

Saturday, March 14, 2015

Foam from industrial effluents covers the surface of the Yamuna River in New Delhi, as a man, center background, tries to catch fish



Rivers and Us…

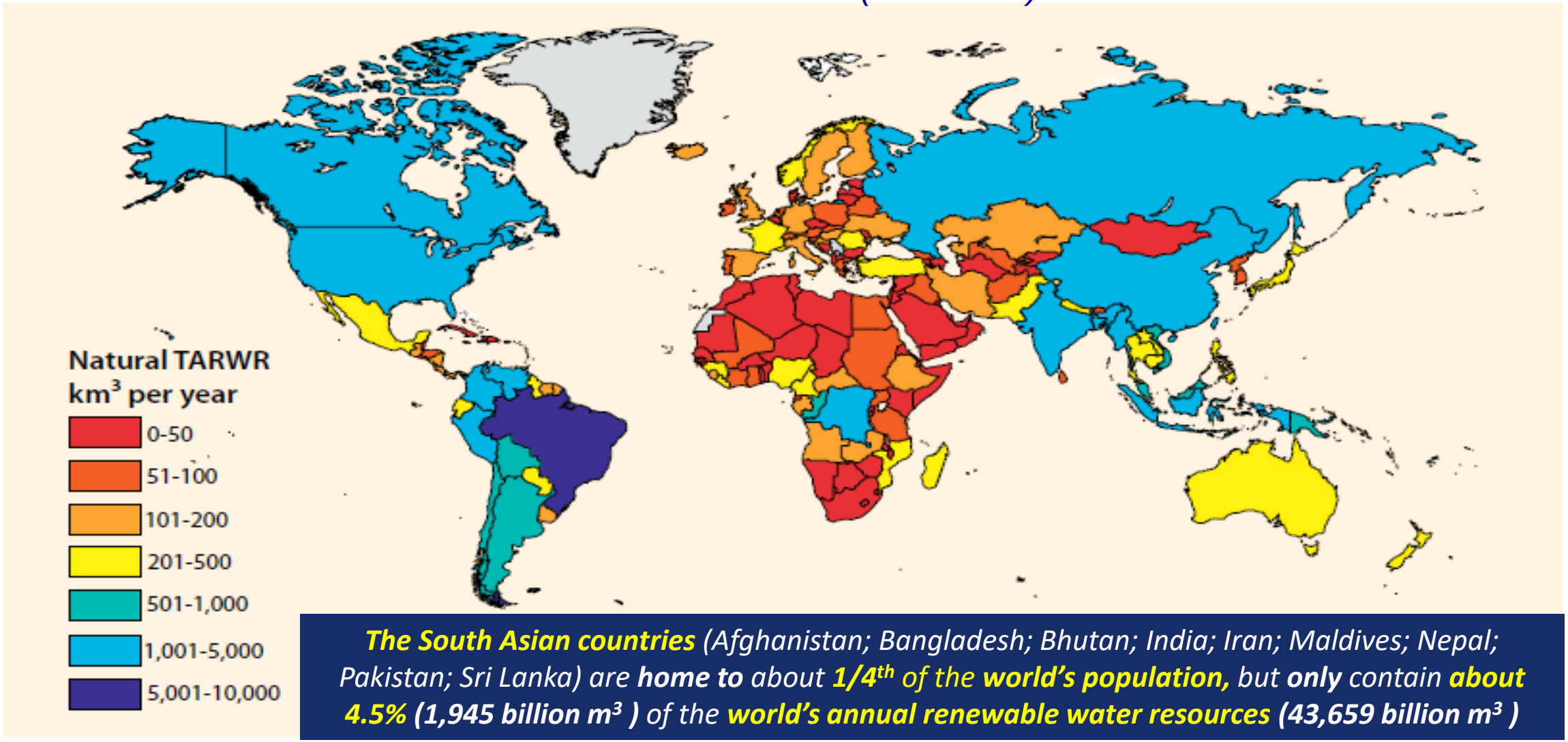


Major Challenges in Water Sector

Global & ***Indian Scenario***

State of Water Resources

Total annual renewable water resources: Global *(1985-2010)*



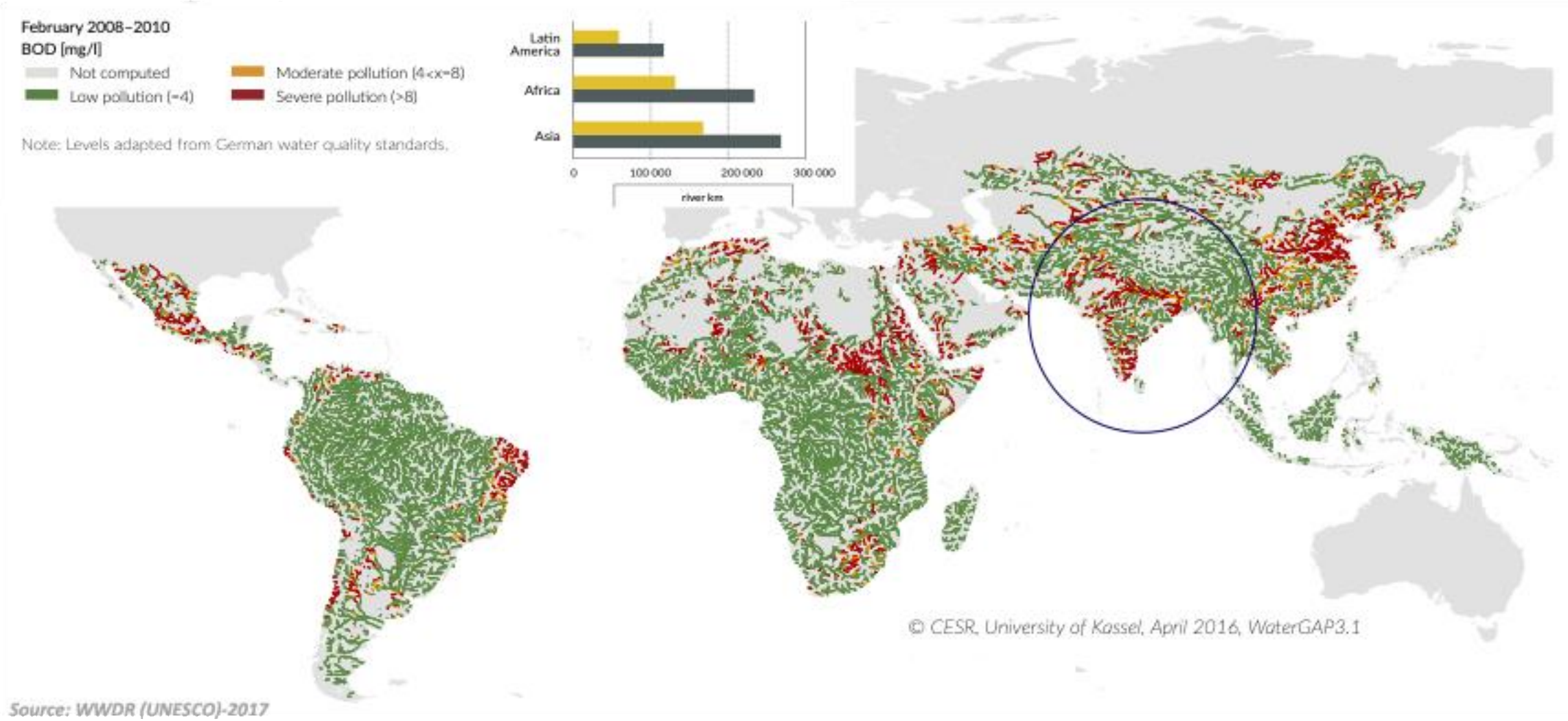
The South Asian countries *(Afghanistan; Bangladesh; Bhutan; India; Iran; Maldives; Nepal; Pakistan; Sri Lanka) are* ***home to*** *about* ***1/4th*** *of the* ***world's population,*** *but* ***only*** *contain* ***about 4.5%*** ***(1,945 billion m³)*** *of the* ***world's annual renewable water resources*** ***(43,659 billion m³)***

Source: WWAP 2012. The UN WWDR 4: UNESCO`

Water Pollution

Water Pollution

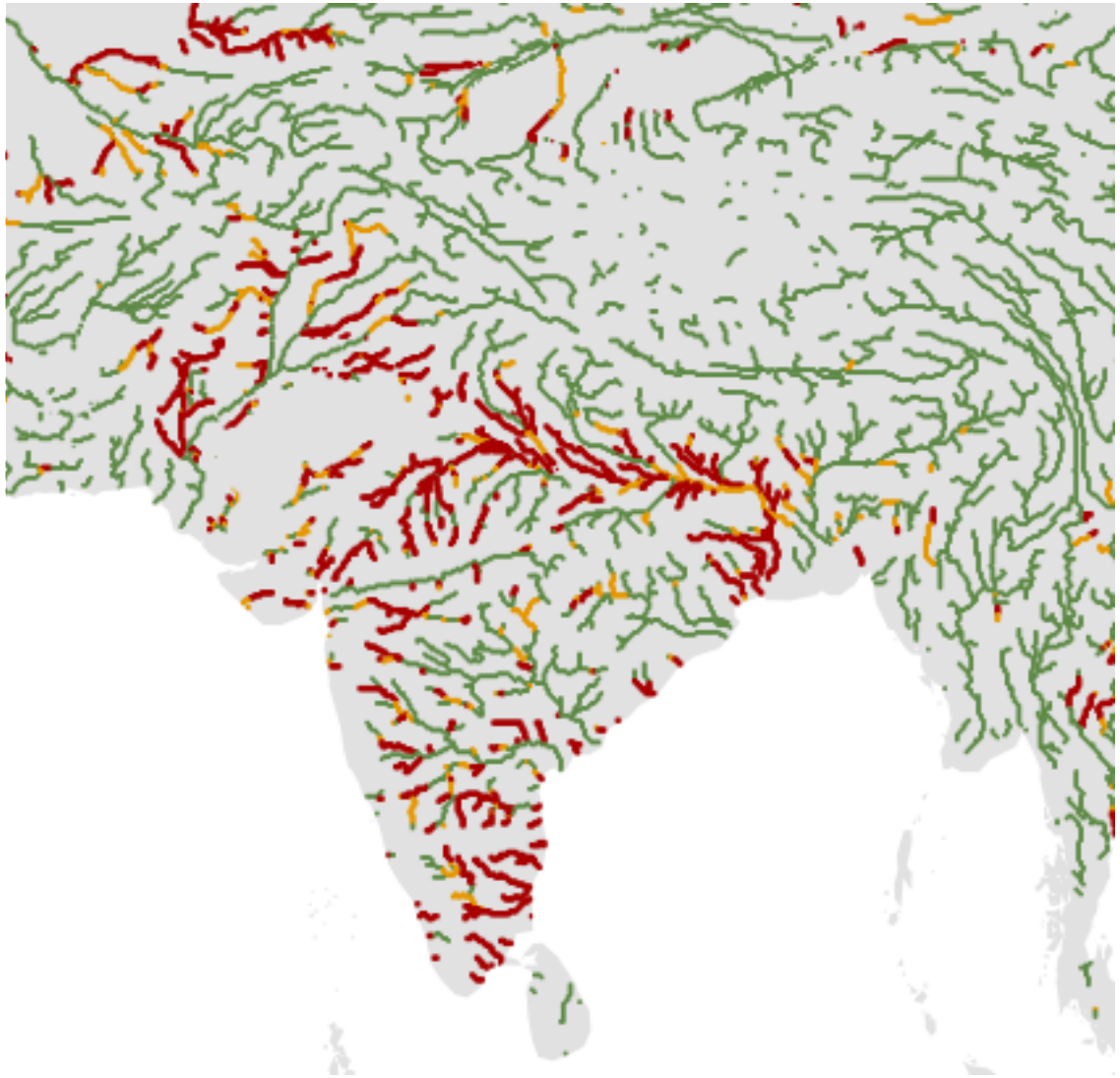
World** (Africa, Asia, Latin America): Estimated **BOD in River Streams (2008-2010)



Source: WWDR (UNESCO)-2017

Water Pollution

***India:** Estimated **BOD in River Streams** (2008-2010)*

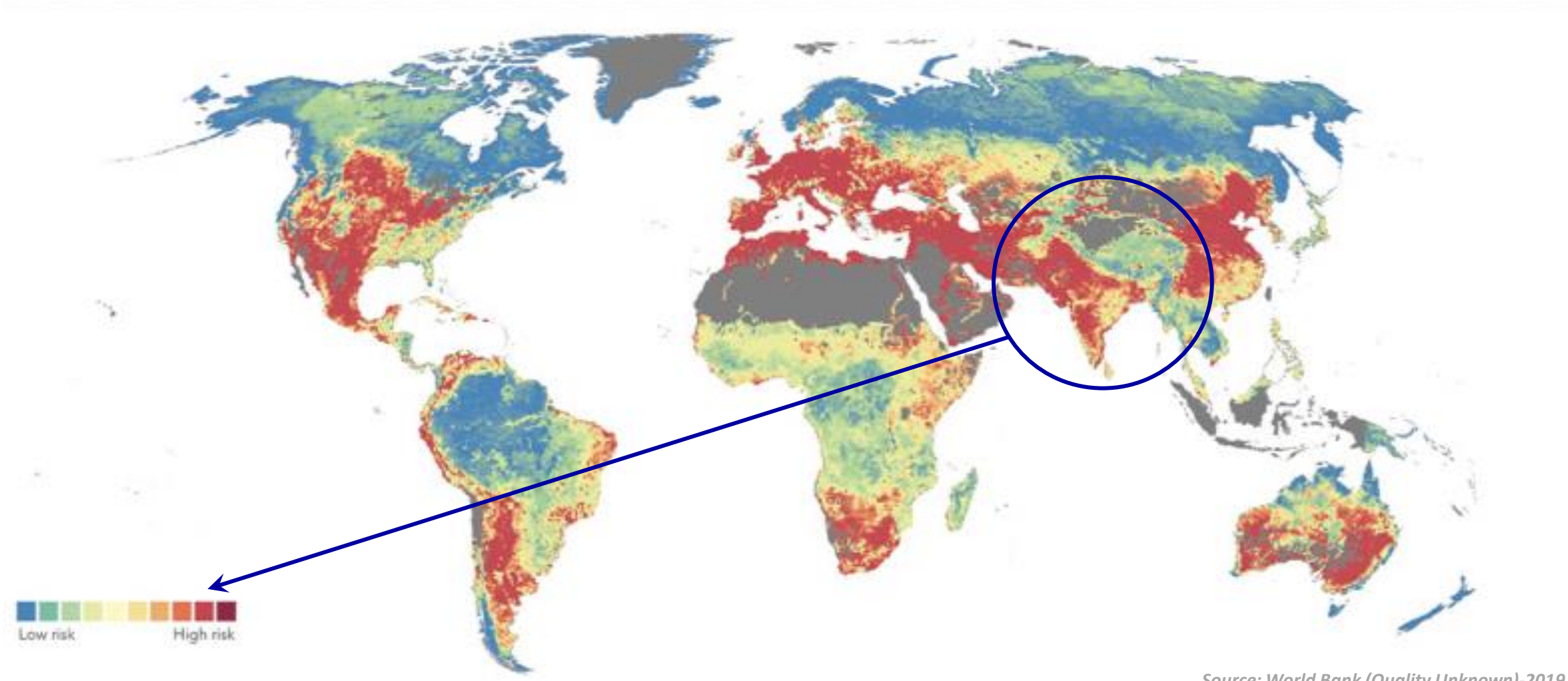


Note: Levels adapted from German water quality standards.

Source: WWDR (UNESCO)-2017

Water Pollution

Global Risk of Water Pollution (Poor Water Quality) *(BOD, N & EC)*



Source: World Bank (Quality Unknown)-2019

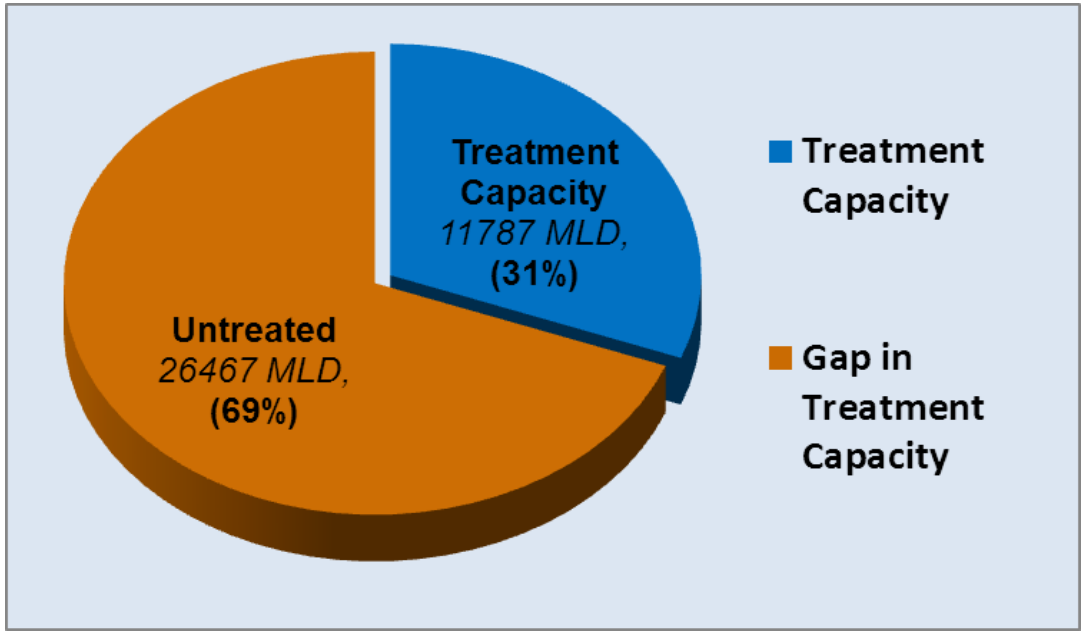
Economic Impact of Water Pollution

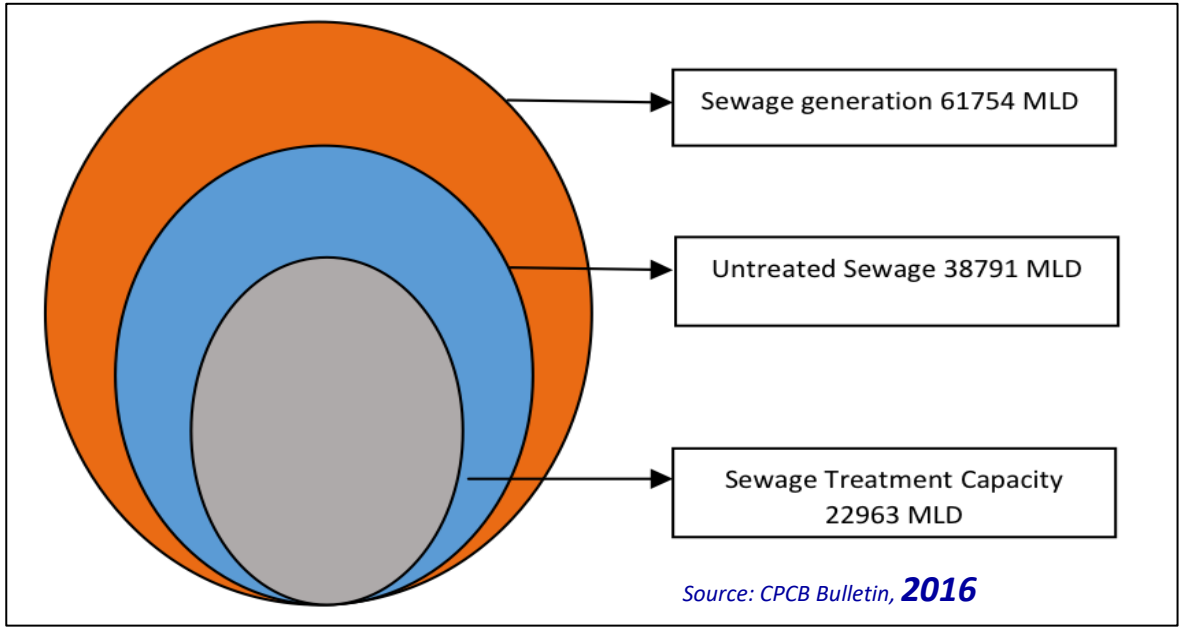
Fall in GDP Growth in Downstream Regions of Polluted Rivers

- **When** the **BOD** level **exceeds 8 mg/L** (a **heavily polluted level** in rivers), the **GDP growth falls** significantly, **by 0.82 % points**, **in downstream regions**.
- This is **compared** with a **mean growth rate of 2.33 %**, implying that around **a third of growth is lost**.
- When the sample is restricted to only **middle-income countries**, where BOD is a bigger problem, the **impact increases** to **1.16 percentage points**, **implying** that **almost half of growth is lost**.
- In **high-income countries**, where levels of BOD are lower, GDP only declines by 0.34 percentage points in regions downstream of heavily polluted rivers.

Source: World Bank (Quality Unknown)-2019

Wastewater: India





(2009-10): *Estimated **sewage generation** (Class I cities and Class II towns (**2009-10**) was **38254 MLD,** which is **expected to be more at present**. Against this, the existing treatment capacity (STPs) is about **11787 MLD,** which is about **31% of total sewage**.*

(2016): Estimated **sewage generation** (Class I cities and Class II towns was **61754 MLD**. Against this, the existing **treatment capacity** (STPs) is about **22963 MLD,** which is about **37 % of total sewage**.

Water Pollution

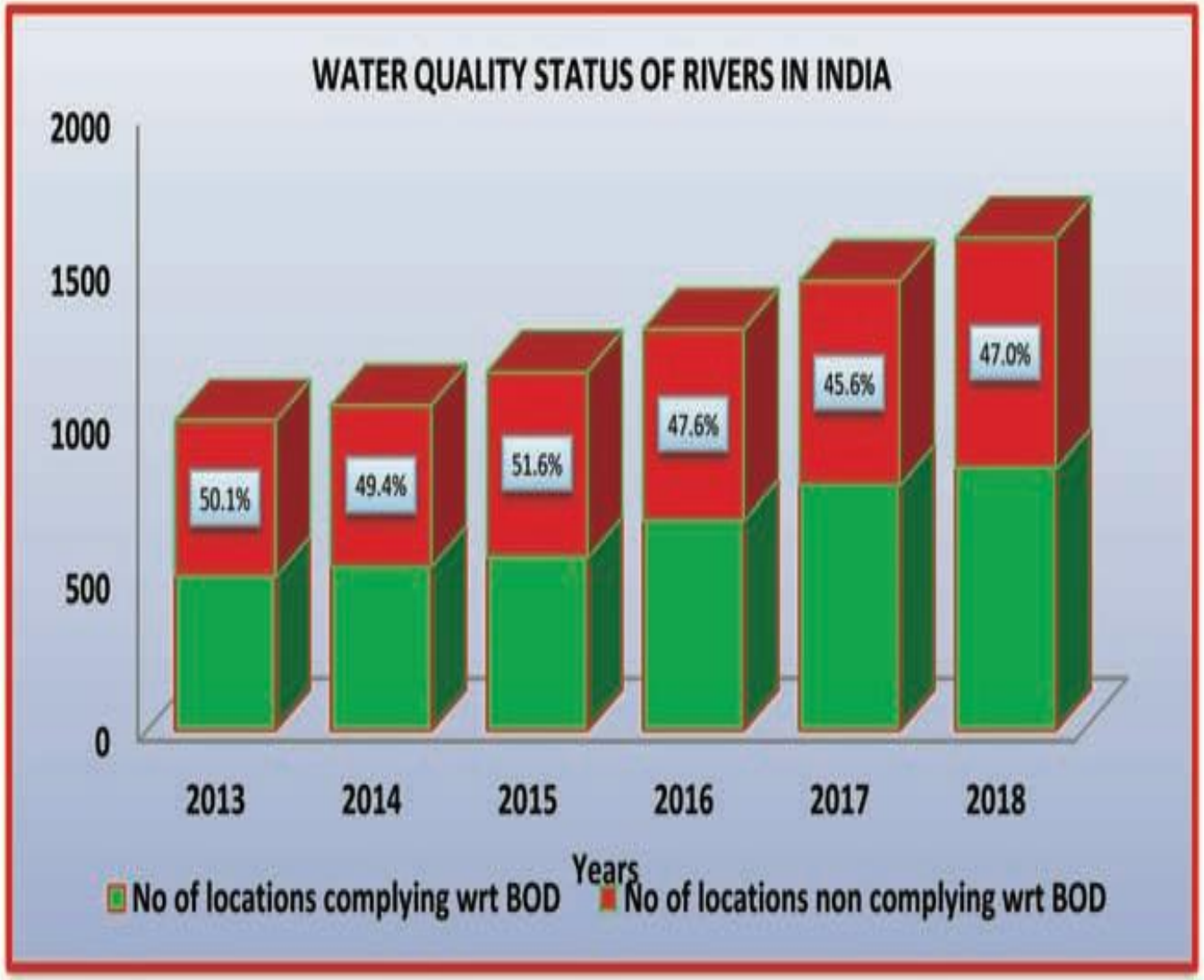
Deteriorated surface water quality

Continued trends of river water pollution

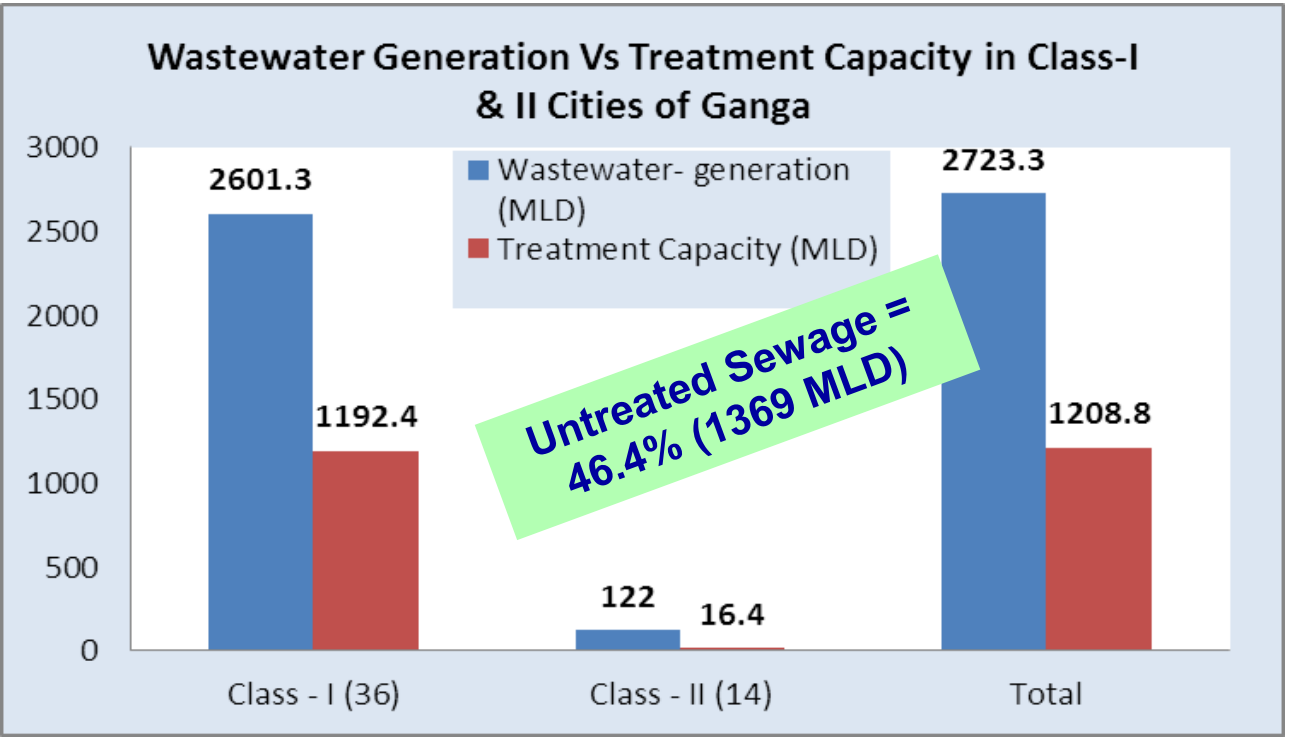
- **BOD exceedance**
- **Bacteriological contamination (Total Coliform)**

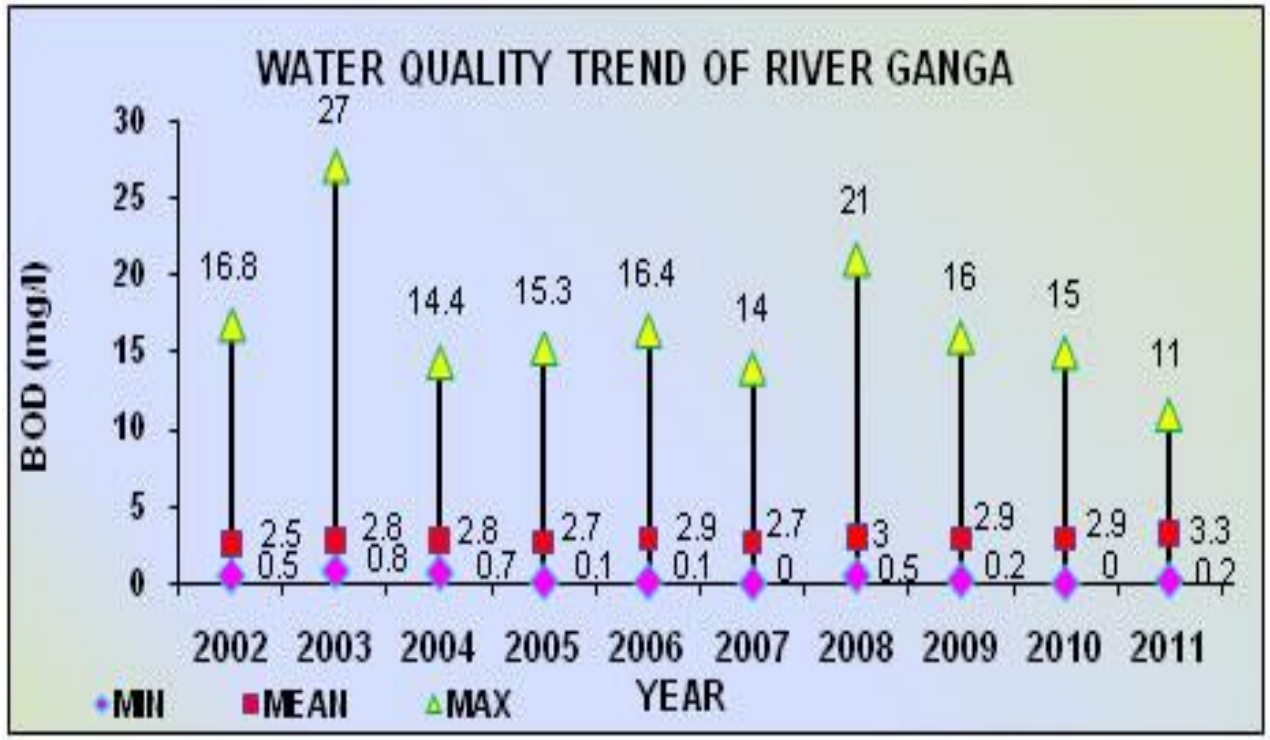
Lakes & wetlands

- Pollution observed for Loktak lake (Manipur), Hussain Sagar lake (Hyderabad), Renuka Lake (Himachal Pradesh)
- Meghalaya and Tamil nadu show heavy pollution for their wetlands. Wetlands of many states are moderately polluted.



Water Pollution: River Ganga





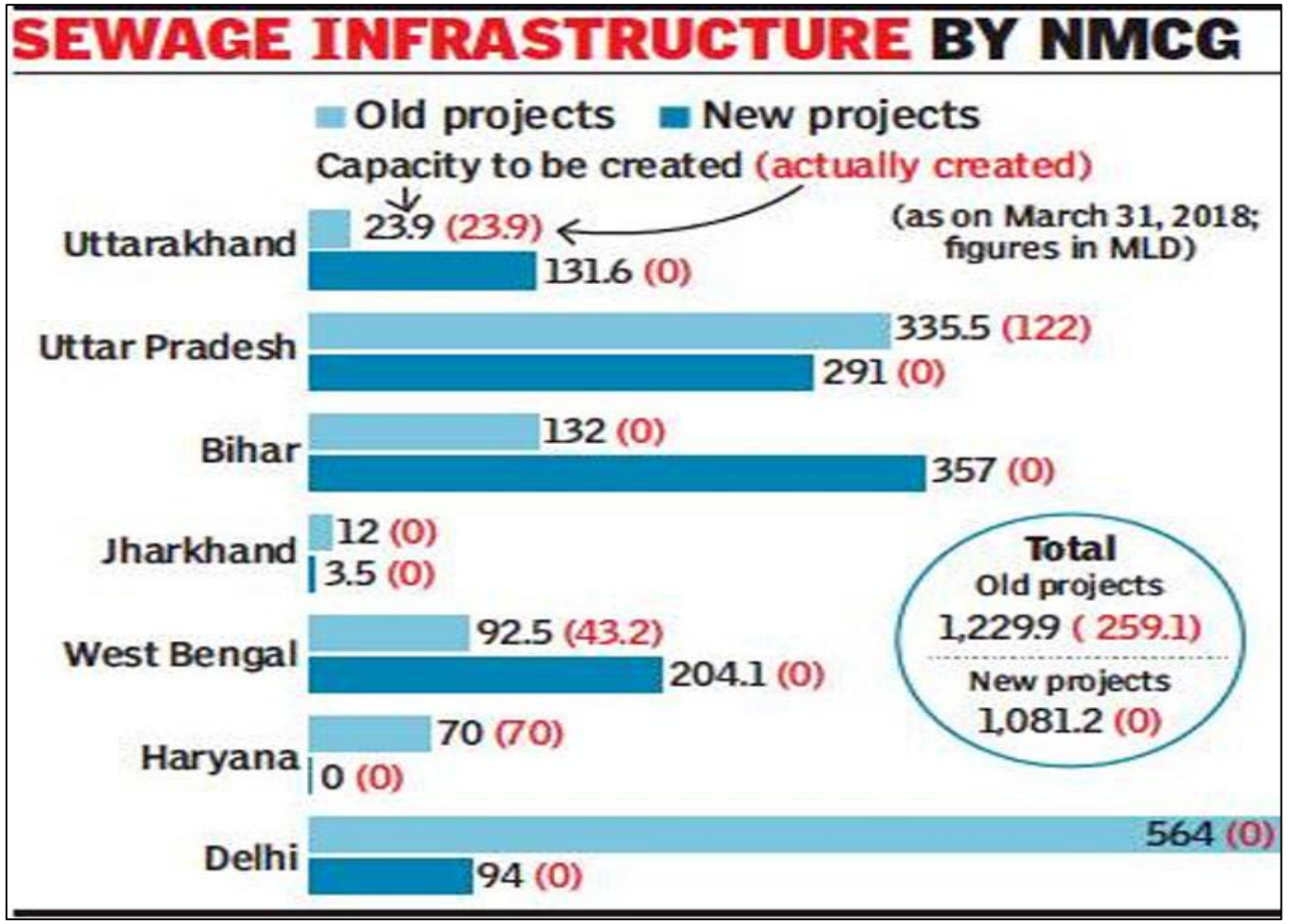
- **Untreated/partially treated domestic Sewage** & industrial effluents**:** About **46.4% (1369 MLD) of total** generated **wastewater** (2953 MLD) is **discharged untreated** from **97 Towns** along the **main-stem of Ganga.** ***…(NMCG 2018)***
- **WQ** of **Ganga** lagging behind: **BOD** (2001-2011)- max. range- **11-27 mg/l**; **Others-** Total & Faecal **Coliforms**, Salinity, **Heavy metals, Pesticides** etc. **(TERI Study: BOD, TC, Hg Contamination)**

Water Pollution: River Ganga

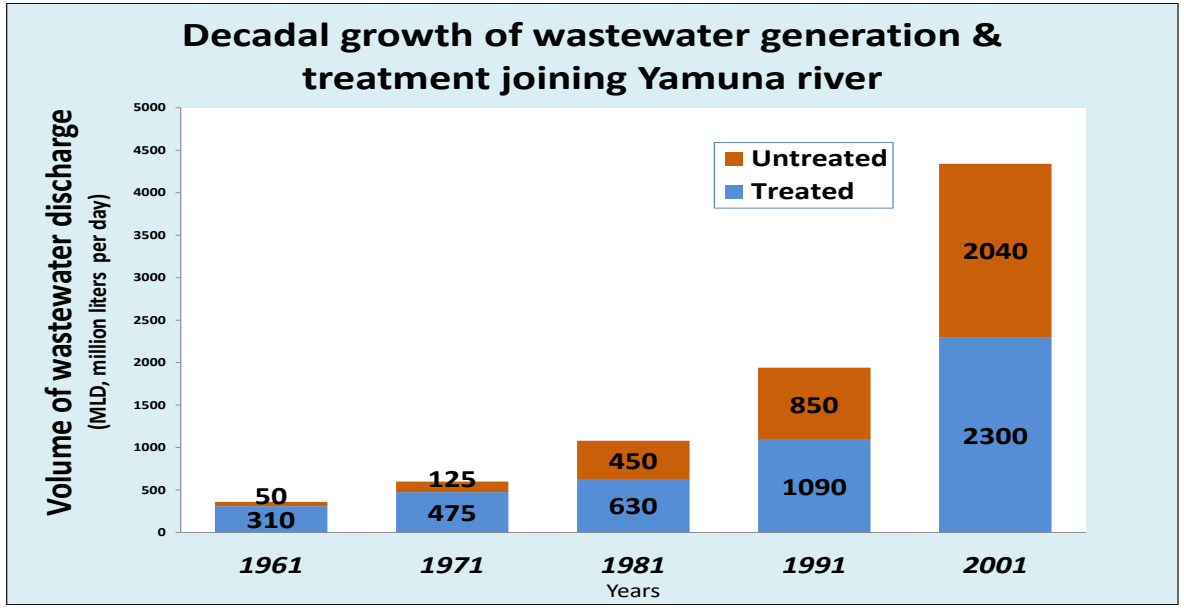
"1.3 billion litres of waste flows into Ganga every day"

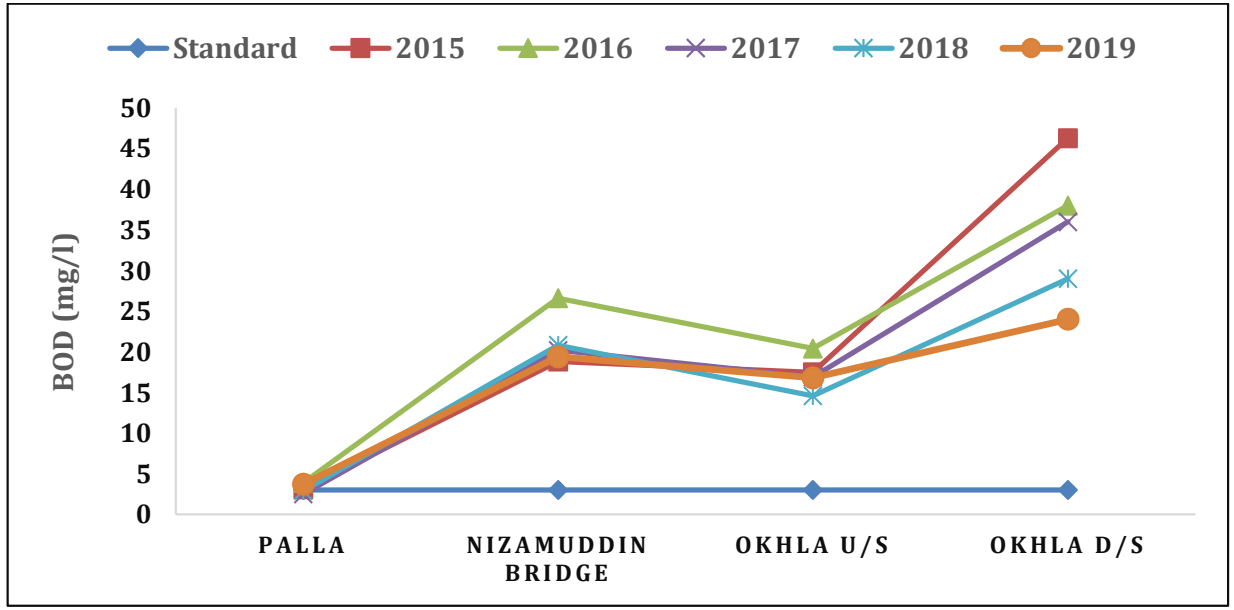
- National Mission for Clean Ganga (**NMCG**) has **created sewage treatment capacity** of just over **259 MLD**, which is about **11% of the 2,311 MLD** the programme seeks to create..

(As on 2018)



Water Pollution: River Yamuna





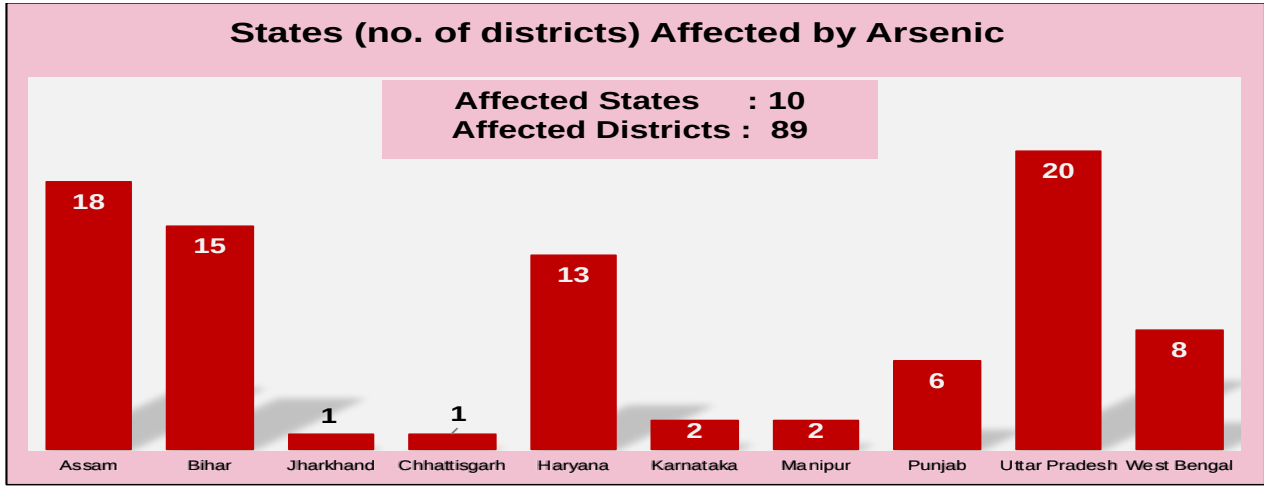
- Discharge of **untreated domestic sewage** (~80%); *untreated/partially treated* **industrial effluents; Others**
- **Delhi (the most polluted stretch of Yamuna)**
  - Of the **3267 mld** of sewage generated, e**xisting** treatment **capacity** ~ **2330 mld** (17 major STPs). Of this, the estimated **utilised capacity** ~ **1267 mld** (**45%** of total sewage generated)
  - Average **BOD** & **DO** ranged between **15-23 mg/l** & **0.0-0.1 mg/l respectively** (2011); **BOD** upto **45 -20** mg/L in **last 5 years**
- **GAP** & **YAP** could not achieve the expected cleaned state of rivers (investment till 2005 – INR 51.7 Billion)

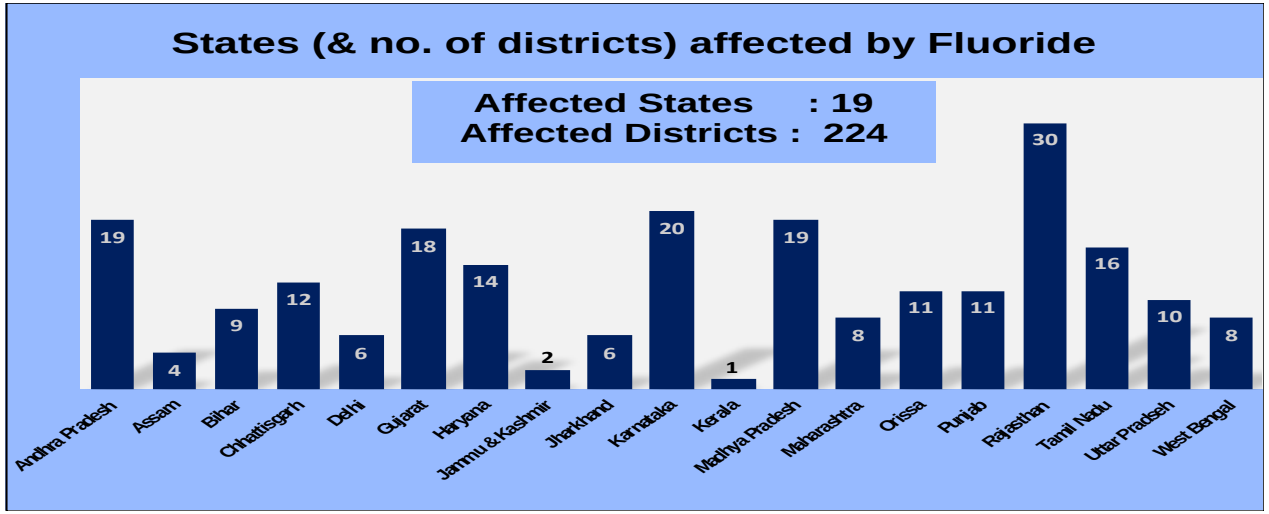
*Need for **focus beyond just infrastructural investment** involving **integration** of **institutional**, **financial** & **social mechanisms** to **facilitate** the **prevention and reduction** of river **pollution***

Water Pollution: Groundwater Contamination

Main pollutants of concern (Affect drinking water quality)

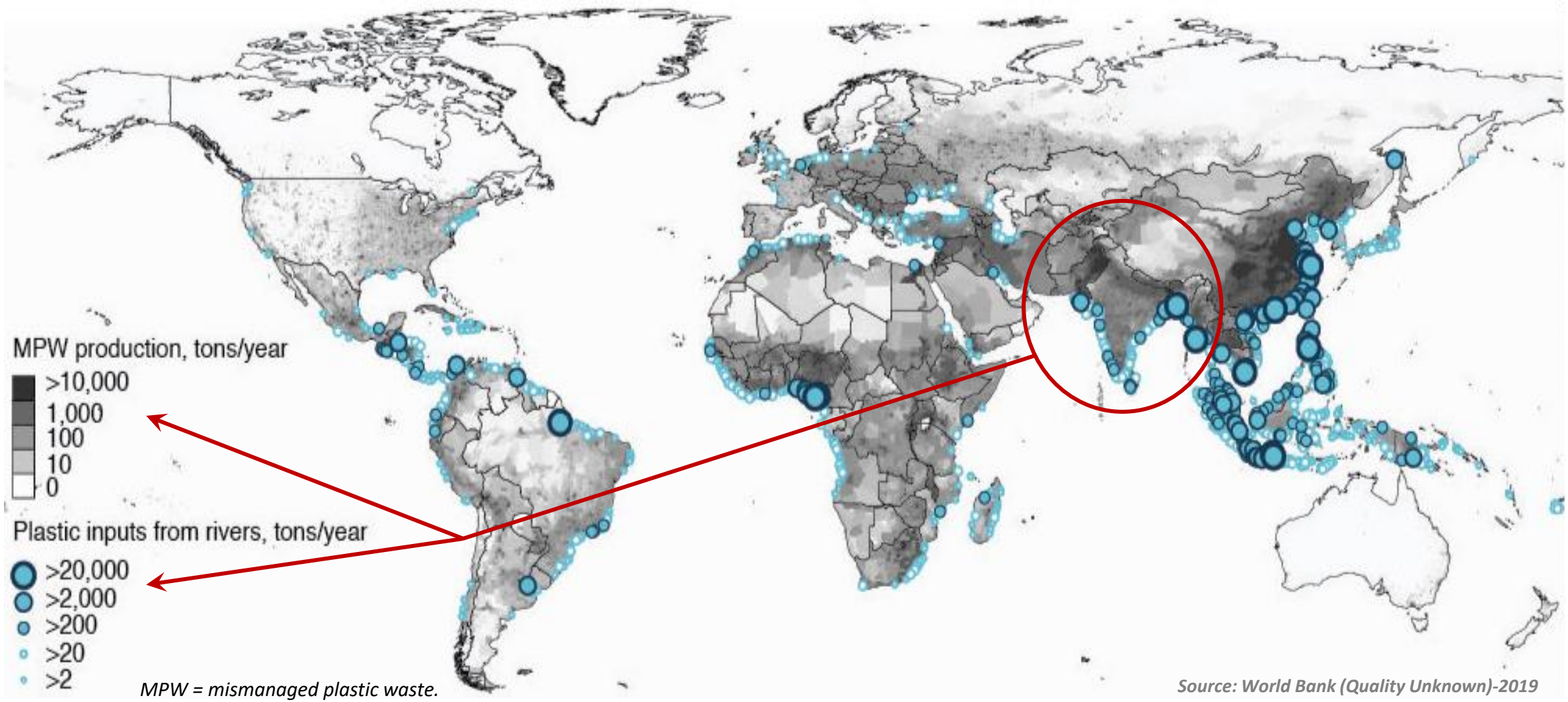
- ***Fluoride**:* Rajasthan (worst affected); Gujarat, Orissa and Andhra Pradesh, (Several other states)
- ***Arsenic**:* West Bengal, Bihar, U.P and Chhatisgarh
- ***Nitrate & Iron**:* Several states
- ***Inland Salinity**:* Northern & western states [Rajasthan, Haryana (10000 µS/cm), Punjab & Gujarat]
- ***Coastal Salinity ingress**: e.g.* Tamil Nadu & Saurashtra coast; Orissa coast & Pondicherry region.
- ***Heavy Metals & Pesticides***





Water Pollution: Plastics

Plastics: Mass of River Plastic Flowing into Oceans



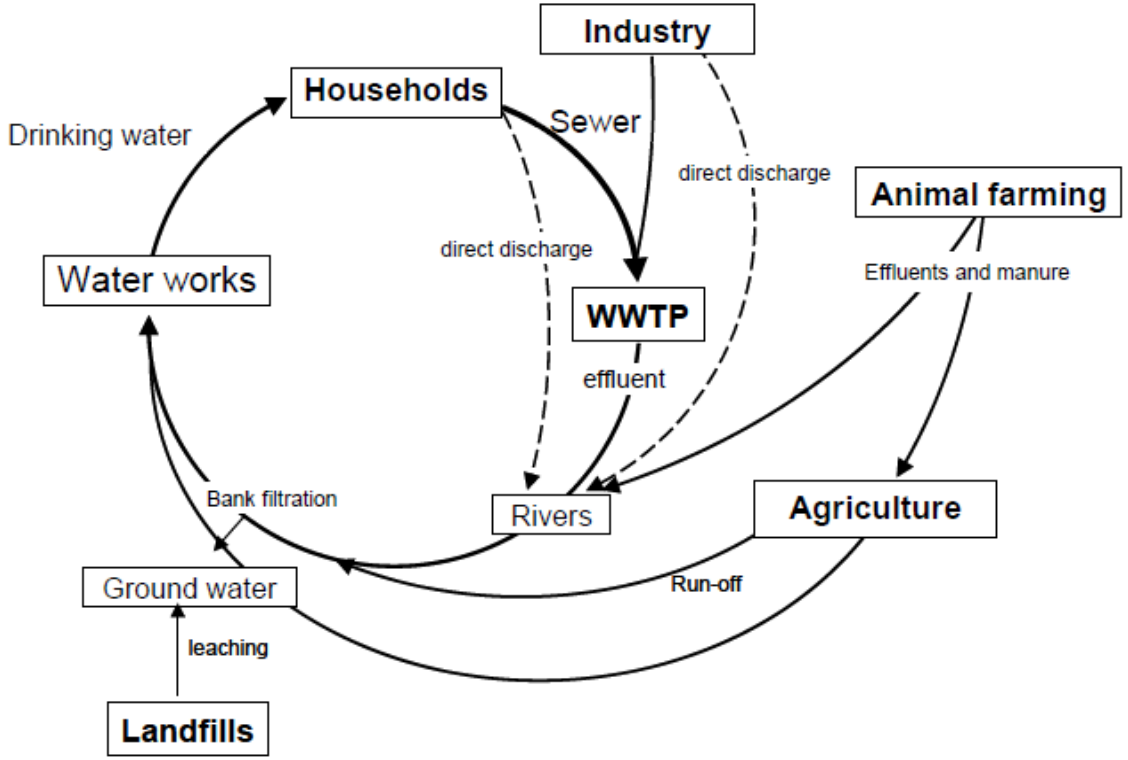
MPW = mismanaged plastic waste.

Source: World Bank (Quality Unknown)-2019

Emerging Pollutants/Contaminants (EPs/ECs)

"Emerging pollutants (EPs): Defined** as **synthetic** or **naturally** occurring **chemicals** that are **not commonly monitored** in the **environment** but which **have** the **potential to enter** the **environment** and **cause** known or suspected **adverse ecological and(or) human health effects"

- **EPs/ECs**: Currently **not part of routine monitoring** programs & their **fate**, **behavior** and **eco-toxicological effects** are **less understood**.
- EPs are **categorized** into **more than 20 classes** related to their **origin (Pharmaceuticals, Personal Care/Cosmetics, Preservatives etc.)**
- The **Pharmaceuticals- 17b-estradiol** (**E2**), 17a-ethinylestradiol (**EE2**) and **Diclofenac** as **priority hazardous substances** *(European Commission, 2012).*
- More than **200 pharmaceuticals** alone **reported** in **river waters globally. (**with **max concentrations** of **6.5 mg/l** for **Ciprofloxacin)** *(Hughes et al., 2013).*
- **Conventional secondary treatment** processes are **inadequate to remove ECs**



EP/EC Occurrence: **Point** source (mainly **urban** and **industry**) or **diffuse (Non-point)** source (**agriculture**) pollution.

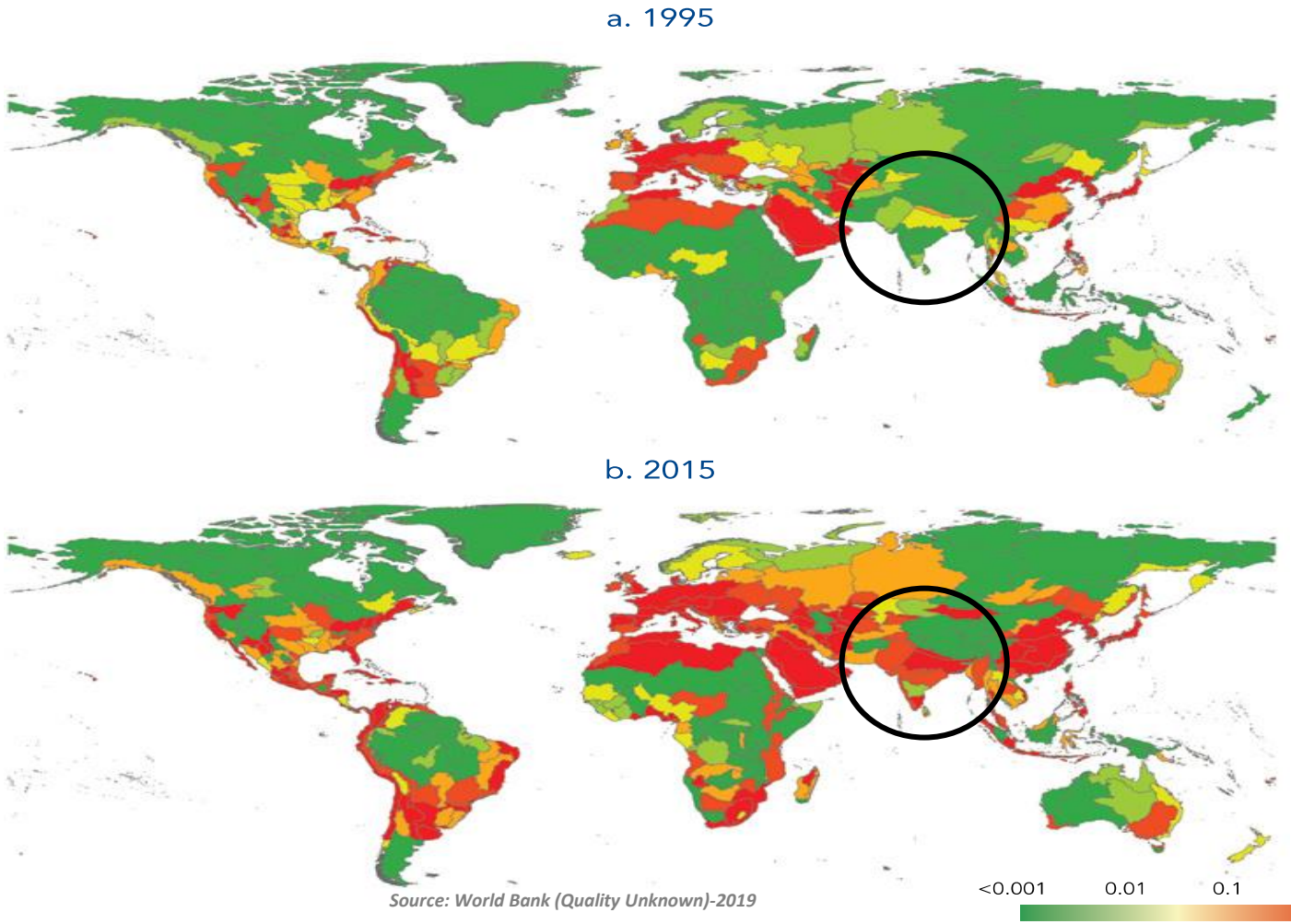
ECs Occurrence: Current knowledge *(in wastewaters & surface waters)*

Pharmaceuticals:

Risk of Antibiotic Ciprofloxacin (1995 Vs 2015)

Emerging Contaminant	Family/use	Final Effluent; (ng/l)	Surface Water; (ng/l)
Pharmacueticals			
Carbamazepine	Antiepileptic	826-3,117	<0.5-251
Diclofenac	NSAID	58-599	<0.5-154
Ibuprofen	NSAID	143-4,239	1-2,370
Amoxicillin	Antibacterial	31	<2.5-245
Metronidazole	Antibacterial	265-373	<1.5-12
Chloramphenicol	Antibacterial	<6-21	<10
Personal Care Products			
Triclosan	Antibacterial	25-200	5-48
4-benzophenone	Sunscreen	2701-4,309	<3-227
Methylparaben	Preservative	<3-50	<0.3-68

Source: **Bruce Petrie a, Ruth Barden b, Barbara Kasprzyk-Hordern**; A review on emerging contaminants in wastewaters and the environment: Current knowledge, understudied areas and recommendations for future monitoring:



Source: World Bank (Quality Unknown)-2019

Others:

- **Radioactive Substances: Uranium** in Groundwater (Rajasthan, Gujarat, Punjab etc.), Radium isotopes etc.
- **Nuclear waste: (Plutonium etc.)**

Government Response

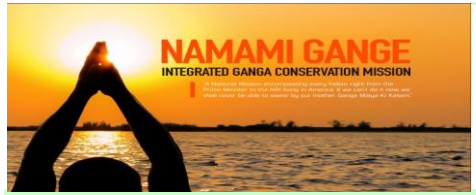
Major Programs and Initiatives

Government Responses

Major Policies/Regulation

- **The Water (Prevention & Control of Pollution) Act, 1974**
- **Pollution control**: **Ganga Action Plan (GAP-I, II, III))**; **YAP** (**Yamuna Action Plan**), National River Conservation Directorate (NRCD).
- **The Environment (Protection) Act**, **1986**
- **National Water Policy** (**2012**),
- **Groundwater regulation**;
- **NAPCC** (**National Water Mission**) **2008/09**.
- **Namami Gange, SBM, Smart Cities, AMRUT** (….)
- JNNURM (Jawaharlal Nehru National Urban Renewal Mission):
- UIDSSMT (Urban Infrastructure Development Scheme for Small and Medium Towns)

Recent Programs: Namami Gange & Swachh Bharat Mission



- **Rejuvenation of river Ganga**
- **Conservation of water bodies**
- **Conservation of ground water**

Nirmal Dhara *(Unpolluted Streams/Clean flow)*

- **Municipal, Industrial, Domestic (urban & rural) wastewater management**

Aviral Dhara *(Uninterrupted/ continuous Flow /Streams)*

- **Efficient irrigation, river bank, wetland conservation**

➢ **Budget (2015): Rs. 2100 Cr *(~0.33 b$)*** for **cleaning** of Ganga **(2016-17): Rs. 2250 Cr**

➢ **"Clean Ganga Fund"**

MoJS; DoWR, RD & GR


Photo Source: Ministry of Water Resource, River Development & Ganga Rejuvenation

Swachh Bharat Mission

Budget outlay (2015) - Rs. 6000 Crores *(~0.95 Billion USD)*

- includes **Rs. 2500 Crores *(~0.4 b$)* for NRDWP** for Supplementing the States, and
- **Rs. 3500 Crores *(~0.55 b$)* for the Swachh Bharat Abhiyan for Rural Sanitation.**

Budget outlay (2016-17): INR 9000 Cr

- **MoUD & MoJS; DoWR, RD & GR)** for urban & rural areas

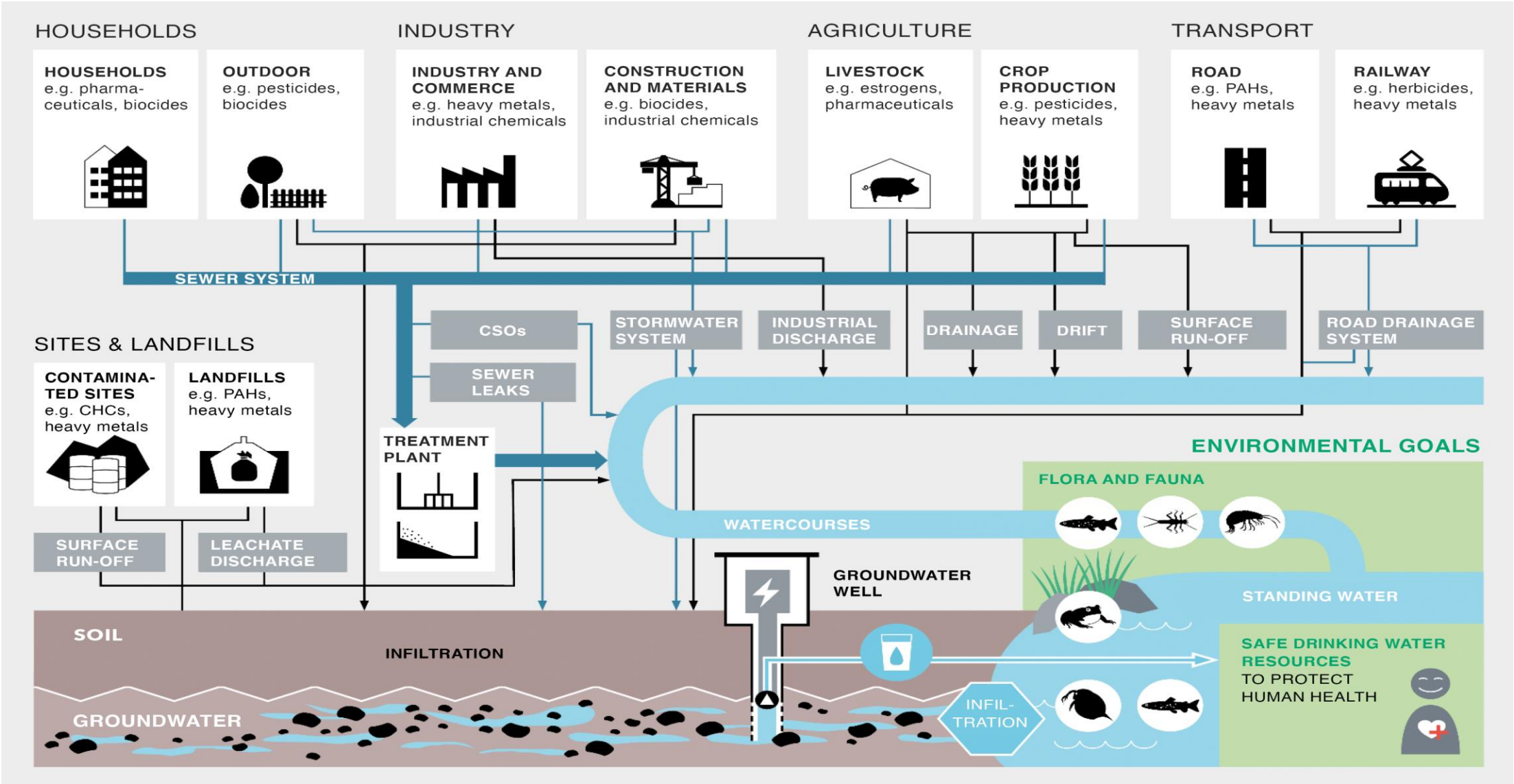
Components:

- **Household toilets**; **Community toilets**; **Public toilets**
- **Solid waste management;** IEC & Public **Awareness**; **Capacity building; Swachh Bharat Kosh**

Can Zero Pollution be Achieved in India ?

…What Needs to Be Done?

Pollutants in Water Cycle



Integrated Approach: Efficient Water Use & Pollution Abatement

Reducing Wastage/ Resource recovery

Improving Efficiency & Productivity

Water Conservation Reuse/Zero discharge

Enhancing Sectoral Water Use Efficiency; Reducing Pollution; Circular Economy

Domestic (Urban/Rural)

- *Reduction in UFW/ NRW/ leakages*
- ***Wastewater recycle, Ruse & RR***
- *Improving access & storage*
- *Rain Water Harvesting*
- *Maintaining water quality*

Agriculture/ Irrigation

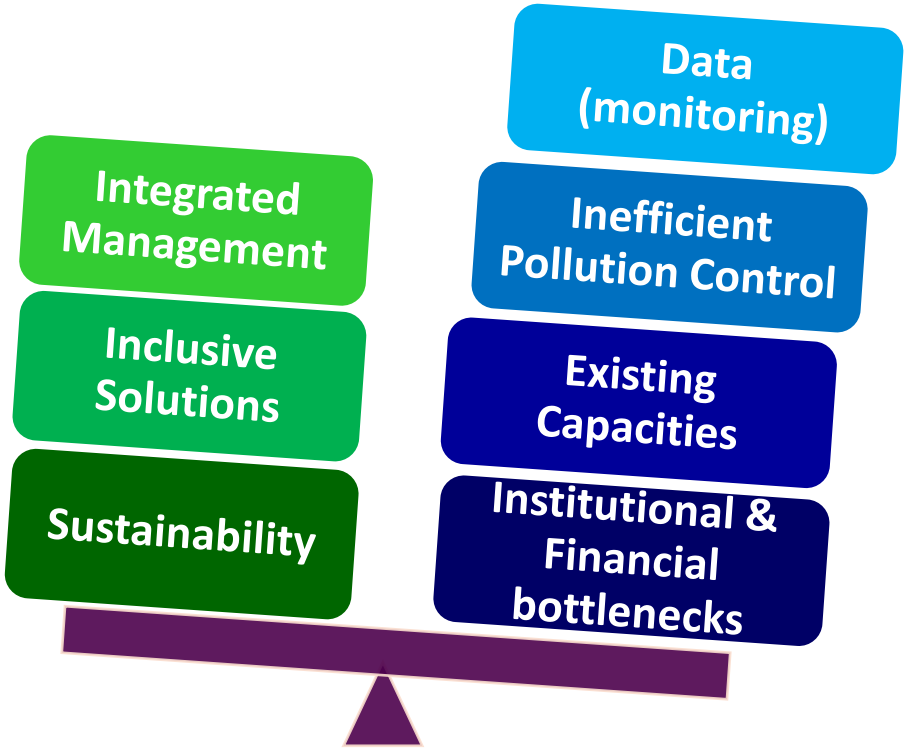
- *More Crop per Drop*
- *Reduction in losses*
- *Improving storage & usage*
- *Improved technologies & practices (drip/Sprinkler)*
- ***Reduce Non-point source of pollution***

Industrial

- *Reducing Specific water consumption (SWC)*
- *Reduction in losses & improving water productivity*
- ***Wastewater Recycle/reuse/ Zero Discharge/Water +ive***
- *Use of advanced technologies*
- *Reduction in losses*

Water Sustainability & Security

Addressing Imbalances in Water Management



- **Pollution (prevention & control)**: Sewage collection; treatment capacities, O&M of STPs; recycle/reuse; Revision of Standards/norms
- **Water use efficiency: Agriculture/ irrigation, Urban, Industrial**
- **Existing capacities** of **agencies:** Need training & **capacity building**
- **Integrated approach** to water use, conservation & wastewater **management, circular economy**
- **Inclusive solutions**: Involving wide range of **stakeholders**

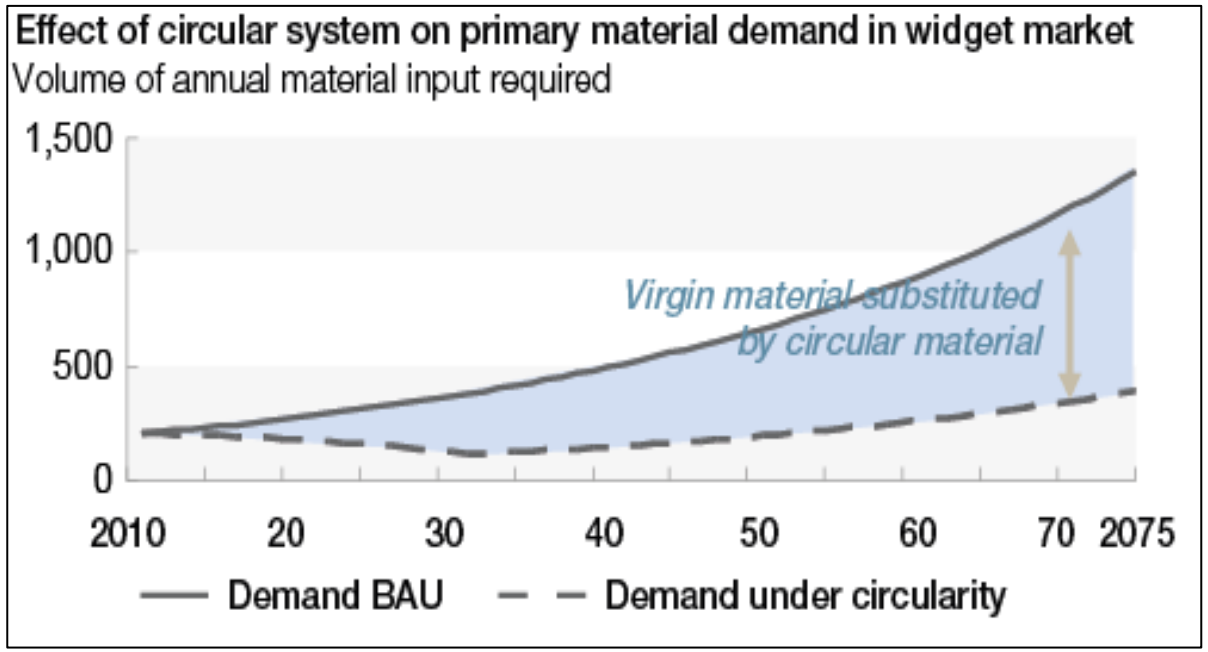
- **Institutional coordination**: Multiplicity, Need for **integrated decision making** & policy **implementation framework**
- **Financial reforms**: Innovative **incentive/disincentive** mechanisms**; adequate water pricing**
- **Data** availability & management (**real time** monitoring & **decision making**)

Water & Circular Economy

Concept *(World Economic Forum)*

A **circular economy** is an industrial system that is **restorative** or **regenerative** by **intention** and **design**.

- **Replaces** the **end-of-life concept** with **restoration**,
- Shifts to **use** of **renewable** energy,
- **Eliminates use of toxic chemicals**, that impair **reuse** and **return to** the **biosphere**, and
- Aims for **elimination of waste** by **superior design** of **materials**, **products**, **systems** and **business models).**



Water ….as Product

- **Extract Energy, Nutrients** *(Resource Recovery)*
- **Reuse/Reuse** of **Water/Wastewater** *(Resources)*
- **Prevention** of **impurity/contamination** in the first place
- **Value Chain** approach

Water ….as Resource

- Managing **Water Demand**; Water **Conservation**
- **More Efficient Water Use,** More **Water Productivity**
- **Zero discharge/Water Neutral/Water Positive** entities
- **Integrated** & **sustainable** water **withdrawal** & (Integrated **Watershed/River** Basin Management)

Opportunities & Interventions

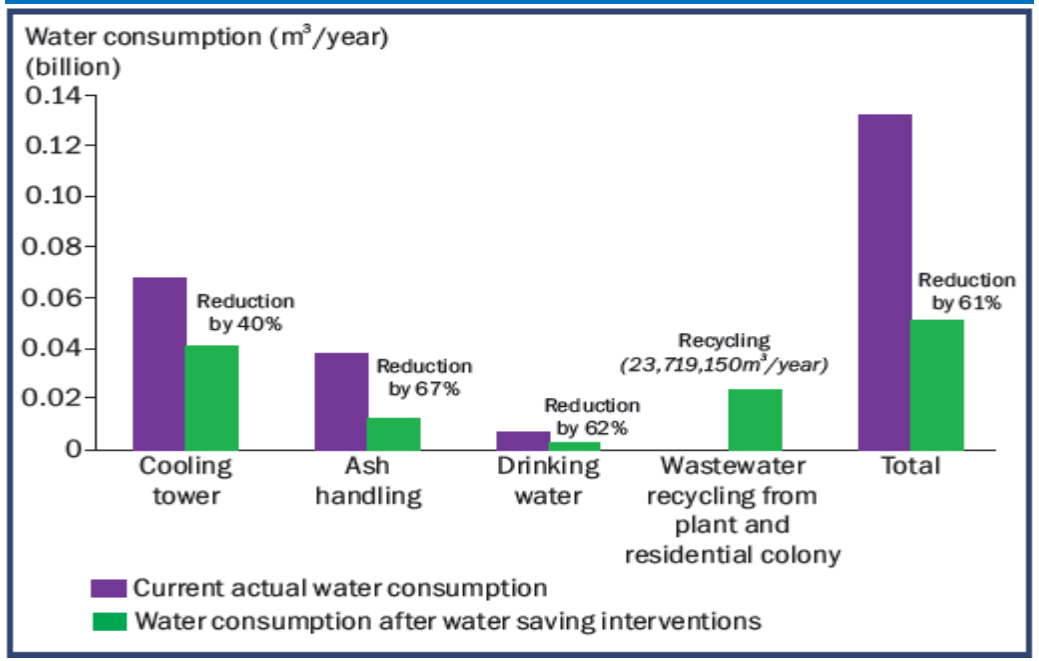
(Wastewater Recycle/Reuse/Resource recovery)

A Few Examples

Water Savings & Wastewater Reuse: Opportunities *(Examples from TERI)*

Indian Industries (TPP, Heavy Engineering, Pulp & Paper, etc.)

TPP (3,000 MW): Recycling waste water can save ~ 17.9 million m^3/year with **financial saving of ~ INR 72 Million**



Thermal Power Plants: The **potential** of daily **water saving** was about **18% to 23% of intake water**
(e.g. Actual reduction** from **4.8 m^3/MW** to **3.2 m^3/MW)

Heavy Engineering: Water **Saving Potential = 46.8 % of Intake Water (675 m^3/day)**

Healthcare (GSK): (**Water footprint reduction** in value chain- Wheat, Barley, Milk); Water saving **potential** of **20.69 MCM** ***(e.g. RT/RWH, Farm Ponds, Artificial recharge of GW, Drip/ sprinkler irrigation)***

Tobacco Industry: Water saving potential **– about 55 m^3/day (~ 22.2% of** the **freshwater** intake**)**

IT Industry *(WIPRO)*: Water saving potential **– about 638 m^3/day (~ 43% of total** plant **water consumption)**

Railways: Recycling Wastewater can **save ~0.23 MLD water at one cluster of washing line**. (Overall recycling wastewater could save ~**1-2 MLD water (45%-60% of** freshwater **demand-supply gap**)

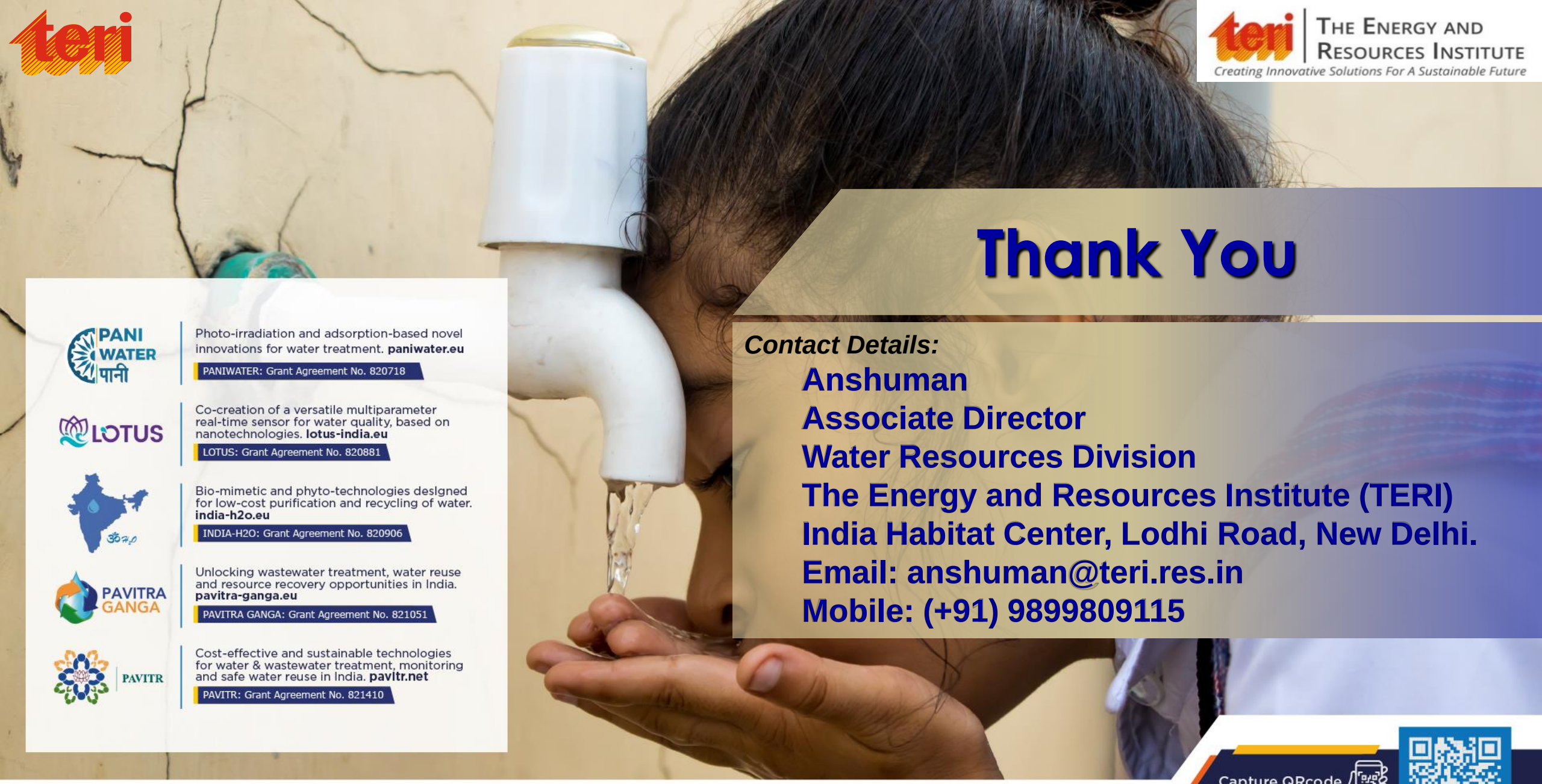
Wastewater Reuse & Resources Recovery *(Few Examples…)*

Resource Recovery: Biogas production & electricity generation; Kodungaiyur, Tamil Nadu, India

- **Wastewater Reuse**: **Kodungaiyur STP of 110 MLD** treat sewage of Manali and Chinnasekkadu regions. The **Chennai Metropolitan Water Supply and Sewerage Board** (**CMWSSB**) assigned contract to **VA TECH WABAG** on **DBO** mode. About **36 MLD wastewater from the STP is reused** in **Chennai Petroleum Corporation Ltd.** (**CPCL**).
- **Resource recovery:** The **STP produces about 12,500 m^3** of **biogas per day from which**, **about 13 MW/day of electricity is generated**. The STP has achieved about **98% self-sufficiency** in terms **of power consumption** (WABAG, n.d.).
- Monetary saving: **INR 20 million/annum** by **using** the on-site generated **electricity**.

Resource Recovery: Biogas production and electricity generation; Rithala, Delhi, India

- **Wastewater Reuse**: **Rithala STP** (two STPs of **181 MLD** capacity each) receives sewage from North-West Delhi. **Treated wastewater** from the **STPs are reused** for **gardening and in thermal power plants (Tata Power Delhi Distribution** and **Pragati Power Corporation Limited).** In **STP-II,** designed and built by **SUEZ, biogas generated** is **used for electricity production, within** the **treatment plant.**
- **Resource recovery:** In 2015, **STP-II** generated **20000 kWh** of **power daily,** which helped **meet** about **30% - 35% of the electricity demands of** the **STP-II.**
- **Monetary savings** due to captive electricity production is estimated to be **INR 56.6 million per annum.**



Thank You

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PANI WATER पानी

Photo-irradiation and adsorption-based novel innovations for water treatment. **paniwater.eu**

PANIWATER: Grant Agreement No. 820718

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LOTUS: Grant Agreement No. 820881

Bio-mimetic and phyto-technologies deslgned for low-cost purification and recycling of water. **india-h2o.eu**

INDIA-H2O: Grant Agreement No. 820906

PAVITRA GANGA

Unlocking wastewater treatment, water reuse and resource recovery opportunities in India. **pavitra-ganga.eu**

PAVITRA GANGA: Grant Agreement No. 821051

PAVITR

Cost-effective and sustainable technologies for water & wastewater treatment, monitoring and safe water reuse in India. **pavitr.net**

PAVITR: Grant Agreement No. 821410

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