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NAMAMI GANGE

Pollution Accidents and Crisis Management

Part 1: Strategy Paper to deal with pollution accidents in Ramganga River Basin

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Executive Summary

Aim of the project was the development of a strategy paper to deal with accidental pollution and to improve response mechanism towards crisis management.

Broadly, the following components were proposed to be covered in the Strategy Paper:

- Overview/ Categorization of major risk areas of pollution accidents in Ramganga basin
- Suggestive response measures for counteracting impacts of accidental pollution incidents
- Recommendations towards framing strategy for crisis management at organizational levels

The Strategy Paper shall:

- Serve as a tool/handout for executing agencies/operators and the concerned authorities in adopting safety measures to deal with category specific threat.
- Be a reference document for framing accidental pollution management strategies at different organisational levels, based upon the recommendations agreed with NMCG.

As agreed upon with NMCG, to limit the scope of pollution accidents being covered in this strategy paper to Industrial and Municipal sources, the pollution incidents covered are both point source pollution from industries in the basin. The Ram Ganga basin is part of the Ganges River basin. The crisis management strategy for dealing with such incidents in the Ganges River basin under the aegis of National Mission for Clean Ganga is articulated in this study.

- Serve as a tool/handout for executing agencies/operators and the concerned authorities in adopting safety measures to deal with category specific threat.
- Be a reference document for framing accidental pollution management strategies at different organisational levels, based upon the recommendations agreed with NMCG.

A description of major risk areas of pollution accidents in Ramganga basin is given in Chapter 4. The following major risk areas in Ramganga River Basin were identified:

- Point Sources 1: Industrial area around Moradabad, Rampur and Bareilly in Uttar Pradesh and Kashipur Industrial Area in Uttarakhand
- Point Sources 2: Urban wastewater around Moradabad and other major Towns located in Ram- ganga Basin

Ramganga sub-basin is having high population load of 18.2 million (2011 census) and many Industrial units are operational in the Ramganga sub basin. High population coupled with large number of indus trial units in the sub basin (in cities like Kashipur, Moradabad, Kannauj) poses a threat to the river water quality due to possible pollution accidents in the area. There are 7 major cities, namely Moradabad, Rampur, Bareilly, Shahjahanpur, Farrukhabad, Hardoi and Kannauj, located in the catchment area of the river under Uttar Pradesh. Out of these 7 cities, only the 3 cities Moradabad, Rampur and Bareilly have sewage/effluent flows into river Ramganga. In the remaining 4 districts (Shahjahanpur, Farrukhabad, Hardoi, Kannauj), no drain, either domestic, industrial or mixed, flows into river Ramganga. Hence there is no contribution of pollution load into river Ramganga from these 4 districts. The total domestic and industrial discharge flows into river Ramganga through 28 drains as well as through some minor drains directly discharging into the river. Out of 28 drains, 4 drains meet river Gagan, which ultimately flows into river Ramganga at Moradabad. As per desk inventory, approximately 421 MLD of sewage and 24 MLD of industrial effluent is being discharged into the river. The estimation of industrial effluent is based upon the consented discharge quantity from the units. But actual industrial effluent may be higher than estimated, because of additional discharge by consented industries and discharge from illegal industries, operating in non-conforming areas.

The polluted stretch of River Ramganga is located in UP State and receives approximately 24 MLD treated industrial effluent from 121 water-polluting industries. However, from upper catchment located in Uttarakhand, 20 Grossly Polluting industries (GPIs mostly Pulp & Paper) and 40 other industries (located along the Dhela Bhella and Kosi rivers) discharge almost 38.4 MLD treated effluent. In the Ramganga Basin, Industries which are grossly polluting in nature belong to Sugar, Pulp & Paper, Distillery, Textile, Slaughter House and Electroplating etc. However, all these industries have functional ETPs and treated effluent is discharged in to the river but due to lack of dilution water in the river, most of the times river only carries treated industrial wastewater and treated/untreated sewage discharged from urban agglomerations. In entire Ramganga basin, huge gap between sewage generation and its treatment capacity is also observed. Therefore, Establishment of Sewage Treatment Plants of adequate capacity in all major towns of Ramganga Basin is prime importance. Laying of Sewerage Network & Connection of households to the sewer line in order to utilize the installed capacity of existing STPs of Moradabad and Rampur should also be done on priority. Re-inventorisation of Water Polluting Industries (vulnerable to accidental discharges viz. Sugar, Distillery, paper etc.) in the catchment area of the drains and their status with respect to consent, installation of ETP, adequacy of ETP and final discharge point should also be completed. Adoption of cleaner technologies by water polluting industrial sectors, having major impact on water quality of the Ramganga river and its tributaries, is highly advised. Imposing stringent norms in Distillery, Pulp & Paper, electroplating industries will also reduce the overall pollution load in the river. Ensuring strict compliance of Installation of Online Continuous Effluent Monitoring System, Flow Meter & Web Cams in GPIs with connectivity to the server of CPCB and State Pollution Control Board will also help to reduce and monitor accidental discharges.

Following are the key measures which may prevent and control urban and industrial pollution accidents:

Urban Pollution Control

- Time bound Implementation of Polluted River Stretch Rejuvenation Action Plan prepared by Uttarakhand and Uttar Pradesh Pollution Control Board for Ramganga River and its Tributaries like Dhela, Bhela and Kosi River.
- Establishment of Sewage Treatment Plants of adequate capacity in all major towns of Ramganga Basin to fill the gap between sewage generation and its treatment.
- Laying of Sewerage Network & Connection of households to the sewer line in order to utilize the installed capacity of existing STPs of Moradabad and Rampur.
- Interception & diversion of the drains having high sewage load by Preparation of DPR for channelization including diversion of sewage and interception of all drains (excluding drains carrying industrial wastewater) for ensuring proper treatment through upcoming STPs.
- Installation of Web Cams & Online Continuous Effluent Monitoring System in STPs/ ETPs.
- Regulation for water reuses and Improvement of regulatory enforcement.
- Untapped drains to be provided with In-Situ bioremediation based treatment.
- Compliance of SWM Rules (2016) shall be strictly followed for collection, segregation, transportation, and disposal of Solid Waste. There is a big need for solid waste processing infrastructures in the Ramganga catchment.
- Strictly ensuring prohibition of dumping of solid & other waste within 500 Meters of the banks of the river.
- Treatment & disposal of legacy waste dumped within 500m of the bank of the river & ensure Collection & Segregation of Solid Waste as per provision of SWM Rules, 2016.

Control over Industrial Pollution Accidents

- Re-inventorisation of Water Polluting Industries (vulnerable to accidental discharges viz. Sugar, Distillery, paper etc.) in the catchment area of the drains and their status with respect to consent, installation of ETP, adequacy of ETP and final discharge point.
- Adoption of cleaner technologies by water polluting industrial sectors having major impact on water quality of the Ramganga river and its tributaries.
- Imposing stringent norms in Distillery, Pulp & Paper, electroplating industries.
- Ensure strict compliance of Installation of Online Continuous Effluent Monitoring System, Flow Meter & Web Cams in GPIs with connectivity to the server of CPCB and State Pollution Control Board.
- Reduction of water uses enhance recycling and reuse of treated water. Installation of sealed flow metering system along with running hours at the inlet water source and outlet and at inlet pipeline of different process operation and outlet of ETP.

- Closure and legal action against the illegal water polluting industries operating in non-confirming /residential areas.
- Usage of cyanide in electroplating should be phased out and various metal bearing streams shall be segregated by way of dedicated marked lines, to segregate wastewater according to its characteristics.
- ETP must be provided with tertiary treatment units like Reverse Osmosis Plant, Ultra Filtration, Ion Exchange etc, to enable recycling of treated effluent in the process.
- Unit shall reduce the wastewater discharge up to 50% by adopting cleaner technologies such as Controlling spillages by using troughs between tanks and avoiding haphazard rinsing and wash- ing Recycling of treated effluent for rinsing.
- Routine and surprise inspection GPIs and Red category of industries for ensuring compliance of effluent discharge standards as prescribed under E (P) Rules, 1986, as amended.
- Action Plan for Distillery & Fermentation Sector for Mitigation of Pollution to ensure ZLD.
- Restriction on spent wash storage capacity in the Distilleries units.
- Strict compliance of CPCB directions to ensure safe storage and handling of Molasses's generated from the sugar mills.
- Sugar mill shall ensure that molasses generated by the units is not leaked/discharged into surface water bodies/ground and shall be stored in proper tanks meant for this purpose.
- To ensure proper pecautionary measures for the storage of excess molasses, if stored in Kutcha lagoons, open tanks as per NOC of Excise/concerned Department.
- Molasses stored in such temporary storage tank shall be properly utilized/consumed before approaching monsoon season. Sugar Mills shall explore the utilization of molasses by other distilleries within the State or in the nearby State and legal formalities if any.
- Strict compliance of Hazardous and Other Wastes (Management & Trans boundary Movement) Rules (2016) for prevention and minimization of any chance of land and water contamination in the catchment.
- The residue generated from flue gas scrubber and tar containing wastes (generated due to spills/debris containing tarry wastes, used oils, scrubber residue, etc.) shall be disposed as hazardous wastes through common TSDFs as per the conditions stipulated under consent / authorization issued by concerned SPCB.
- Used oil procured for recycling shall meet the specification mentioned in the part A of Schedule V (HOWM Rules, 2016).
- Used oil and its recycled products shall be handled in compatible containers with an unbroken screw top lid. Cool, dry, well ventilated, and covered sheds must be available on the premises for used and waste oil.

- There should be a dedicated hazardous storage area for temporary storage of hazardous waste generated during utilization process in the industry. Wastewater generated from floor-wash- ings, spillages, washing plastics, collected water while recycling the used oil, scrubber bleed shall also be treated in Effluent Treatment Plant (ETP).
- Process and primary sludge of ETP of Pulp and Paper industry is categorized as HW and utilization of waste pulp from process sludge & primary sludge to produce Paper board/Mill board shall follow Standard Operating Procedure (SOP) prescribed by Central Pollution Control Board.
- Utilization of Metal and metal bearing wastes for recovery of metals and Utilization of ETP sludge should also be done as per standard operating procedures of CPCB.

Incidents of fish deaths are common in the Ram Ganga basin. Studies indicate that a key reason for fish kills is the discharge of raw sewage (both domestic and industrial) into waterbodies. Raw sewage enters the water body by direct discharge, that were traditionally supposed to carry stormwater.

Large quantities of pesticides are used every year along the river basin agricultural areas. By the surface runoff, floods and monsoon rains the residues of these substances are entering the river in large amounts year per year. The agricultural runoff, which is rich in fertilizers (such as Nitrate, Phosphorus and Kalium), is a growing concern of non-point pollution in the Ganges River as well as Ram Ganga River. If conditions like low temperature add on top, these residues persist and tend to bio-concentrate in the food web. Studies have shown residues sometimes are above the acceptable limit.

For this reason, there is a need to quantify the substances entering the basin in States of Uttarakhand and Uttar Pradesh. Despite the major plans to control the use of pesticides, occurrence and high level of pesticides have been continuously detected across many rivers in the country. Several hundred different types of pesticides are currently used within agriculture within the Ganga River basin. Estimated from agricultural and other sources, above 9000 MT of pesticides were annually used for agricultural practices in the Ganga River basin (Ghosh, Chatterjee, & Samanta, 2009). In the recent studies of (National Ganga River Basin Authority NGRBA, 2011) it is estimated 21000 MT of pesticides are emitted in the basin annually. Risk assessment is important for management, policy projects, decision making and their implementation. For the future, more detailed and comprehensive studies of the total pesticide use along the agricultural areas of river Ganga basin is required. Impact and accumulation of pesticide level in biota along with matrix studies is highly recommended and useful.

The objectives of the overall contracting services to develop “Strategy Paper to deal with pollution accidents in Ramganga River Basin including Crisis Management” are:

A. Development of a proposal clearly defining responsibilities of NMCG for efficient crisis management due to pollution accidents in Ganga Basin.

B. An implementable strategy paper to deal with pollution accidents in Ramganga Basin is available with NMCG.

This document covers Part B of the service.

1. Introduction

The Ramganga river flows for over 650 km until it joins the Ganga at Tehra Ghat village, Hardoi district, Uttar Pradesh. The mean annual regulated flow at the basin outlet is around 6.3 billion cubic metres (BCM) which is 2% of the total flow of the Ganga. Around 73% of the utilizable groundwater resource in the Ramganga basin is presently abstracted for both irrigation purposes and domestic supply.

The Ramganga is a 'near-pristine' river in the lower Himalayas until it reaches the foothills, where it starts facing fragmentation at Kalagarh Dam, abstractions at the Hareoli Barrage, sewage, and industrial pollution from Kashipur, Moradabad, and Bareilly; encroachment of floodplains, over-exploitation of groundwater, degradation of wetlands and other unsustainable activities leading to reduced groundwater recharge and potentially reduced base flows. Despite this, the Ramganga restores its river health to some extent before the confluence with the Ganga, which is evident from the fact that Dabri is a reasonable habitat for some of the native aquatic species of the Ramganga. (Source: Environmental flows for a Healthy Ramganga, WWF Report 2018)

There are 121 major water polluting industries scattered within the three districts Moradabad, Rampur, and Bareilly. Mainly Sugar Mills, Paper Mills, Textile, Distilleries, Slaughter Houses, other industries and numerous urban settlements situated along the course of River Ramganga discharge their effluent / sewage into the river. The polluted river stretches receive considerable amounts of wastewater every day leading to a considerable deterioration of the water quality. (UPPCB, 2019)

It has been decided, that GIZ together with NMCG will be working on a River Basin Management Plan for the Ramganga Basin to set an example for other sub-basins within the Ganga Basin. In this context, it has also been decided to work on a strategy paper in the Ramganga Basin regarding accidental pollution. The approach towards dealing with pollution accidents may essentially be at two stages:

First, by adopting preventive measures and second, by minimizing the negative impacts post occurrence. In line with this, measures to deal with pollution accidents have well been adopted in European rivers, such as "Accident Risk Spots" mapping as in Danube River basin and the "Rhine Alarm Model" comprising of an efficient and effective alarm system to reduce the number and size of events of accidental river pollution as well as to improve the control of these pollution incidences. High population coupled with large number of industrial units in the Ramganga Basin (in cities like Kashipur, Moradabad, Kannauj) pose a threat to the river water quality due to possible pollution accidents in the area, and subsequently it demands a well framed strategy in place to deal with such incidences for effectively managing the crisis.

These key terms guide the development of this strategy paper, which final purpose it to lead to the development of an Emergency Preparedness Plans (EPP) or Emergency Action Plans (EAP). This process comprises the situation assessment enhanced with a gap assessment and draft the options for the future. The output is a roadmap for addressing pollution accidents embedded in a future emergency pre- paredness and action plan.

2. Key Principles

In this chapter the basis for the development of "Potential measures to address accidents in the Ram- ganga River basin" is described, which is taken up and specifically explained in Chapter 5.

Crisis management manifests in the preparation of Emergency Preparedness Plans (EPP) or Emergency Action Plans (EAP), which enable the stakeholders to be clear about the following key aspects:

- Threats and risks
- Roles and responsibilities of stakeholders including their organisational structure and qualification
- Definition of objectives in preparing for and dealing with a crisis situation
- Monitoring of the system and triggers activating warning and emergency levels
- Emergency response mechanisms
  - → Emergency identification,evaluation and classification,response actions
  - → Notification trees or call-down trees
  - → Emergency/responseactions
- Preparedness and preventive actions

These key terms guide the development of a strategy paper that can finally lead to the development of an EPP or EAP. The terms are also in line with the measures that have been adopted in European rivers to cope with pollution accidents.

Preparing for and dealing with a crisis situation needs a clear understanding among all parties involved about the objectives of the crisis management. It is obvious to prevent accidents from happening, but the way to achieve that can be different and is also a decision made based on available resources.

Firstly, how much effort has to go into prevention is a legitimate question and implies that responsible authorities have to build capacity in monitoring of potential polluters and enforcement and approval of preventive measures.

Secondly, how much effort is needed to cope with a current accident in terms of monitoring, situation assessment, operation centres and launching and coordinating counter measures.

2.1 Definition of accidents

The threat and risk analysis for pollution accidents requires to be aware of the potential pollution point and non-point sources, the substances, concentrations and loads that may lead to pollution accidents, match critical substances to industries, what actions can lead to accidental pollution and the behaviour of the substances once they have reached the river. The last point calls for the evaluation of the propagation of substances in the river, travel time, dilution within the cross-section (lateral) and along the river (longitudinal). Depending on the substance, it is possible that mixing processes do not happen quickly, and the concentration is very inhomogeneous in a cross-section. The design of proper monitoring concepts requires this information, otherwise the risk is high to have a monitoring system in place that is "blind" because wrong locations and wrong time intervals have been chosen.

Attention must also be paid to the definition of what is an accident. Therefore, the first step is a clear definition of events to be considered as an accident. The exact definition must be done on multiple criteria, which are not trivial and have to be elaborated based on watershed specific and political boundary conditions. The definition of what is an accident can be split into two main categories: General criteria and Guidance values. The general criteria are set once and provide general guidance on a pollution accident definition. These criteria may be part of the decision. Or, in case of extremely hazardous substances or substances, where even lowest amounts are extremely toxic or monitoring and measuring comes technically to it limits, the sole trigger of a pollution accident scenario. The guidance values provide the specific numbers to define the triggers for entering an emergency and require that monitoring systems are designed accordingly.

Therefore, as agreed upon with NMCG, the scope of pollution accidents being covered in this strategy paper will be limited to Industrial and Municipal sources. Possible accident sources will be limited to anthropogenic sources.

Examples what anthropogenic sources may cause accidents, possibly in combination with each other, are:

A. Polluters directly discharging / not directly discharging / storing hazardous substances

B. Unforeseeable / expected events

Expected events aim at discharges from industries or urban settlements as regular events due to the design of a sewer drainage system or simply due to regular/standard operation procedures. The effect in the river is comparable to an unforeseeable accident with the difference that it is just a matter of time when it will happen.

Polluters directly discharging into the river are obvious. Indirect polluters, however, are often not easily identifiable and therefore pose an unknown risk. An indirect polluter owns the potential that hazardous substances reach the river through a more complex pathway, for instance through the connection to a drainage system/treatment plant, groundwater infiltration, false connections to a drainage system or other transport media.

Storage of hazardous substance is again more obvious and should always be added into the list of potential root-causes for pollution accidents. Another root-cause for pollution related to floods is linked to the flooding of areas containing critical infrastructure like gas stations, oil tanks, sewage treatment plants etc.

2.2 Scope of pollution accidents

The entry point for a strategy to cope with pollution accidents is the development of manuals on hazardous substances and a database of hazardous substances. While the manuals should provide detailed information on hazardous substances (e.g., information on toxicity for both human and environment; persistence; interaction with other substances; counter measures; etc.), the database should contain comprehensive information on the substances and the locations including data related to drainage routes, travel time, access routes, responsible operators, points for interventions, etc. This type of information can be considered as a baseline for a pollution accident strategy.

The information should be easily accessible. A suitable approach is certainly an open web platform.

2.2.1 Relevant sources / content of the database

Relevant sources for pollution accidents are

- Industrial areas
- Municipal wastewater

Into a database system all locations which fulfil the following criteria are to be integrated

- Existence of substances (storage, production, used within production,
- and, available in such amounts that already partial leakages are likely to exceed thresholds.

A European example of such a database is described in chapter 3.1.2 (E-PRTR database).

The potential threats of relevant sources come from point sources (usually through sewer system, e.g., leakage in a single pipe due to lack of maintenance). These relevant sources are usually located in industrial areas and municipalities. For the definition of a relevant pollution source, existing accident prevention measures and security features are not relevant. If above mentioned criteria apply, the location is identified as a potentially relevant source, whether preventive safety measures are in place.

Mapping of these sources is paramount to be complete in terms of defining preventive measures (in- spections, reporting, regular safety drills, etc.) from which preparedness measures can be derived (e.g., location of monitoring stations). The application of GIS has become state-of-the art and is recommended for displaying and combining/overlaying with other parameters (e.g., which substances are located where and what amount). This facilitates both inventory of preparedness measures and support when an accident occurs.

2.2.2 Potential impacts

In the context of this Strategy paper the most relevant potential impact of pollution accidents is on river water quality of Ramganga river. Other, more indirect impacts may be on groundwater quality, biodiversity, and several others, such as crops or soil, as well as on public health.

Even though environmental impacts might not directly affect public health immediately, the interactions with the affected environment (e.g., drinking ground water, eating crops polluted by substances or their decomposition products) might affect public health later. This shows that impacts also largely vary both on temporal and spatial scale. Three terms are important:

- **Persistence**

  Some substances may be persistent and stay for years and decades in the environmental system. These substances have a high probability of bio accumulation in human bodies through food chains

- **Concentration**

  Highly toxic substance may cause tremendous impacts through their heigh toxicity, even though only small amounts are released,

- **Dispersion**

  Depending on their chemical behaviour, substances can be washed away and diluted easily, some will aggregate and stay in the same place for a longer period (e.g., heavy metals deposit in sediments)

The three terms play a role when implementing a database system and the relevant parameters. Substances at each location must be assessed in terms of persistence, concentration, and dispersion.

2.3 Design of monitoring

Monitoring is an essential part in crisis management. The fact that pollution is the main concern adds complexity. Depending on the physical and chemical composition, pollutants expose different behaviour and can stratify in watercourses depending on flow conditions, geometry of the outlet point, geometry of the river channel, wind conditions, etc. To be able to timely monitor adverse effects of substances, it is recommended to consider the following components: Emission and immission-based monitoring: active dischargers reporting on issues and responsive early warning system with (semi-) continuous measurements.

Chemical-physical parameters like oxygen content, pH value, conductivity, turbidity, and temperature can be monitored automatically and continuously. They serve as proxies for many other substances that require to take samples. Continuous water monitoring combines both early detection of unauthorized discharges and identification of changes in water quality (trend monitoring). Since many substances can only be monitored semi-continuously, biological early warning systems can also be operated to detect toxic substances in water.

For instance, the movements of daphnia can be monitored with a camera. In the event of significant changes in their behaviour, it can be concluded that there is acute water pollution.

The problem of stratification and mixing is illustrated by an example taken from the River Weser. Mixing processes depend on turbulence and flow and thus can vary largely. In the example below, assuming homogeneous concentrations at location 38.5 or even downstream will result in wrong estimates. As such, representative measuring points must be identified with great care, as stratification and mixing processes significantly influence observations.

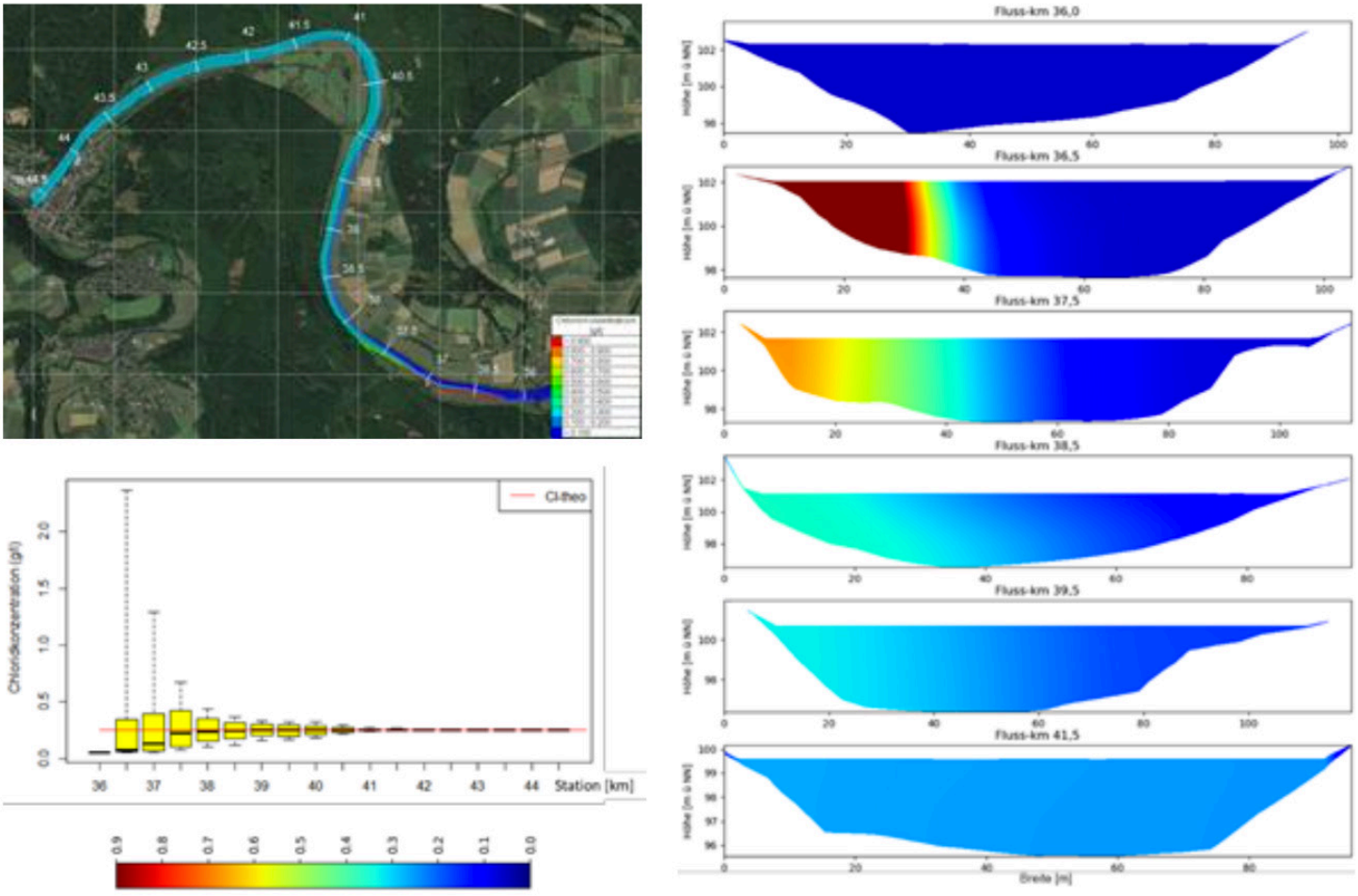

Figure 1: Point-source emission and mixing behaviour of the river for a specific flow (SYDRO Consult GmbH, 2017)

The triggers, which are used to enter crisis mode and lead to warnings, depend on the monitoring and thus are subject to the same complexity

3. European practices to deal with pollution accidents

3.1 Examples of existing European regulations

3.1.1 European Water Framework Directive (DIRECTIVE 2000/60/EC)

The European Water Framework Directive (WFD) (EC, 2000) was adopted in 2000. It sets out a precise timetable for getting all European waters into good condition. Several Articles in the WFD refer to accidental pollution. Thus, numerous activities have already been undertaken in the Member States to implement the requirements of the WFD on dealing with accidental pollution. Some examples are listed and described briefly.

- **Article 11 (3) l WFD requires measures in the fields of installation related water conservation and accident precautions**
  - → Basic measures are the minimum requirements to be complied with and shall consist of any measures required to prevent significant losses of pollutants from technical installations, and to prevent and/or to reduce the impact of accidental pollution incidents for example as a result of floods, including through systems to detect or give warning of such events including, in the case of accidents which could not reasonably have been foreseen, all appropriate measures to reduce the risk to aquatic ecosystems.

The requirements for implementation of Article 11 (3) l WFD raise many questions. Based on an inventory and analysis of the regulations and stipulations of the EU and UN ECE and the recommendations of the international river basin commissions (Danube, Rhine, Oder, Elbe), a report (Federal Environment Agency, 2009) elaborates an action strategy for implementing Article 11 (3) l.

The approach towards dealing with pollution accidents is essentially at two stages-first, by preventing pollution accidents and second, once the polluting events occurred, by minimizing their negative impacts.

The "safety chain" in risk management (Figure 2) is based on a time schedule in 3 main categories, each with 2 sub-categories, from strategic preparation for the event through damage containment to after care.

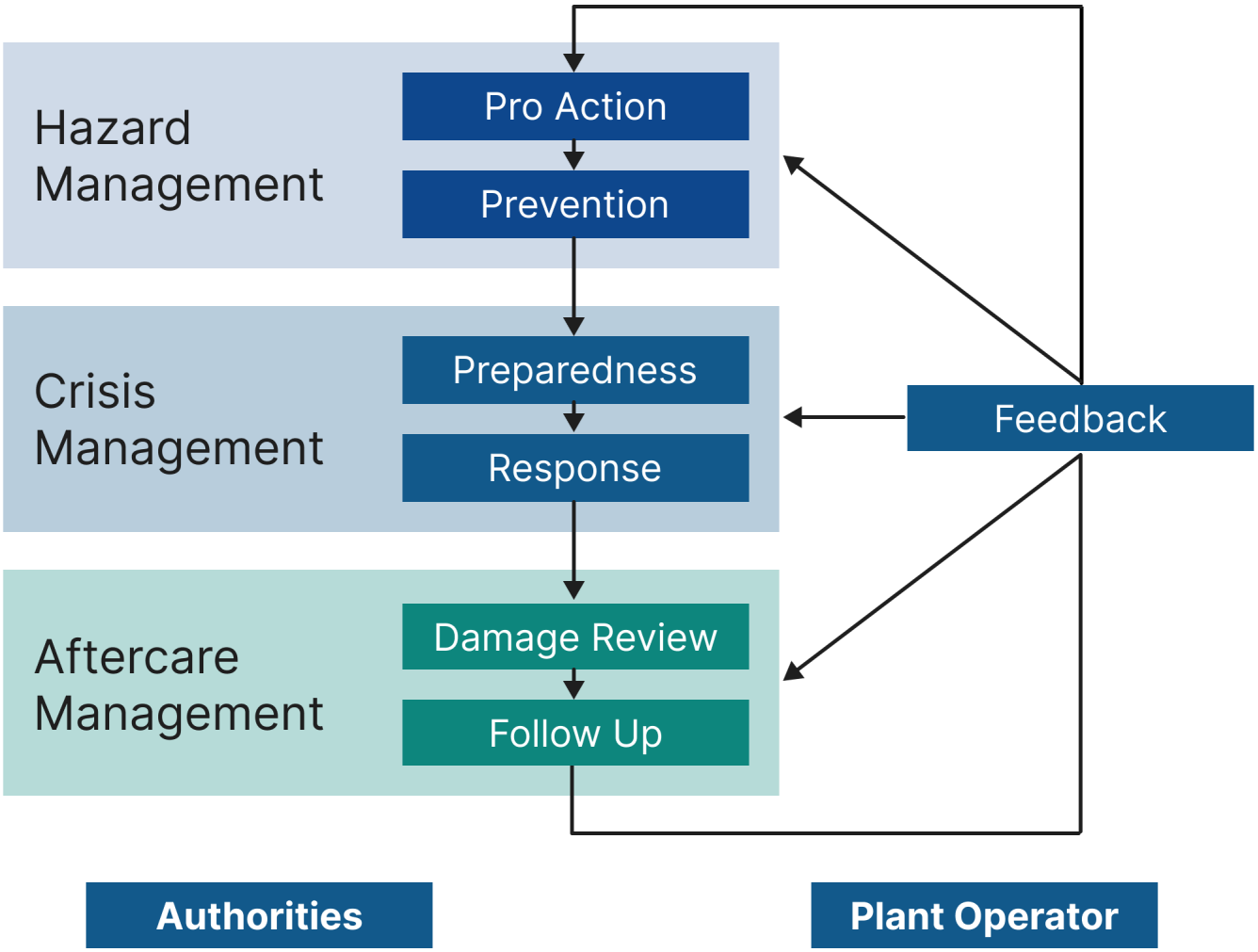

Figure 2: "Safety Chain" in risk management (Federal Environment Agency, 2009)

The following table contains the recommendations by the international River Commissions on Rhine and Danube rivers on different issues dealing with pollution accidents (UBA 2009). Examples from this report as well as from case studies Danube and Rhine River Basins are used in the following chapter.

Table 1: Overview of recommendations and activities relevant to installation safety by River Commissions on rivers Rhine and Danube (UBA 2009) (not exhaustive)

IRBC	Recommendation Title	Published
ICPR / IKSR	▪ Definition of Substances dangerous to water ▪ Authorisation procedures for installations of major accident relevance ▪ Overfill protection ▪ Pipework safety ▪ Joint storage ▪ Sealing System ▪ Wastewater substreams ▪ Transhipment ▪ Fire protection concept ▪ Installation monitoring ▪ Site alarm and emergency response planning	1998
ICPDR / IKSR	▪ Recommendation on Safety requirements for contaminated sites in flood risk areas ▪ Performing inventories of accident risk spots	2005 2001
ICPR = International Commission for the Protection of the Rhine; ICPDR = International Commission for the Protection of the Danube River)		

Annex V, 1.3. 1.3.3. Design of investigative monitoring refers to:

- Investigative monitoring which shall be carried out
- Where the reason for any exceedances is unknown,where surveillance monitoring indicates that the objectives set out in Article 4 for a body of water are not likely to be achieved and operational monitoring has not already been established, to ascertain the causes of a water body or water bodies failing to achieve the environmental objectives, or
- To ascertain the magnitude and impacts of accidental pollution,
- And shall inform the establishment of a programme of measures for the achievement
- Of the environmental objectives and specific measures necessary to remedy the effects of accidental pollution.

Monitoring for investigation purposes is only carried out in surface waters when the reasons for high water pollution are unknown or the extent and effects of unintentional pollution, e.g., through accidents in the water body, are to be determined. For this type of monitoring, the federal states of Germany have established about 1.250 monitoring stations in surface waters. For surveillance monitoring nearly 6.000 monitoring stations exist (BMUB/UBA, 2016).

Surveillance monitoring stations represent water sections that are significant from a hydrological and water management point of view. They are predestined for the establishment of fixed measuring stations for continuous monitoring of water quality and dynamics in conjunction with the inclusion of technology for detection and assessment of events relevant to Article 11 (3) l WFD (Federal Environment Agency, 2009). Together with around 14.000 stations for operational monitoring, Germany has a good basis for obtaining an overview on the status of surface water bodies.

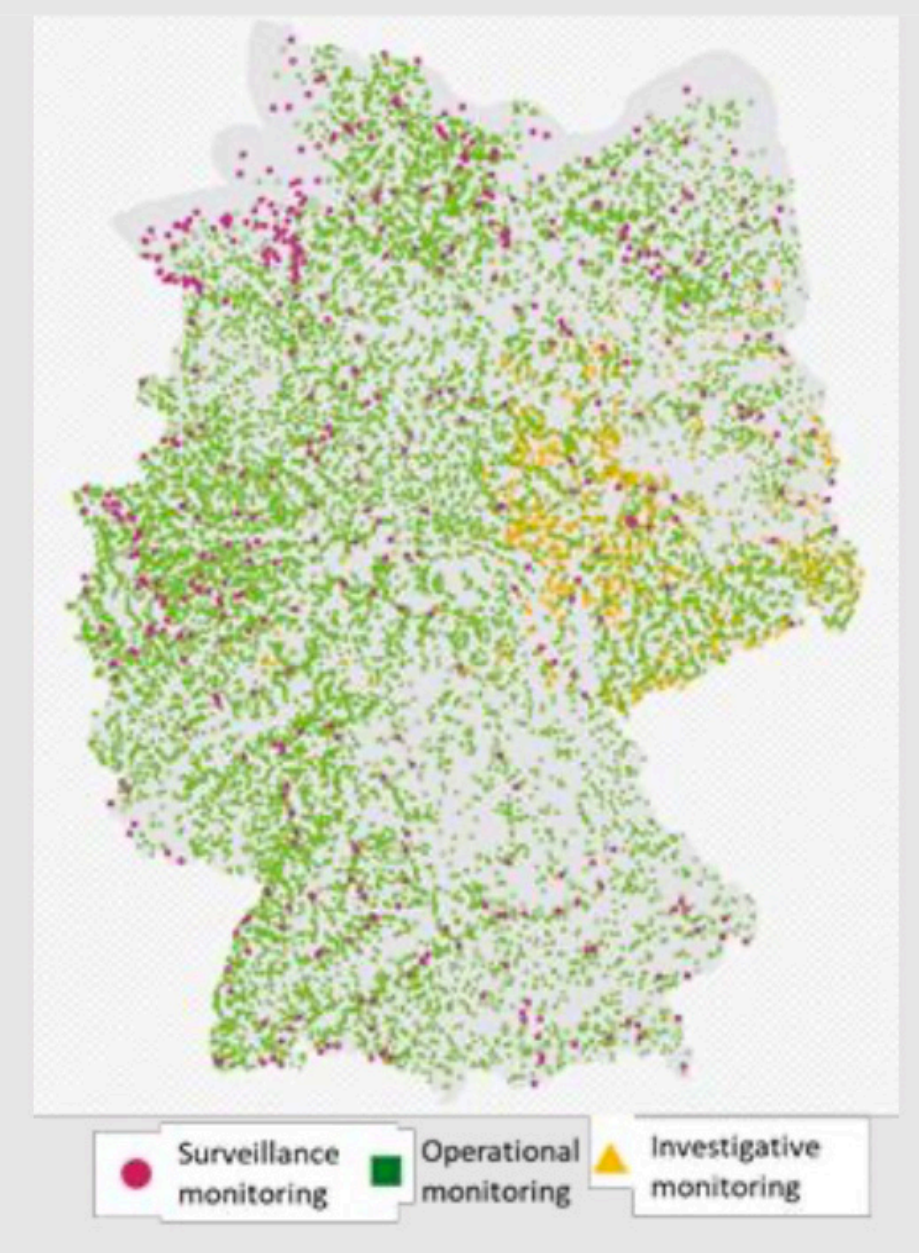

Figure 3: Surveillance, operational and investigative monitoring stations at surface waters in Germany (BMUB/UBA, 2016)

The directives mentioned by the WFD include the Directive on Major Accidents (Seveso Directive, 96/82/EC), the Environmental Impact Assessment Directive (85/337/EEC), the Directive concerning Urban Wastewater Treatment (91/271/EEC), and the Directive concerning Integrated Pollution Prevention and Control (IPPC Directive, 96/61/EC).

3.1.2 The European Pollutant Release and Transfer Register (E-PRTR), Regulation (EC) No 166/2006

The European Pollutant Release and Transfer Register (E-PRTR, kein Datum) is a web-based register established by Regulation (EC) No 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC. The E-PRTR is available to the public free of charge on the internet.

The register contains information on releases of pollutants to air, water, and land, as well as off-site transfers of pollutants present in wastewater and waste.

The register covers 91 pollutants as listed in Annex II of Regulation (EC) No 166/2006, including greenhouse gases, heavy metals, pesticides, and chlorinated organic substances.

The information can be searched using various criteria (type of pollutant, geographical location, affected environment, source facility, etc.). Releases are required to be reported when they exceed a certain threshold and originate from one of the 65 activities listed in Annex I of Regulation (EC) No 166/2006.

The majority of these activities are also regulated under Directive 2010/75/EU on industrial emissions and comprise, in particular, the facilities covered by the following sectors:

- Energy production,
- Production and processing of metals,
- Mineral industry,
- Chemical industry,
- Waste and wastewater management,
- Paper and wood production and processing,
- Intensive livestock production and aquaculture,
- Animal and vegetable products from the food and beverage sector,
- and, Other activities e.g., producing textiles, leather tanning.

Where available, the register also provides information on releases from diffuse sources of air and dif- fuse sources of water (EUR-Lex, kein Datum). The database is based on information e.g., on the sector and activity, the exact location (coordinates), the production branch (e.g., production of paper), the pollutant and pollutant group (e.g., chromium, heavy metals) and the total quantity of the pollutant released (see Table 2). More information: (European Environment Agency EEA, kein Datum).

Table 2: Example for content of E-PRTR database

Facility ID	Latitude	Longitude	Main IA Sector Name	Pollutant Name	Pollutant Group Name	Total Qty	Release Medium
5814	47.8	13.766667	Basic inorganic chemicals or fertilisers	Chlorides (as total Cl)	Inorganic substances	149000000	Water
5761	48.333333	15.933 333	Basic inorganic chemicals or fertilisers	Fluorides (as total F)	Inorganic substances	4680	Water
5761	48.333333	15.933 333	Basic inorganic chemicals or fertilisers	Total phosphorus	Inorganic substances	15300	Water
5746	48.283333	14.316667	Basic inorganic chemicals or fertilisers	Cadmium & compounds (as Cd)	Heavy Metals	50	Water
5858	48.144722	16.493 889	Mineral oil and gas refineries	Phenols (as total C)	Other organic substances	419	Water
5858	48.144722	16.493 889	Mineral oil and gas refineries	Arsenic and compounds (as As)	Heavy Metals	11.6	Water
5858	48.144722	16.493 889	Mineral oil and gas refineries	Zinc and compounds (as Zn)	Heavy Metals	129	Water

3.1.3 REACH: Registration, Evaluation, Authorisation and Restriction of Chemicals

REACH (EC) 1907/2006) is a regulation of the European Union, adopted to improve the protection of human health and the environment from the risks that can be posed by chemicals. REACH stands for Registration, Evaluation, Authorisation and Restriction of Chemicals. It entered into force on 1 June 2007.

REACH requires all companies manufacturing or placing a substance on the EU market in quantities greater than 1t/year to register that substance with the European Chemicals Agency (ECHA) (https://echa.europa.eu/de/).

All public data submitted to ECHA in REACH registration dossiers by substance manufacturers, importers, or their representatives, as laid out by the REACH Regulation, are publicly available. ECHA makes available this information as REACH registered substance factsheets, which contain the full set of non-confidential information from related registration dossiers for a substance. Depending on the number of registrations that have been made for a substance, one factsheet can thus represent data from anything between hundreds of registration dossiers in a joint submission, to data from just one registration dossier.

In the portal result tables are presented:

- **Public substance identity**

  the best available non-confidential substance name, EC, and CAS numbers.

- **Registration status**

  indicating the calculated registration status: **Active** - being actively manufactured or imported to the EEA; **Cease manufacture** - is no longer being manufactured or imported, but still considered to have a valid registration under REACH, and capable of resuming manufacture or import at any time; or **No longer valid** - no longer considered registered under REACH and not currently permitted to be manufactured or imported to the EEA unless and until properly registered again.

- **Registration type**

  indicating whether a given factsheet contains data from a REACH full regis- tration, REACH intermediate registration, or only a limited set of data inherited from a NONS notification.

- **Submission type**

  indicating whether the data in a given factsheet was submitted jointly or individually.

- **Total tonnage band**

  calculated per factsheet from all contributing registrations, based on the estimated quantity of the substance placed on the market. Data is excluded from dossiers where the tonnage is claimed confidential, from Intermediate registration dossiers, and from NONs which have not been updated.

- **Last updated**

  indicating the date on which this registered substance factsheet was last modi- fied with new or updated data, based on an industry submission.

- **Link to the full factsheet**

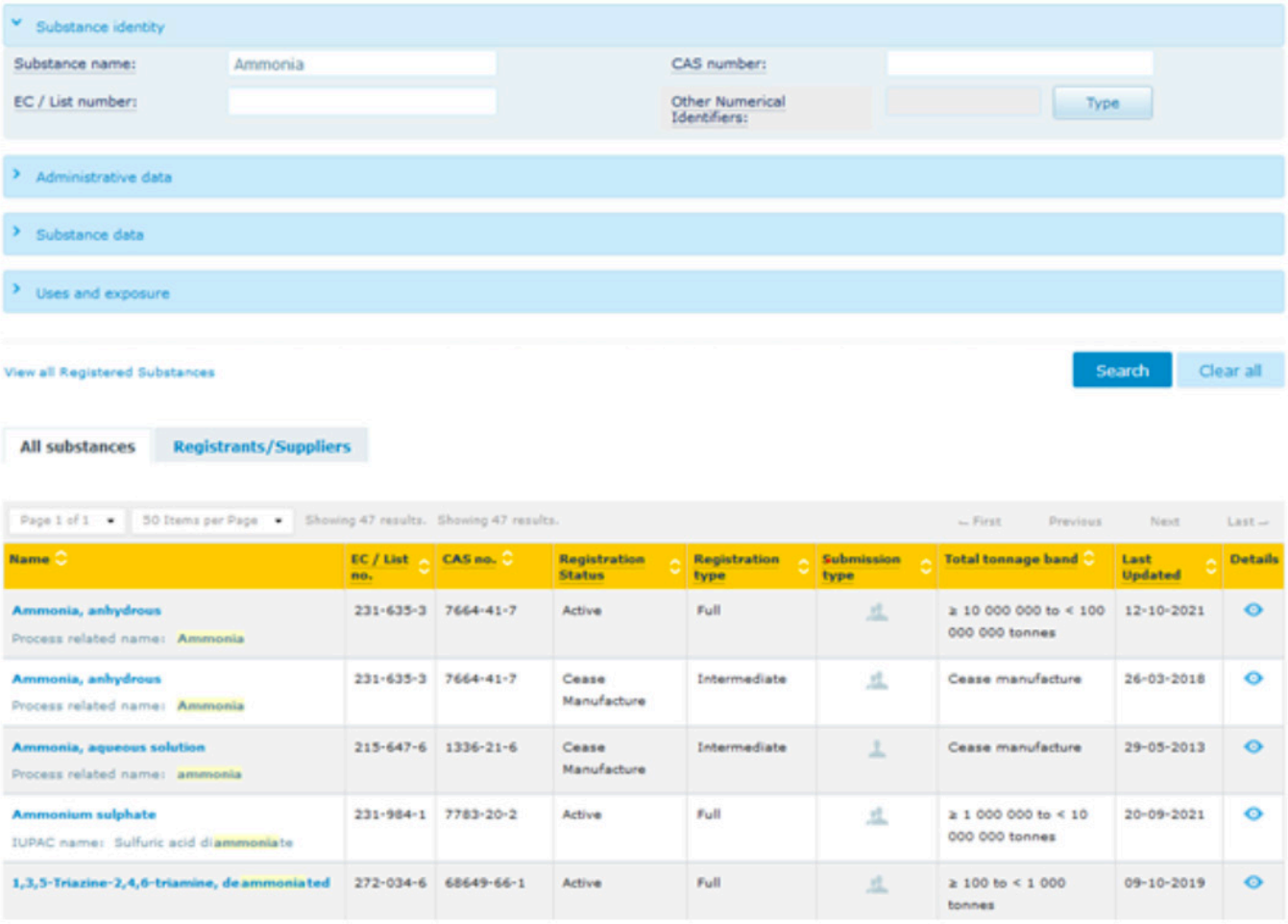

Figure 4: Information on chemical - Registered substances (https://echa.europa.eu/en/information-on- chemicals/)

3.2 Case-Studies

3.2.1 Inventory of Potential Accidental Risk Spots in the Danube River Basin (ICPDR, 2001)

The preparation of an Inventory of Potential Accidental Risk Spots (PARS) is part of a complex of measures designed to support the Accidental Emergency Warning System (AEWS) in the Danube River basin. The Accident Risk Spots inventory encompasses operational industrial sites associated with a major risk of accidental pollution, due to the nature of the chemicals being produced, stored, or used at the plants, as well as contaminated sites including landfills and dumps in areas liable to flooding. The inventory of operating industrial sites was finalised in 2001 for most of the Danube countries and updated in 2003.

The analysis reflects the potential dangers. The actual danger level can only be determined based on an analysis of the safety measures that have been put in place. An evaluation of the quality of prevention, or of the safety rating of the factories concerned, is not the object of the potential risk spot mapping, even though suggestions are proposed as to what steps could be taken to make progressive improvements in the safety level. The approach adopted in the Danube catchment area includes Water Risk Classes (WRC) and the Water Risk Index (WRI).

The preparation of an Inventory of Potential Accidental Risk Spots (PARS) is part of a As the first step an inventory of chemicals (type and amount) in each site is performed, to each substance the Water Risk Class is ascribed. Classification is carried out on the basis of the Ordinance on facilities for handling substances that are hazardous to water (Verordnung über Anlagen zum Umgang mit wassergefährdenden Stoffen (AwSV)) of 18 April 2 (ChemSafetyPro, 2016).

For this purpose, the databank of dangerous chemicals from the Federal Environment Agency in Germany can be used (webrigoletto.uba.de, 2022):

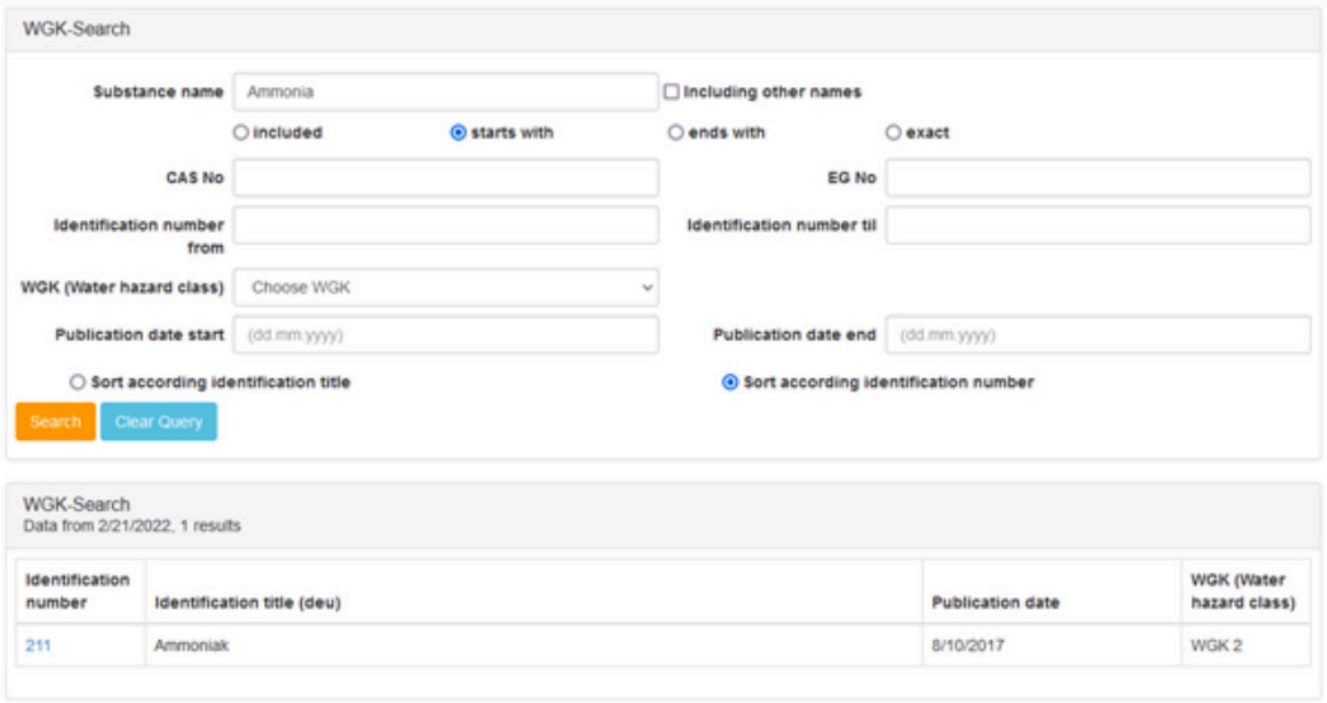

Figure 5: Database of dangerous chemicals (webrigoletto.uba.de, 2022)

Water Risk Classes are ranked into three classes of danger:

- slightly hazardous to water
- obviously hazardous to water
- highly hazardous to water.

Furthermore, substances can be classified as non-hazardous to water (nwg) or are deemed hazardous to water in general (awg). The classification is based on scientific tests on the respective substance. The more toxic a substance is, the more points are assigned. The basic data set consists of the four hazard characteristics:

- Acute oral or dermal mammalian toxicity
- Acute aquatic toxicity
- Biodegradability
- Bioaccumulative potential

If no WRC can be found for a particular substance, then expert estimate is required. Furthermore, substances can be classified as non-hazardous to water or are deemed hazardous to water in general (e.g., commercial fertilisers, liquid manure).

For the determination of the water endangering potential of the assessed site the Water Risk Index is calculated from the amounts of all dangerous substances after their recalculation to WRC 3[1] substance equivalents. From the sum of the WRC 3 - equivalents the WRI can be calculated logarithmically, analogously to the Richter scale in the case of earthquakes. An example of the recalculation is given in the following table.

Table 3: Example for recalculation of Water Risk Index (Inventory of Potential Accidental Risk Spots in the Danube River Basin, ICPDR, 2001)

Substance	Amount (kg)	WRC	WRC 3 - equivalent (kg)	WRI
Paraffine	10000	'0'	10	1
NaOH	10000	1	100	2
Ammonia	10000	2	1000	3
Acrylnitril	10000	3	10000	4
Sum			**11110**	**4,046**

[1] The real differences in danger to water between particular WRC-classes are in the interval of 10-100. To simplify the classification using WRC the factor of danger between classes has been set to 10. This leads to a certain over- estimation of danger of WRC 1 substances and to underestimation of danger of WRC 3 substances. This approach can be justified by the fact that during accidents in addition to toxic effects also other adverse).

In October 2000 the member states of the ICPDR were requested to compile a basin-wide Inventory of Potential Accidental Risk Spots based on the accepted methodology. The survey was focussed to the place and name of the activity, along with the presence of substances capable of causing water pollution and their quantity. In addition, in the interests of cartographical precision the coordinates of the place were to be supplied.

For categorising dangerous activities, the following secondary criteria were introduced:

- For the sake of determining which activities carried the highest risk potential, a cut-off threshold of WRI >= 5 was defined.
- Only those activities were investigated that are located directly on the Elbe, or up to 50 kilometres upstream on its tributaries.
- On this basis it was possible to analyse the potential ARSs (accidental risk spots) in the Danube catchment area and assess their relative significance (see Figure 6)

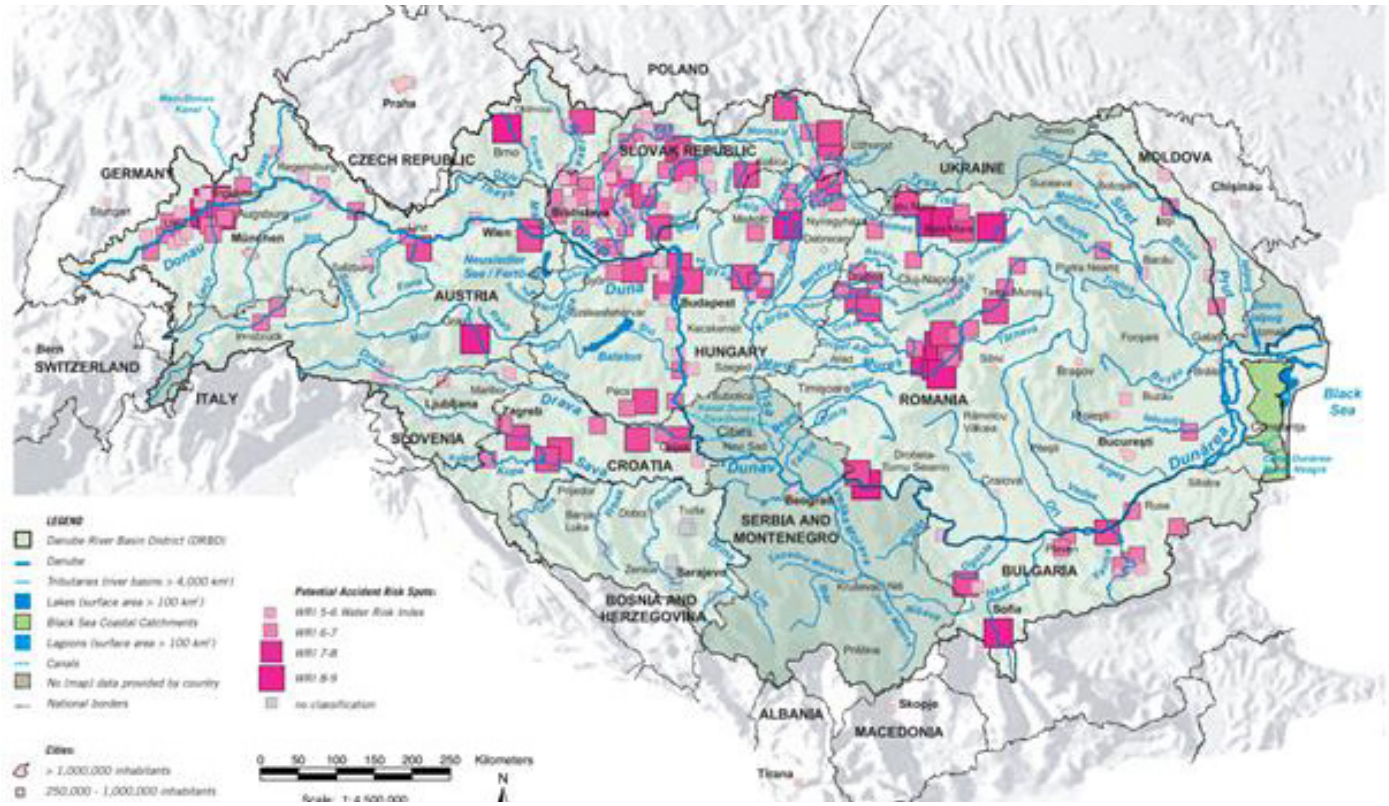

Figure 6: Danube River Basin District: Potential Accident Risk Spots

The investigation discovered that about a third of the entire risk potential, in terms of WRC-3 equivalent mass, is to be found in the Danube catchment area in Germany, while about a quarter is connected with mining activities in Romania. In addition to this, sedimentation basins, or tailing ponds, present an enormous potential hazard.In view of the catastrophic accidents that have happened in the past (Donana, Baia Mare, Baia Borsa, etc.), this conclusion was to be expected. The investigation was able to identify top-priority ARSs in the various member states of the ICPDR, which should prompt the local authorities to take urgent safety measures in these installations.

The analysis of risks spots is reflecting the potential dangers. The actual risk to the environment must be determined more accurately by assessing the effectiveness of existing safety measures put in place in each of these locations. An evaluation of the quality of prevention, or of the safety rating of the factories concerned, was not the object of the PARS-analysis, even though suggestions are proposed as to what steps could be taken to make progressive improvements in the safety level.

3.2.2 “Rhine Alarm System” for Accidental Pollution

Accidents in industrial plants may have far-reaching transboundary effects on water bodies, they may in particular limit their use as drinking or industrial water and damage the aquatic ecosystem. An impressive example was given by the disastrous fire in Schweizerhalle in 1986 which lead to a serious pollution of the Rhine. For several days, fishery and drinking water production had to be stopped even 1000 km downstream, in the Netherlands. In response to this event the ministers of the Rhine bordering countries agreed that all production and storage sites in the Rhine catchment area where larger amounts of substances hazardous to water are liable to occur must meet safety standards preventing any water pollution by such substances.

The International Commission for the Protection of the Rhine (ICPR) entrusted the working group "Prevention of Industrial Accidents and Safety of Industrial Plants" with this task. In the last years recommendations for measures in the relevant fields of safety in plants where substances hazardous to water are handled were formulated. An analysis of accidents along the Rhine has revealed a considerable reduction of accidents in plants where substances hazardous to water are handled. Safety measures are not specific to a drainage area. The target of the documentation in hand is to make the recommendations elaborated by the Rhine bordering countries accessible to the public (ICPR Report: Recommendations of the International Commission for the Protection of the Rhine (ICPR) on the Prevention of Industrial Accidents and the Safety of Industrial Plants). As a first overall task, objectives of a possible measure are clearly defined:

The objective of the Warning and Alarm System is to pass on reports on sudden pollutions with substances noxious to water in the watershed, if the amount and concentration may detrimentally impact the water quality and to warn the authorities in charge of fighting accidents so that

- Threats may be fought,
- Causes may be identified
- Polluters may be identified
- Measures to clean up pollution may be taken
- Measures to avoid and reduce damage may be taken,
- Consequential damage may be avoided.

Damaging incidents, which are expected to cause public interest, are reported as information. These reports, including the warnings, information and search messages issued every year, are compiled in an annual report (Figure 7).

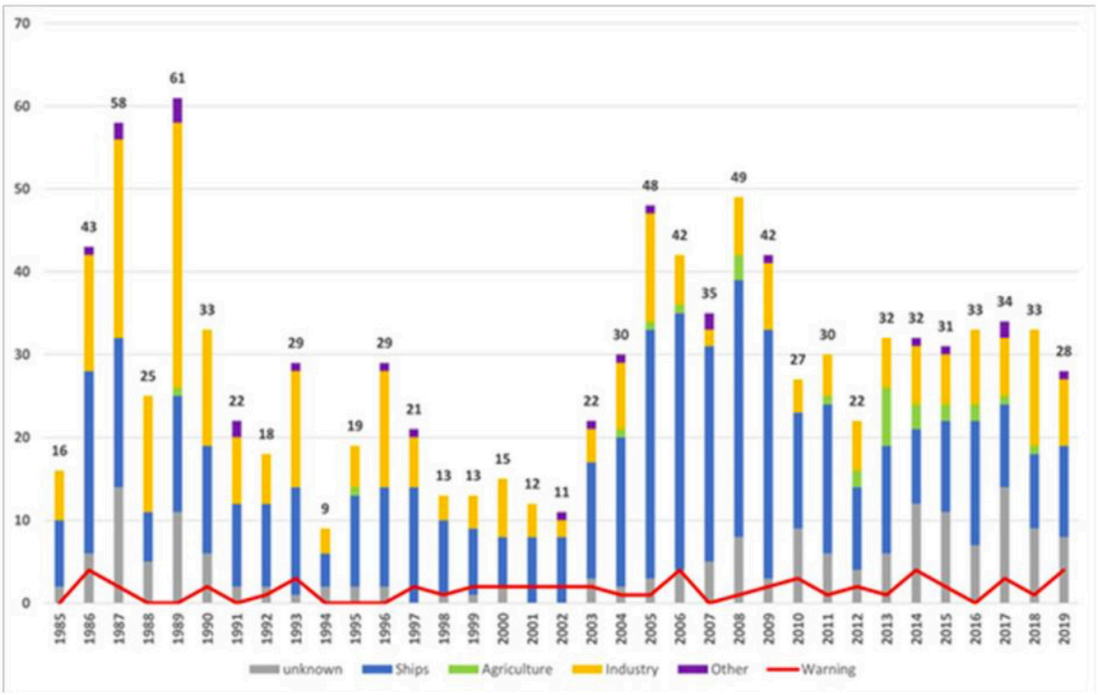

Figure 7: Development of the number of warnings within the International Warning and Alarm Plan Rhine, ships, industry, and agricultural messages, as well as messages from "others" (e.g., transport) and unknown polluters (www.iksr.org,2022)

A second and also important first step is the clear definition of criteria, which issue an alarm. The Warning and Alarm Plan Rhine has two types of criteria, each of them leading to a warning:

General criteria

An information, warning or search announcement is released, when pollutants are released in quantities apt to detrimentally impact the Rhine water quality, to damage water organisms and/or to limit the use of the water body, e.g.,

in cases of:

- A considerable excess of limit values for discharge permits;
- Serious breakdowns;
- Releases of substances during transportation;
- Unusual rise in the concentration of chemical, physical, or organoleptic parameters.
- In addition, the individual case must be considered to determine, whether an information
- or warning is required in cases of Reports resulting from continuous biotests in cases of secured ‚biotest alarms "(notion related to the procedure);
- Reactions expected in the public and the media.

In cases of dangerous situations and damage, the danger is to be evaluated based on:

- Substance properties
- Amounts of substance
- Characteristics of the location
- Extension on the surface.

Guidance values

The following guidance values are recommended for concentrations and pollutant loads leading to an information, warning or search report within the International Warning and Alarm Plan Rhine.

- **Concentration guidance values**
  - The concentration guidance values concern the following monitoring stations along the Rhine: [list of monitoring station along river Rhine]
  - If values are in excess of these guidance values, and depending on the pollutant concentration and present knowledge, an information, a warning, or search report is issued within the Warning and Alarm Plan.
- **Guidance values for discharged loads**
  - In general, daily loads apply to indications of the polluter.

- In cases daily loads exceed guidance values, information or warning is issued by the authorities

- **Remarks**
  - Independently of the afore indicated guidance values concerning the release of a supraregional information/warning/search report these will not be able to cover the requirements in the immediate vicinity of the accident location. These requirements must be pointed out in local or regional Warning and Alarm Plans. It is up to the expert judgement of the authorities in charge to decide, whether information and search reports on events leading to concentrations or loads below the guidance values are passed on downstream. The addressees for information or search reports depend on the context.

Information is hereby collected via two information networks (Broer, 1991):

- **The alarm network**

Accidental water pollution can be detected by people (citizens, shippers, water policemen), and/or by water quality monitoring stations. The Rhine has a set of these stations. [...]. A large number of water quality parameters is continuously monitored: temperature, turbidity, acidity, oxygen, ammonium, electro conductivity, chloride, fluoride. Micropollutants are monitored as well: heavy metals (cadmium, copper, lead, zinc) and organic micropollutants. In order to detect unknown pollution bio-alarm systems are operational (fish, daphnia) or will be applied (algae, bacteria). [...]. Every alarm is verified and transmitted to an alarm station. The International Commission for the Protection of the Rhine against Pollution (ICPR) installed a network for warning and alarming. [...] Each station tries to find out which substances were discharged; how much was spilled in the water and for how long the discharge lasted. [...]. Each station is responsible for the further distribution of information to downstream stations.

- **The hydrological network**

Information on the hydrological situation of the river basin is collected on a daily basis by the national water authorities. [...]. Generally, the required meteorological information is obtained from the national weather services. Depending on the hydrological situation and the location in the basin, the information is updated every 6 to 24 hours. Forecasts of rainfall and river flows are also available. Hydrological information of the river is essential for a good forecast of the travel time of pollutants. This forecast is made by the alarm stations, using the Rhine Alarm Model. In case of an alarm warning, the responsibilities along the river network are clearly specified. As, along its way, river Rhine is the border between 4 countries, this clear definition is of extreme importance. For this reason, the river has a longitudinal structure, based on river kilometrage and additionally a distinction between left and right riverbank (Figure 8). So, for each point on the river, a responsible authority can be easily found. Of course, this clear structure goes much deeper, as

- All information and documents are shared openly and within all languages used in the countries along the river,

- Pathways for communications are clearly specified and information (such as warning) are handed over from one authority to the next one, following pre-defined paths in the direction of flow,

- All above mentioned criteria and structures are applied identical in all countries,
- Clear communication protocols are used for sharing important information and making sure that all relevant institutions receive the information.

The Rhine-Alarm plan is constantly reviewed and, if needed, updated by a commission of all countries, which having frequent meeting over time.

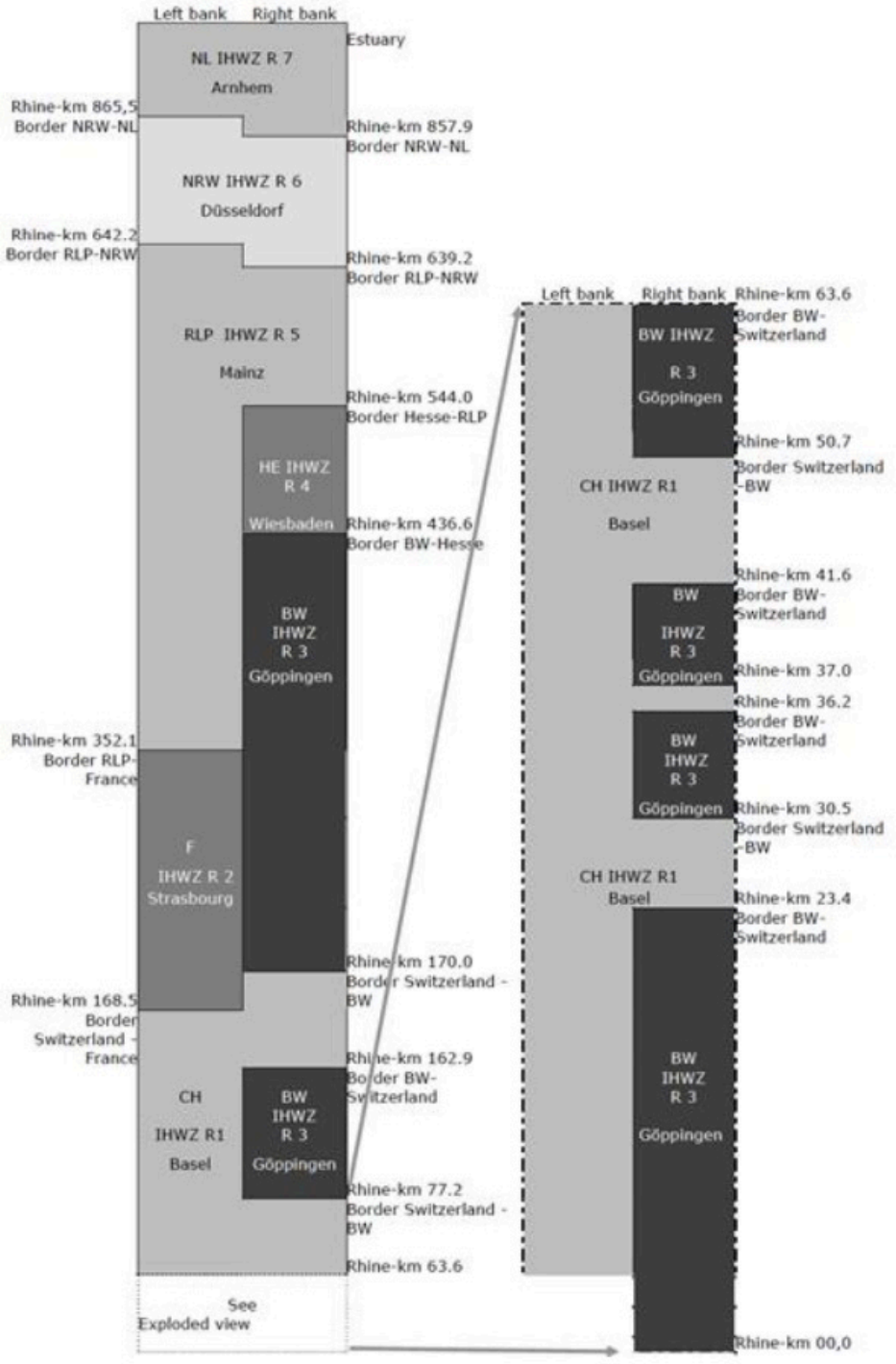

Figure 8: Areas of responsibility of the international main warning centres according to the Warning and Alarm Plan Rhine (IKSR/CIPR/ICBR, International Warning- and Alarm Plan Rhine, State: 01.01.14)

4. Situation overview Ramganga river basin

4.1 List of major threat areas / Hot spots Ramganga river

With around 67% of the whole catchment being used for agriculture, the Ramganga catchment can be classified as a rural area (Table 4). Industry in larger numbers is only settled in the area around the city of Moradabad (Figure 10). Cities and other areas summarized under 'Built-Up' areas are only covering 2,2% and are widely spread within the catchment.

Table 4: Land use and Land Cover Area of Ramganga Basin (Source: (Ali Khan & Tian, 2018)

Class	Area (km^2)	Area (%)
Agriculture	15109.4	66.6
Built Up	497.5	2.2
Deciduous Forest	128.3	0.6
Evergreen Broad leaved Forest	529.1	2.3
Evergreen Needle Leaved Forest	1439.2	6.3
Grassland	119.7	0.5
Mixed Forest	2585.4	11.4
Scrubland	505.0	2.2
Agriculture	709.3	3.1
Wasteland	341.5	1.5
Waterbody	721.3	3.2
Agriculture	**22685.6**	**100.0**

As per land use land cover map (Figure 9) depicted, it can be inferred that 66.6 % of Ramganga Basin is agricultural land and thus the non-point pollution source.

This emerges as first sheet runoff during rainfall over the area. Based on the classification, following Table 4, Figure 9 and Figure 10, the following major hot spots can be identified:

- Point Sources 1: Industrial area around Moradabad, with mostly industry in metal treatment sector
- Point Sources 2: Urban wastewater around Moradabad
- Non-Point Sources: Agricultural areas in the Ramganga catchment

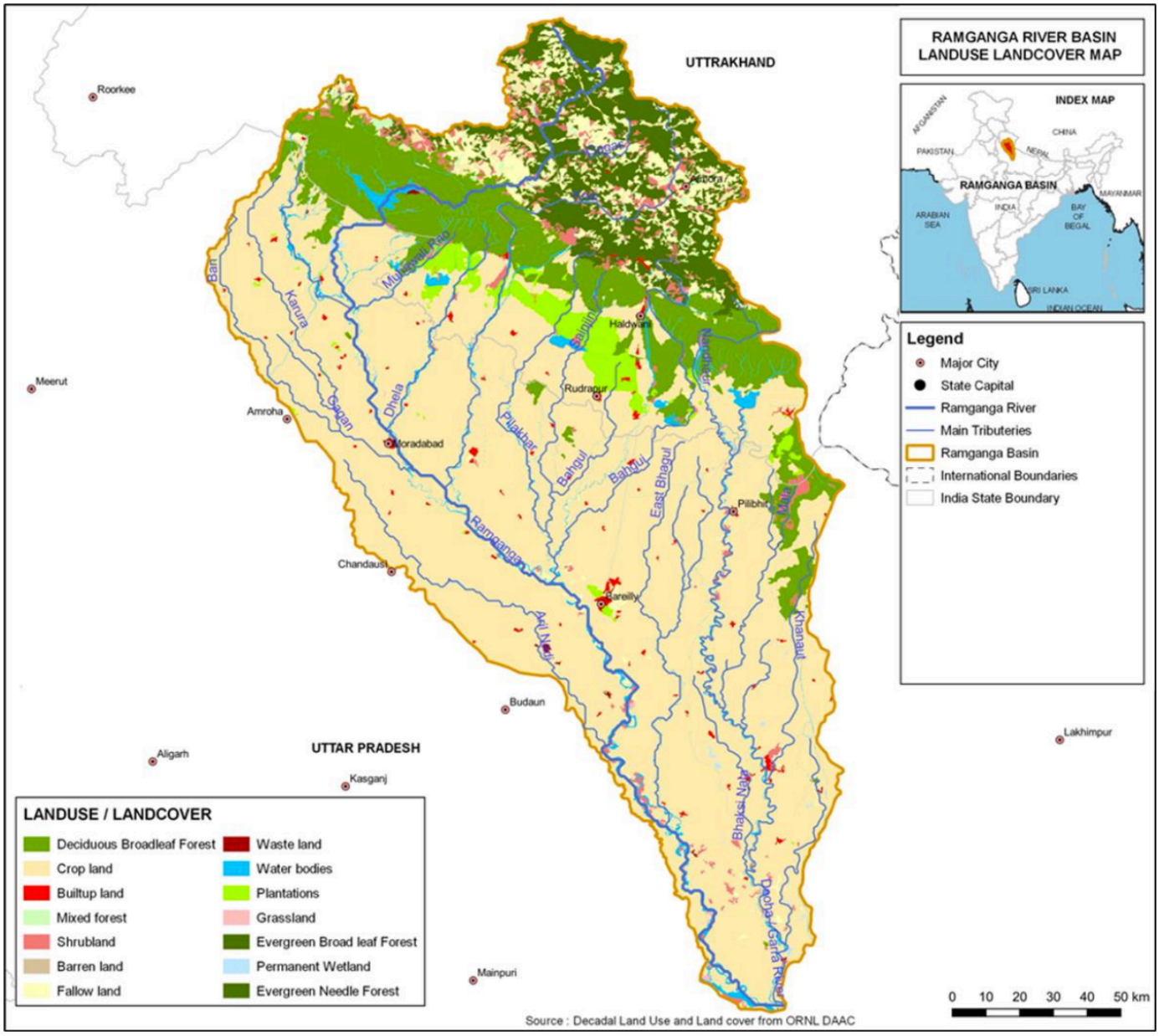

Figure 9: Ramganga River Basin with Land use / land cover shows a river basin highly characterized by agriculture

4.1.1 Point source pollution from Industry

Industrial activities across Ramganga from downstream of Moradabad severely impact the health of the river, as industrial effluents are being dumped into the main stem of the river and its tributaries. Industrial units are mostly located in Uttar Pradesh (Moradabad, Rampur, Bareilly) and are concentrated in industrial pockets of Uttarakhand (Kashipur and Udham Singh Nagar). Considering the importance of these industrial pockets and to understand the existing scenario of accidental pollution in the Ramganga river basin, secondary data and literature were collected from concerned government departments on industrial and urban waste management practices adopted in these towns.

Several meetings and discussions were also planned with stakeholder departments to synthesize the relevant information and to get information about ongoing and planned projects related to pollution abatement. Site visits at Upper and lower stretch of Ramganga basin were also performed in the Month of December 2021 and February 2022, to find out affected river stretches and industries vulnerable for accidental pollution.

In addition, visits of representative industries, especially sugar, paper and distiller were also conducted to understand existing practices of molasses and spent-wash storage, water and wastewater management and compliance of regulatory norms.

4.1.1.1 Industrial Hotspots in Ramganga Basin of Uttar Pradesh (UP)

Presently, approximately 24 MLD treated industrial effluent from 121 water-polluting industries are emitted into a stretch of Ramganga in UP State. The industries are within Sugar, Pulp & Paper, Distillery, Textile, Slaughterhouse and Electroplating sector. These industries have effluent treatment plants and discharge their treated effluent through major (mixed) drains, where the treated industrial effluent is mixed with the sewage. Out of these 121 industries, 105 are only in Moradabad and Rampur area while 16 are situated in Bareilly area. Out of the industries of Moradabad and Rampur (105 units), 4 (2 Distilleries, 1 Paper Industry and 1 Sulfuric acid plant) do not discharge wastewater into any surface water. The rest of 101 industries of Moradabad and Rampur are discharging treated effluent in drains which ultimately reach to Ramganga River.

However, Sugar and Paper Industries mostly recycle their entire treated effluent or use it for irrigation. Still in every case there is a possibility of discharge to overflow. Out of 16 industries in the catchment area of Bareilly, 2 Distilleries do not discharge wastewater into any surface water. The other 14 industries of Bareilly are discharging treated effluent in major and minor drains. The Sugar and paper industry mostly recycle their entire treated effluent or use it for irrigation but still there is a possibility of discharge to overflow. Drain-wise Industrial Units discharges are summa- rized in Table 5 and Table 6 while an overview of water-polluting industries located in the Ramganga River Basin of UP is given in Figure 10. A detailed list is given in Table A1 in the Annex.

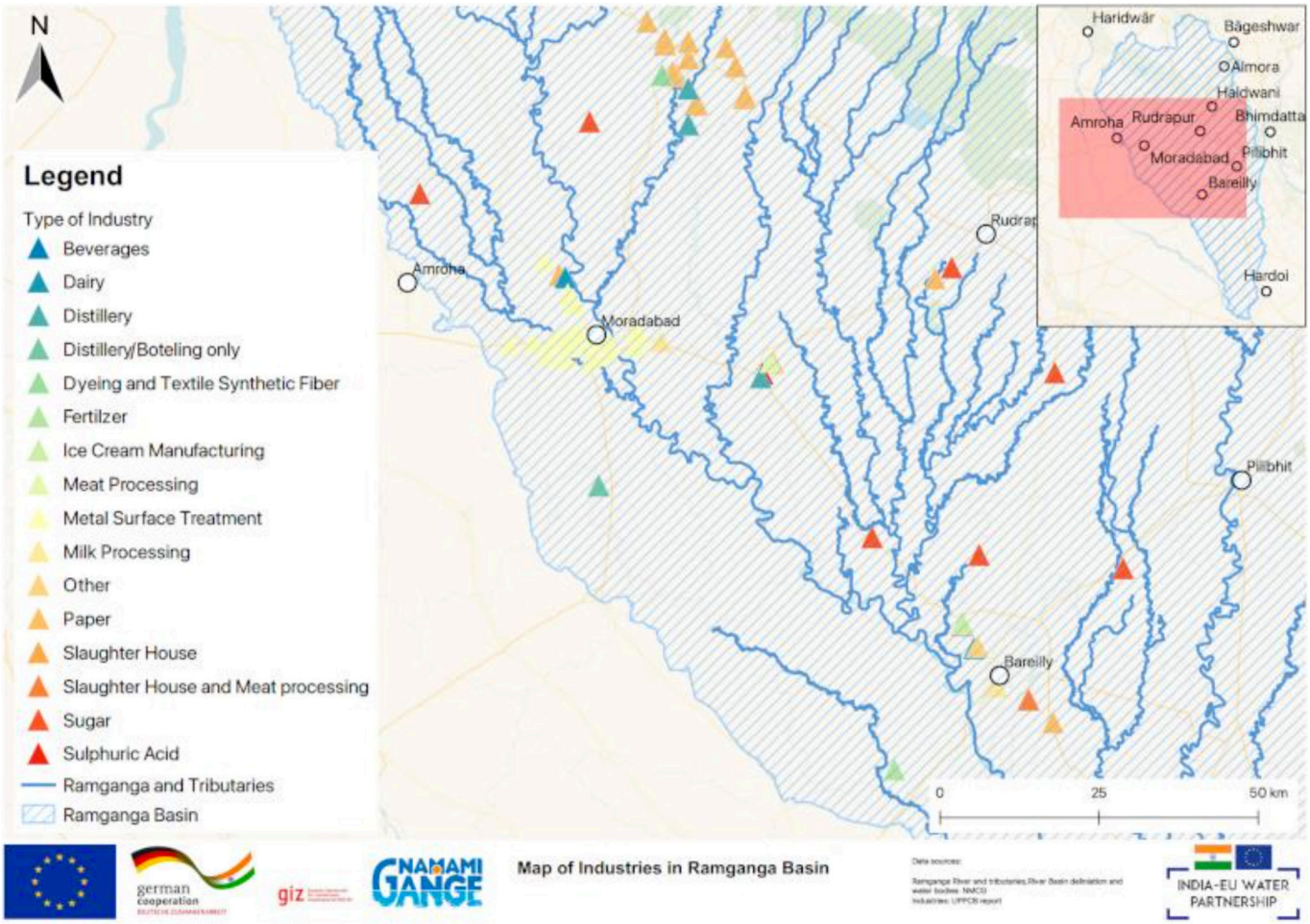

Figure 10: Map of Industries in Ramganga Basin

Table 5: Summary of Industrial Units discharges effluents in Major Drains

District	Drain	Type of Industry *The Type of Industry may be changed as per local conditions							Total Effluent Dis-charge (MLD)
		Sugar	Pulp & Paper Distillery	Distillery	Textiles	Slaugh-ter House Others	Others	Total	Total
Moradabad	Karula						02	02	0.01
	Katghar Rail-way Station	0	0	0	0	0	04	04	0.017
	Prabhat Nagar	0	0	0	0	0	10	10	0.022
	Vivekanand Left						3	3	0.012
	Vivekanand Right		-				4	4	0.024

District	Drain	Type of Industry *The Type of Industry may be changed as per local conditions							Total Effluent Dis-charge (MLD)
		Sugar	Pulp & Paper Distillery	Distillery	Textiles	Slaugh-ter House Others	Others	Total	Total
Moradabad	Chandausi Road drain Left-side						6	6	0.034
	Chandausi Road drain Right-side						1	1	0.003
	Delhi Road Drain Left-side						38	38	0.280
	Delhi Road Drain Right-side						2	2	0.010
Rampur	Rampur			01			2	04	1.012
Bareilly	Nakatiya Drain	-	01	-			-	03	1.6
	Deveraniya Drain	-	-	01			02	03	0.75
Total								80	3.762

Source: Action Plan for Restoration of Polluted Stretch of River Ramganga from Moradabad to Kannauj, UPPCB, Year 2019-20

S. No.	District	Drains	Type of Industry *The Type of Industry may be changed as per local conditions							Total Effluent Dis-charge (MLD)
			Sugar	Pulp & Paper Distillery	Dis-tillery	Textile	Slaughter House Others	Others	Total	Total
1	**Moradabad**	Minor	4	1	1	1	1	18	26	3.725
2	**Rampur**	Minor	3	1	0	0	0	1	05	3.428
3	**Bareilly**	Minor	5	-	1	0	0	4	10	13.052
			12	2	2	1	1	23	41	20.205

Source: Action Plan for Restoration of Polluted Stretch of River Ramganga from Moradabad to Kannauj, UPPCB, Year 2019-20

4.1.1.2 Industrial Hotspots in Ramganga Catchment's of Uttarakhand

River Dhela and Kosi are the main tributaries of River Ramganga while river Bhela is a tributary of river Kosi. All these three tributaries of Ramganga originate from upper reaches of Uttarakhand State and receive industrial wastewater. However, water quality of river Dhela and Bhela indicates that they are highly affected by the industrial pollution as compared to Kosi River.

River Dhela originates from the Ramnagar forest area and passes along the agriculture fields of Tarai region. Tumaria dam is built on the river Dhela upstream of Kashipur for diversion of river water for irrigation purpose, resulting most of the time in non-natural discharge conditions in the river. River Dhela also receives wastewater from nearby industrial units which are predominantly pulp and paper industries, located in Kashipur Industrial area of Udham Singh Nagar District. There are four major drains which contribute industrial wastewater into river Dhela, namely - Pachhana Nala, Dandi Nala, Choti Dhela and Lapakna Nala. River Dhela joins river Ramganga at upstream of Moradabad in Uttar Pradesh.

As per the data received from the Kashipur Regional office of Uttarakhand Pollution Control Board, there are 12 Grossly Polluting industries (GPIs), mostly Pulp & Paper industries, located along the Dhela river banks, which discharge almost 28662 KLD (28.6 MLD) treated effluent in river Dhela. However, all these industrial units have functional ETPs and only treated effluent is discharged in to the Dhela River. Due to lack of dilution water from natural flow in the river, most of the times river only carries treated industrial wastewater. List of Grossly Polluting industries (GPIs) situated in the Dhela river catchment is summarized in Table 7 while wastewater discharged from these units are depicted in Figure 11.

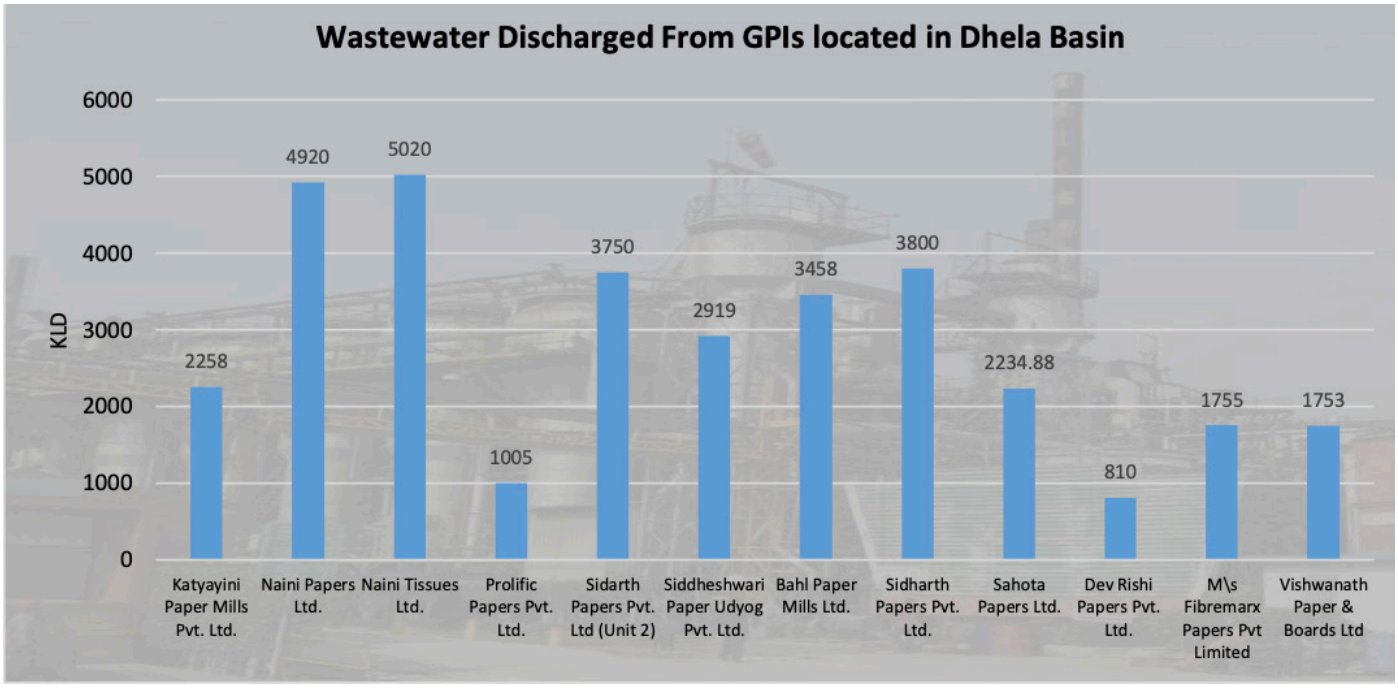

Figure 11: Wastewater Discharged from GPIs located in Dhela Basin

Table 7: List of GPIs located in catchment of river Dhela, Kashipur, Uttarakhand

S. No.	Industry Name	Address	Wastewater Generation (KLD)
1	Katyayini Paper Mills Pvt. Ltd.	Near Sodhi Farm, Vill. Kuddiyawala-Jaspur Road, KKP- Kashipur	66.6
2	Naini Papers Limited	7th K.M. Stone, - Moradabad Road, Kashipur	2.2
3	Naini Tissues Ltd.	7th Km-Moradabad Road, Kkp- Kashipur	0.6
4	Prolific Papers Pvt. Ltd.	Khasra No. 83, -Village Girdhai, Tehsil Kashipur, District U.S. Nagar, KKP-Girdhai	2.3
5	Sidarth Papers Pvt. Ltd (Unit 2) (Formerly Sidarth Papers Ltd)	7th K.M. Moradabad Road, Kashipur, KKP-Kashipur	6.3
6	Siddheshwari Paper Udyog Pvt. Ltd (Formerly Siddheshwari Paper Udyog Ltd.)	7th K.M. Moradabad Road, KKP- Kashipur	0.5
7	Bahl Paper Mills Limited	Khasra No. 28 Min (Baghelwala) & 74/1 (Girdhai)-5th Km Stone, Aliganj Road, Kashipur(US Nagar), Kkp-Baghelwala	11.4
8	Sidharth Papers Pvt. Ltd. (FormerlySidharth Papers Ltd.)	7th K.M. Moradabad Road, KKP- Kashipur	2.2
9	Sahota Papers Limited	Khata No.07, 150, 260, 212, 269,139, 272,219 Kh No-235,126,233, Village Narayanpur Post Jaspur (U.S.Nagar) U.K	3.1
10	Dev rishi papers Pvt. Ltd. (former name munnaji Papermill Pvt. Ltd)	Khasara No. 275, 277, 285, Village- Jagatpur Patti, Jaspur, Kashipur	1.5
11	M\s Fibremarx Papers Pvt Limited	7th Km Milestone, Village- Haldua Shahu, Post - Shivrajpur	
12	Vishwanath Paper & Boards Ltd	Village Halduwa Shahu,Tehsil Jaspur	3.2
	Total Wastewater Generation (Treated Effluent)		**33682.8 (33.6 MLD)**

Source: Uttarakhand Pollution Control Board

River Bhela is a small spring-fed River, originating also from the agricultural fields and receives spill over water from Tumaria dam, agriculture wash off and industrial wastewater from industries situated in Ramnagar Road and Bazpur road of Kashipur industrial area. After travelling through Kashipur Town, river Bhela finally joins with the river Kosi near Khabriya Bhur Mustakham village, district Rampur, Uttar Pradesh. Other than some minor drains, Nakti Nala, Pathri Nala and IGL drains are three major drains which contributing industrial wastewater into river Bhela.

There are mainly 6 Grossly Polluting Industries (GPIs) located at Kashipur industrial area. Out of the 6 GPIs, two GPIs are maintaining ZLD while rest of the 4 industries is discharging about 2570 KLD wastewater directly or indirectly into river Bhela. Apart from this 6 GPIs, there are 40 other water polluting industries also located in the catchment and generating about 3379 KLD wastewater. Individual industries have provided their own wastewater treatment system (ETP /STP) of appropriate capacity.

Details of Grossly Polluting Industries (GPIs) are mentioned in Table 8 while wastewater discharged from these units are depicted in Figure 12. A list of other small water polluting industries located in the catchment of river Bhela is provided in the Annex in Table A-2.

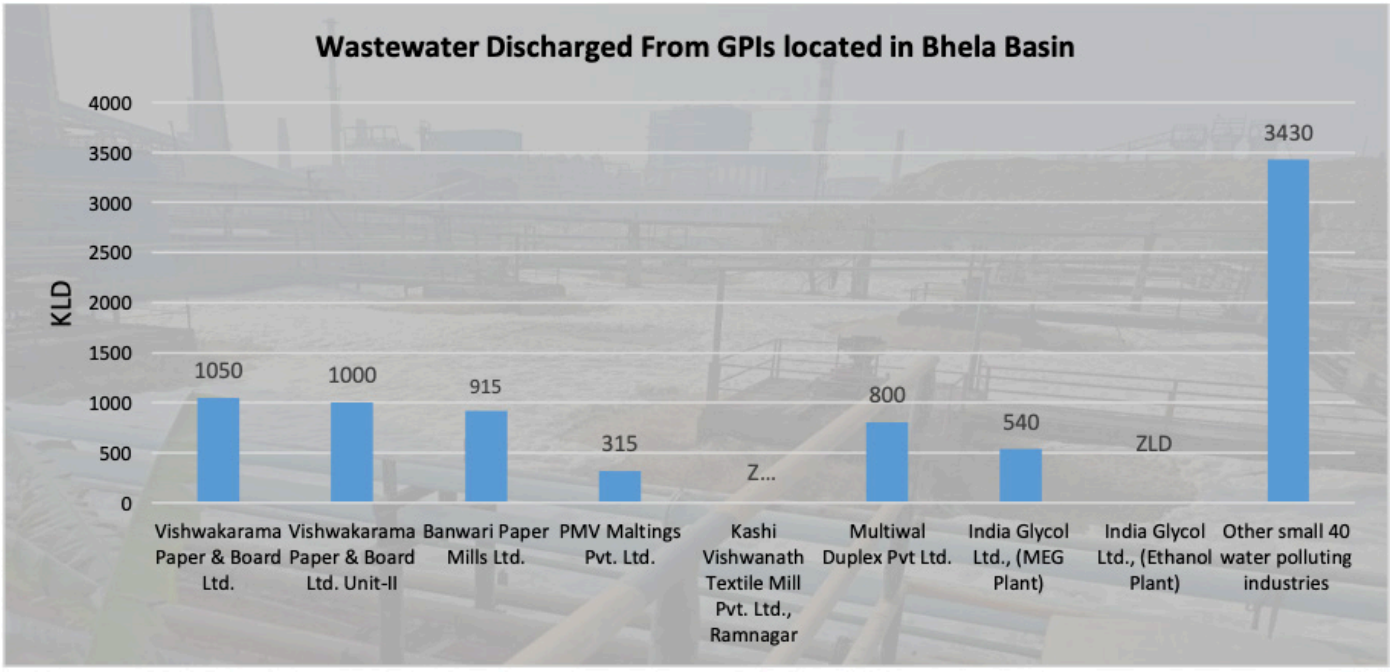

Figure 12: Wastewater Discharged from GPIs located in Bhela Basin

Table 8: List of GPIs located in catchment of river Bhela, Kashipur

S.No.	Industry Name	Wastewater Generation (KLD)	Wastewater Generation (KLD)	
(1)	(2)	(3)	(4)	
1	Banwari Paper Mills Ltd. Ramnagar Road, Kashipur.	1375	915	
2	PMV Maltings Pvt. Ltd, Nand Nagar Industrial Estate, Mahuakheragan, Kashipur.	900	315	
3	Kashi Vishwanath Textile Mill Pvt. Ltd., Ramnagar Road, Kashipur.	600	500	
4	Multiwal Duplex Pvt Ltd., Vill-Gangapur Gosain, Kundeshwari Road, Kashipur	1015	800	
5	India Glycol Ltd., (MEG Plant) Bazpur Road, Kashipur.	25248	540	
6	India Glycol Ltd., (Ethanol Plant), Bazpur Road, Kashipur.	5596	1920	
A	Total Wastewater Generation from GPIs	-	2570 KLD	
B	Others 40 water polluting industries (Details included in Table 6)	-	3379 KLD	

Source: Uttarakhand Pollution Control Board

	Status of Treatment Plant	Capacity of ETP (KLD)	Final mode of disposal of effluent
	(5)	(6)	(8)
	Operational captive ETP	1350	Nakti Nala
	Operational Captive ETP	500	Drain leading to Bhela river
	Captive ZLD with RO and MEE	500 KLD- ETP	ZLD through RO and MEE.
	Operational Captive ETP	800	Pathri Nala
	Operational Captive ETP	540	Drain leading to Bhela river
	Captive ZLD with RO and MEE	ZLD through MEE	ZLD through MEE
	Operational Captive ETP	Individual captive ETP	

Table 8: List of GPIs located in catchment of river Bhela, Kashipur

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5	India Glycol Ltd., (MEG Plant) Bazpur Road, Kashipur.	25248	540	
6	India Glycol Ltd., (Ethanol Plant), Bazpur Road, Kashipur.	5596	1920	
A	Total Wastewater Generation from GPIs	-	2570 KLD	
B	Others 40 water polluting industries (Details included in Table 6)	-	3379 KLD	

Source: Uttarakhand Pollution Control Board

The Kosi originates in the middle Himalayas in the Kumaon region of Uttarakhand. Kosi river is one of the few major Himalayan rivers that does not have a glacial source. River Kosi receives approximate 3879 KLD treated industrial wastewater from two Pulp & Paper industries located in the stretch between Sultanpur to Pattikalan. List of GPIs located in the catchment of River Kosi, US Nagar (Uttarakhand) can be found in Table 9.

	Status of Treatment Plant	Capacity of ETP (KLD)	Final mode of disposal of effluent
	(5)	(6)	(8)
	Operational captive ETP	1350	Nakti Nala
	Operational Captive ETP	500	Drain leading to Bhela river
	Captive ZLD with RO and MEE	500 KLD- ETP	ZLD through RO and MEE.
	Operational Captive ETP	800	Pathri Nala
	Operational Captive ETP	540	Drain leading to Bhela river
	Captive ZLD with RO and MEE	ZLD through MEE	ZLD through MEE
	Operational Captive ETP	Individual captive ETP	

Table 9: List of GPIs located in the catchment of River Kosi, US Nagar (Uttarakhand)

S.No.	Industry Name	Address	Wastewater Generation (KLD)
1	Cheema Paper Ltd, Kashipur	103 - 9th km, Stone, Bazpur Road Kashipur	2649
2	Multiwal Pulp & Board Mills (P) Ltd. Kashipur	9th km, Stone, Bazpur Road Kashipur	1230

Source: Uttarakhand Pollution Control Board

4.1.2 Mapping of Urban Pollution Risk Sources (Sewage & Urban Pollution Hotspots)

4.1.2.1 Sewage & Urban Pollution Hotspots in Ramganga Basin of Uttar Pradesh (UP)

There are 7 major cities, namely Moradabad, Rampur, Bareilly, Shahjahanpur, Farrukhabad, Hardoi and Kannauj, located in the catchment area of the river under UP. Out of these 7 cities, only the 3 cities Moradabad, Rampur and Bareilly have sewage/effluent flows into river Ramganga. In remaining 4 districts (Shahjahanpur, Farrukhabad, Hardoi, Kannauj), no drain either domestic or industrial or mixed, flows into river Ramganga. Hence there is no contribution of pollution load into river Ramganga from these 4 districts. As per the study conducted by UPPCB and Jal Nigam, Uttar Pradesh, total sewage discharged into Ramganga river through 28 major drains is approximately 421.31 MLD. In the polluted stretch of river Ramganga, total sewage and industrial effluent discharge is approximately 445 MLD. The total domestic and industrial discharge flows into river Ramganga through 28 drains as well as through some minor drains directly discharging into the river. Out of 28 drains, 4 drains carrying cumulative flow of 8.86 MLD, meet river Gagan, which ultimately flows into river Ramganga at Moradabad.

As per desk inventory, approximately 421 MLD of sewage and 24 MLD of industrial effluent is being discharged into the river. The estimation of industrial effluent is based upon the consented discharge quantity from the units. But actual industrial effluent may be higher than estimated, because of additional discharge by consented industries and discharge from illegal industries, operating in non-conforming areas. Summary of drains polluting River Ramganga in UP region is mentioned in Table 10 while detailed drain wise data regarding sewage, industrial effluent, number of industries in the drains and status of tapping is given in Table A3 in the Annex.

Table 10: Summary of drains polluting River Ramganga in UP region

S. No.	District	No. of Drains	Type of Drains			Status of Drains		
			Domestic	Industrial	Mixed	Tapped	Untapped	Partially Tapped
1	**Moradabad**	24*	15	0	9	-	22	02
2	**Rampur**	01	0	-	1	-	01	-
3	**Bareilly**	3	1	-	2	-	3	-
		28	16	0	12	-	26	02

Source: Joint Verification report submitted in Hon'ble NGT in OA No. 200/2014 and desk inventory of UPPCB
* Out of 28 drains, 4 drains carrying cumulative flow of 8.86 MLD, meet river Gagan, which ultimately flows into river Ramganga at Morada- bad.** Rest 06 Units are based on Zero Liquid Discharge.

	Industries		Sewage Discharge (MLD)			Total Discharge in River
	Number	Treated Effluent (MLD)	Treated	Untreated	Total	
	70	0.4515	12	200	212	212.4515
	24	3.7525				3.7525
	03	1.012	-	34.31	34.31	35.322
	4	3.428				3.428
	05	2.683	-	175	175	177.683
	0	13.052				13.052
	115*	24.379	12	409.31	409.31	455.689

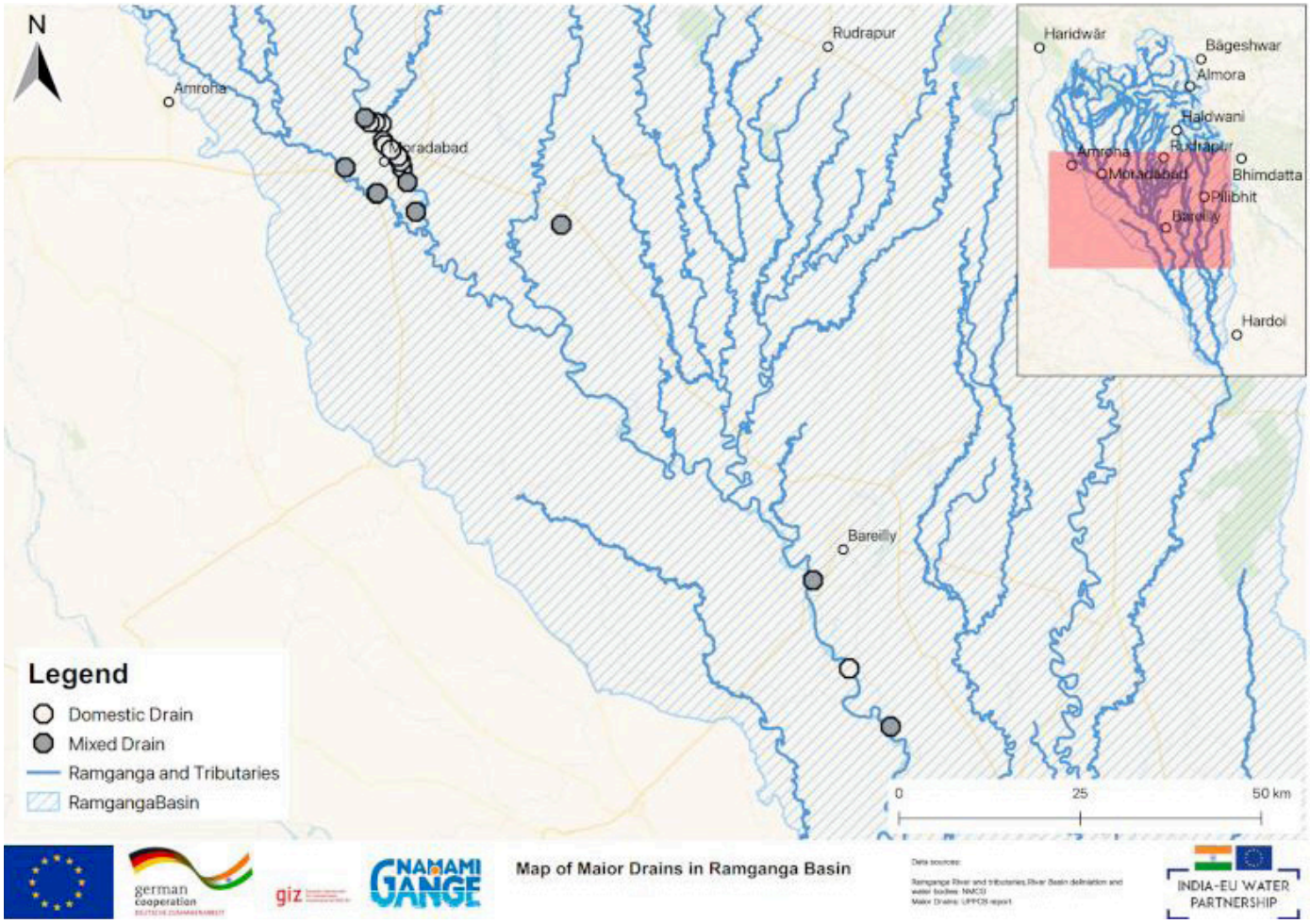

Figure 10: Map of Major Drains in Ramganga Basin

4.1.2.2 Under Ramganga River Catchment Located in Uttarakhand State (UP)

There are six major drains namely – Laxmipur Minor Nala, Kailash Mandap wala Nala, Gabiya Nala, Ice Factory Nala, Beljudi Nala and Gularia Nala which carrying sewage / municipal drainage from Kashipur town, before finally merging into Dhela river. Apart from these sewage drains, there are four major drains viz. Dandi Nala, Pachhana Nala, Lapakna Nala and Choti Dhela which discharge industrial wastewater into river Dhela.

In Bhela river, three industrial drains namely – Nakti Nala, Pathri Nala and IGL nala which carries industrial wastewater and two municipal drains namely - Jaspur Khurd Nala and Hempur Ismail Nala discharge sewage into the river and adversely affecting the water quality of river Bhela. For the Kosi River, Mukundpur Nalla and open channel which carries treated wastewater of 2 Pulp & Paper industries to the river are the main contributor of pollution load in the river.

4.1.2.3 Impacts of pollution accidents like oil spillage and inappropriate storage/ disposal of hazardous waste/municipal solid waste

Solid Waste Generation & Management

There are 7 Cities and Towns situated within the catchment of River Ramganga in Uttar Pradesh. Out of these 7 cities, only 3 cities, namely Moradabad, Rampur and Bareilly, are considered as contributory towns for pollution load generated by waste disposal and management of solid wastes. Currently, these three towns generate approximate more than 800 TPD solid waste. As shown in Table 11 and mentioned in the UPPCB report (UPPCB, 2019), based on the projected population, estimated MSW generation will reached to 1073 TPD in Year 2030. However, in Uttarakhand State, Ramganga river from Gairsain to Mandal Reserve Forest: has a length of 105km with elevation ranging from 1200 to 3069 metre above mean sea level. There is about 1 Class III, 1 Class IV, 1 Class V cities and 29 villages in this upper stretch of Ramganga River. Status of Solid Waste Generation in the ULBs located in Ranga Basin of Uttarakhand State is summarized in Table 12.

Waste processing facility with 400 TPD is operational only in Moradabad, while in other towns waste processing facilities are in early stage of planning or under construction. Therefore, a big need for solid waste processing infrastructure exists in the Ramganga catchment. Insufficient management and disposal of solid wastes create irreversible damage to the environment.

Leachate generation from dumping and legacy waste disposal site is a major problem for municipal solid waste (MSW) landfills and causes significant threat to surface water and groundwater. Therefore, Compliance of SWM Rules (2016) shall be strictly followed for collection, segregation, transportation, and disposal of Solid Waste. In Moradabad treatment and disposal of legacy waste, approx. 300.000 tons has also been started. In Bareilly town, treatment, and disposal facility for Bakharganj legacy waste is also in an advanced stage of implementation. This will most likely reduce ground water contamination and river pollution. Urban civic agencies and village authorities should also strictly ensure prohibition of dumping of solid and other waste within 500 Meters of the banks of the river. It is also required to establish new solid waste and Construction & Demolition wastes processing and disposal facilities to fill the gap of solid waste generation and disposal.

There are 26 villages located on the banks of this Priority-IV polluted stretch of river Ramganga located in UP state. The total population of these villages is 63,826 which generate 6.894 TPD of unsegregated solid waste. This unsegregated solid waste is dumped in open plots or ponds/low lying areas in the villages which contribute to water and ground water pollution.

Table 11: Gap Analysis of Municipal Solid Waste Management based on Year 2030 Population in the catchment of River Ramganga located in UP State

S. No.	City	Population (As per census 2011)	Estimated Population 2030	MSW Generation Estimated (TDP) (@350 GM/ Capita / day)	Available Procesing Facility (TPD)	GAP (TPD)
1	Moradabad	887871	1313321	459.66	300	159.66
2	Rampur	325313	457709	160.2	No	160.2
3	Bareilly	903668	1297369	454.08	No	454.08
4	Shahjahanpur	There is no contribution of MSW into river Ramganga from these 4 districts				
5	Farrukhabad					
6	Hardoi					
7	Kannauj					
	Total	2116852	3068399	1073.94	300*	773.94

Table 12: Status of Solid Waste Generation in the ULBs located in Ranga Basin of Uttarakhand State

S. No.	Location / ULBs	Solid Waste Genetration (TPD) in year 2017	Prediction Solid Waste Generation (TDP) for year 2041
1	Kashipur	36.48	93.22
2	Rudrpur	77.25	273
3	Jaspur	15.6	35.13
4	Bazpur	7.6	13.2
5	Sitarganj	5.9	11.3
6	Haldwani	64.26	122
7	Ramnagar	16.4	41
8	Sutlanpur Patti	2.9	4.7
9	Kaladhungi	3.8	4.9
10	Bhikiyasain	1.3	2.38

Hazardous Waste Generation and Management

Hazardous waste such as lead acid battery scraps, used oil, waste oil, spent catalyst and other waste, such as waste tyres, paper waste and metal scrap are used as raw material by the recycling industry and as supplementary resource for material and energy recovery. Accordingly, it is always preferable to utilise such waste through recycling, or for resource recovery to avoid disposal through landfill or incineration. Disposal of hazardous and other waste through burning or incineration leads to emissions, causing environmental and health issues. Any disposal in water bodies or in municipal dumps leads to toxic releases due to leaching in land and water entailing into degradation of soil and water quality.

As per Desk Inventory of UPPCB (2019), there are 154 industrial units scattered in Moradabad, Rampur and Bareilly districts of Uttar Pradesh generate approximately 940 Ton/Annum of hazardous waste. This waste is being managed by U.P Waste Management Facility and Bharat Oil Waste Management Ltd., located near Kanpur Dehat, which are the authorized hazardous waste treatment, storage, and disposal facilities (HWTSDF).

In Uttarakhand State, about 53.94 MTA hazardous waste is generated from the industries located in the catchment of river Dhela. Recyclable hazardous wastes, mainly used oil and contaminated barrels, are being recycled through registered recyclers, while landfillable waste is being disposed thorough M/S Bharat Oil and Waste Management Pvt. Ltd. located at Lakhsar, Distt. Hardiwar.

However, in Bhela river catchment, about 1606 MTA hazardous waste is generated which is being disposed thorough M/S Bharat Oil and Waste Management Pvt. Ltd which is an authorized Hazardous waste treatment, storage, and disposal facility (HWTSDF). Out of total HW generated, 1233 MTA spent silver catalyst of India Glycol Ltd is being disposed though registered recyclers. Other recyclable hazardous wastes, mainly used oil and contaminated barrels, are being recycled through registered recyclers. Landfillable waste is being disposed in HWTSDF.

Considering the large number of Hazardous waste generating industries in the Ramganga river catchment, strict compliance of Hazardous and Other Wastes (Management & Trans boundary Movement) Rules (2016) is required for prevention and minimization of any chance of land and water contamination in the catchment. The residue generated from flue gas scrubber and tar-containing wastes (generated due to spills/debris containing tarry wastes, used oils, scrubber residue, etc.) shall be disposed as hazardous wastes through common TSDFs as per the conditions stipulated under consent/authorization issued by concerned SPCB. Used oil procured for recycling shall meet the specification mentioned in the part A of Schedule V (HOWM Rules, 2016). Used oil and its recycled products shall be handled in compatible containers with an unbroken screw top lid. Cool, dry, well ventilated and covered sheds must be available on the premises, e.g., for waste oil or faulty charges. There should be a dedicated hazardous storage area for temporary storage of hazardous waste generated during utilization process in the industry.

Wastewater generated from floor-washings, spillages, washing plastics, collected water while recycling the used oil, scrubber bleed shall also be treated in Effluent Treatment Plant (ETP). Process and primary sludge of ETP of Pulp and Paper industry is categorized as HW and utilization of waste pulp from process sludge & primary sludge to produce Paper board/Mill board shall follow Standard operating Procedure (SOP) prescribed by Central Pollution Control Board.

Utilization of Metal and metal bearing wastes for recovery of metals and Utilization of ETP sludge should also be done as per standard operating procedures. A study on water quality was performed during two calendar years (2014, 2015) at 23 stations of river Ramganga and its tributaries (Gurjar & Tare, 2019). 24 parameters such as oxygen level, temperature, pH, but Heavy Metals as well, were monitored and analysed by using cluster analysis. Results are that water quality in the mainstem of river Ramganga are within desirable limits for freshwater aquatic life and outdoor bathing/recreation except in the middle stretches where it receives domestic and industrial waste carried through the tributaries like Dhela and Kosi river. From this, necessary actions are required to reduce pollution in these tributaries. Figure 13 illustrates three pollution levels of Ramganga river and tributaries.

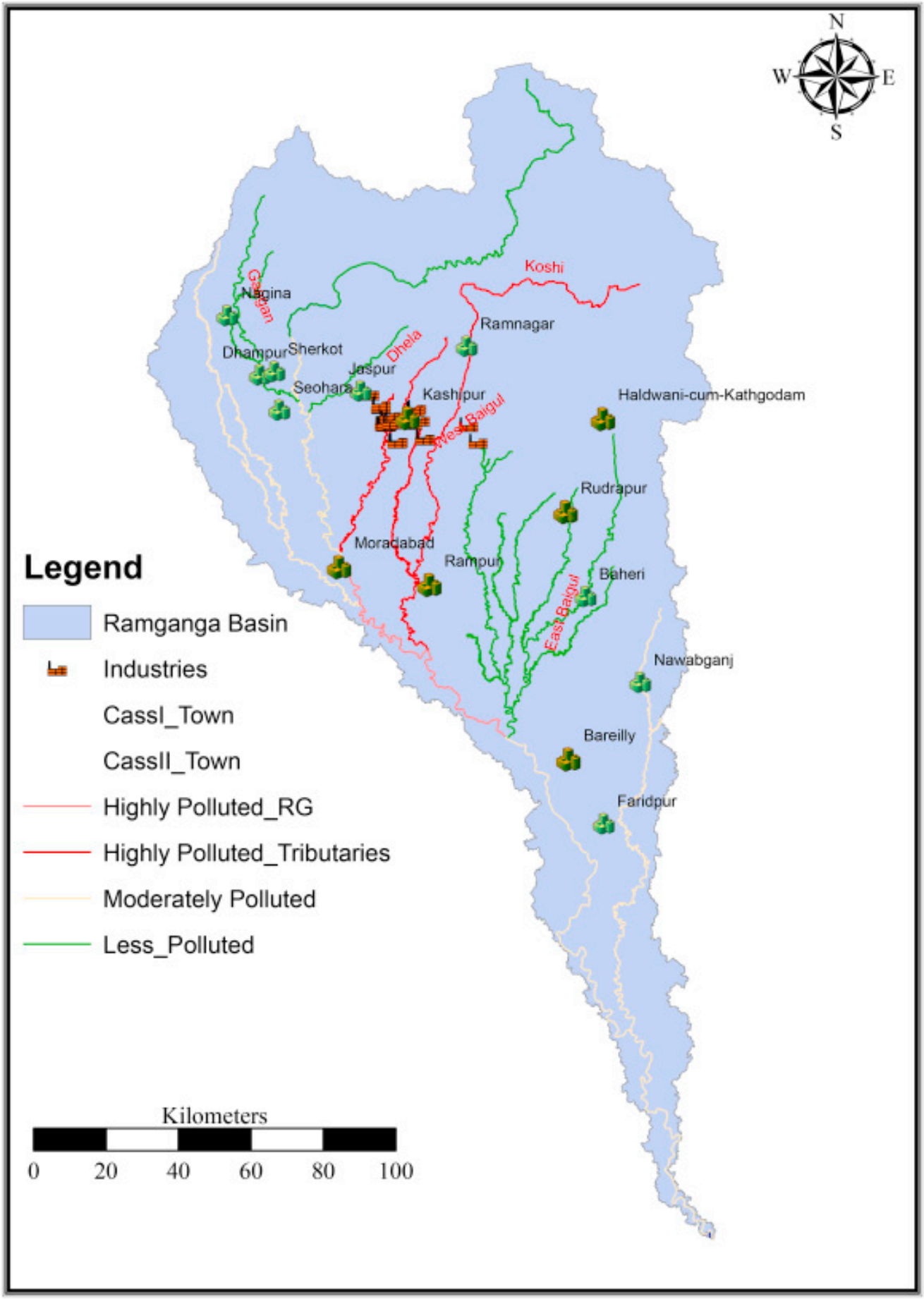

Figure 13: Illustration of pollution levels in Ramganga river network (Gurjar & Tare, 2019)

4.1.3 Non-Point Pollution from Agriculture

Agriculture is the major livelihood activity of the majority of rural population in the Ramganga Basin. It is, therefore, necessary to study the dynamics of agriculture with a view to understand the nature and extent of dependency on it. In the Ramganga basin, which spans Uttarakhand and Uttar Pradesh, the major source of livelihood of the population in both states is agriculture. Hence, the first sheet flow after rain generally carries pollutants/pesticides in the river. High pesticide application along the river basin agricultural fields leads to the bioaccumulation of these residues in the ecosystem through several means (Schulz and Peall, 2001; Gavrilescu, 2005; Holvoet et al., 2007; Takatori et al., 2008), accumulation of these residues has the potential of impact on non-target organisms, and to the natural environmental conditions (Takatori et al., 2008; Carriquiriborde et al., 2014). The total usage of pesticides in Ganga basin between year 2012–2017 was 72,741 MT, which is 27% of countries total consumption (PQRS, 2017).

Previous studies carried out have shown, that organochlorine pesticides are being abundantly used, as detected in number of studies carried out (Rehana et al., 1995; Sankararamakrishnan et al., 2005; Ghosh et al., 2009; Singh et al., 2012; Mutiyar and Mittal 2013; Chakraborty et al., 2016; and Mondal et al. 2018). These pesticides, organochlorines, pyrethroids, organophosphates, and carbamates upon application cause serious impacts by their persistence in the environment, toxicity to non-target organisms, long-range transmission and bio-accumulation under favourable environmental conditions (Naqvi and Vaishnavi, 1993; Contreras Lopez, 2003; Briz et al., 2011; Gao et al., 2013). Despite the major plans to control the pesticide pollution, occurrence and high level of pesticides have been continuously detected across many rivers of the country. Several hundred formulations of pesticides are currently used for agricultural purposes along the river Ganga basin. Estimated from agricultural and other sources, above 9000 MT of pesticides were annually used for agricultural practices in the Ganga river basin (Ghosh et al., 2009). In the recent studies of (NGRBA, 2011) it is estimated 21000 MT of pesticides are applied in the basin annually.

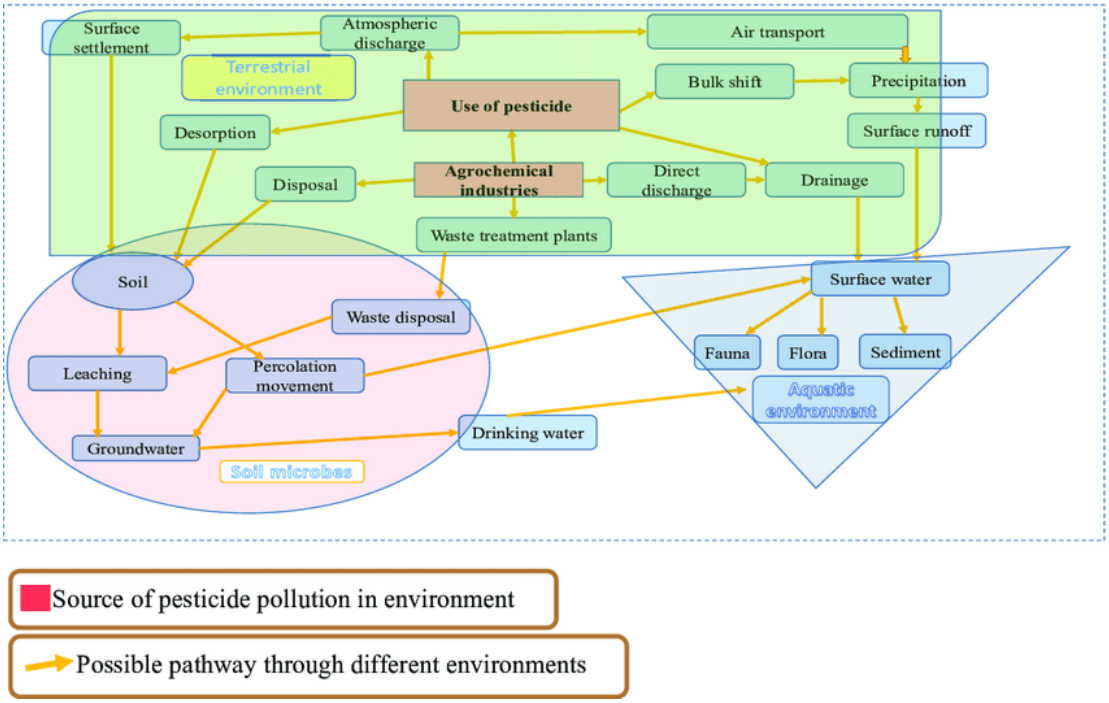

Figure 14: Possible pathway of pesticide pollution in water through different compartments. (Source: Shah ZU and Parveen S. 2021)

The pattern of use shows insecticides always dominate the formulations followed by herbicides and at last fungicides. In the insecticide category, organochlorines were predominantly used till 1990, after which the use of organophosphate formulations increased. The consumption pattern of pesticide uses in year 2014 was, insecticide 80%, followed by herbicide 15% and fungicide 2%. Phosphamidon, butachlor, mancozeb, quinalphos, monocrotophos, paraquat, endosulfan, isoproturon are commonly consumed pesticides (Bhushan et al., 2003).

4.2 Risk assessment and risk categorisation of major pollutants

4.2.1 Industrial Risk Assessment & Key Pollutants

As mentioned earlier, Ramganga receives approximately 24 MLD treated industrial effluent from 121 water polluting industries/Grossly Polluting Industries (GPIs) located in UP region. The industries are grossly polluting in nature which belong to Sugar (12), Pulp & Paper (3), Distillery (4), Textile (1), fertilizer (1) Slaughter House (4) and Electroplating (86). Out of these 121 units, 105 water polluting units are only in Moradabad and Rampur area while 16 units are situated in Bareilly area. Out of water polluting industries of Moradabad and Rampur (105 units), 2 Distillery units, 1 Wastepaper based Paper Unit and 1 Sulfuric acid plant are based upon Zero Liquid Discharge into any surface water. Rest of 101 units of Moradabad and Rampur are discharging treated effluent in drains, which ultimately reaches to Ram- ganga River. However, Sugar, Wastepaper based Paper industries mostly recycle entire treated effluent or use it for irrigation, but still there is possibility of discharge to overflow.

Ramganga basin located in Uttarakhand state is also having 20 Grossly polluting industries (16 paper industries) discharging almost 35 MLD treated effluent in nearby drainage that ultimately find its way to Ramganga tributaries viz. Dhela, Bhela and Kosi rivers.

It is pertinent to mention here that based on pollution control board norms, Grossly Polluting Industries (GPI) are those industrial units which is discharging wastewater more than 100 KLD and/or hazardous chemicals used by the industry as specified under the Schedule-I, Part-II of The Manufacture, Storage and Import of Hazardous Chemical Rules of 1989 under Environment (Protection) Act, 1986. In addition to this, some other factors viz. generation and storage of by-products (like molasses, spent wash which are vulnerable to accidental discharges) and possibility of groundwater contamination by storage of treated wastewater or by-products are also considered before conducting industrial risk categorization under this assignment. Based on above mentioned factors, all these GPIs located in the Ramganga basin were further classified as High, Medium and Low category for possible risk of accidental discharges and summary of the same is provided in Table 13.

Table 13: Type of Industries, their Risk category and Pollutant of Concern in Industries located in Ramganga basin

Ramganga Basin of Uttar Pradesh State

S.No.	River	Industry Type	No. of Industries	
1	Ramganga & Tributaries	Sugar	12	
2		Paper	03	
3		Slaughter House	04	
4		Electroplating	86	
5		Distillery	04	
6		Dyeing and Textile Synthetic Fiber	1	
7		Fertiliser	1	
6		Other Industries	10	

	Possible Risk of accidental discharge	Influence of stakeholders	Rationale	Chemical & Pollutants of Concern
	8.5	High	Due to storage of molasses & high quantum of effluent storage/ generation	Molasses's & Effluent having higher BOD & COD Load
	2.5	High	Due to high quantum of effluent storage/generation)	Black Liquor & Effluent having higher BOD & COD Load & Present of toxic metals
	2.3	Medium	Due to high quantum of effluent storage/ generation	Effluent having higher BOD & COD Load
	0.53	Low/Medium	Due to Scattered distribution & limited quantum of effluent generation	Heavy metals
	ZLD	High	Due to risk of safe storage of Molasses & Utilization of spent wash	Molasses's & Spent wash
	1.5	High	Due to utilization of various chemicals, Dye in the process & high quantum of effluent generation	Dye, synthetic chemicals and Effluent
	5.7	High	Due to utilization of various chemicals, nutrients, metals in the process & high quantum of effluent generation	Effluent having higher COD and ammoniacal nitrogen & metals
	2.9	Low	Due to Scattered distribution & comparatively fewer polluting industries	Effluent

Ramganga Basin of Uttar Pradesh State

S.No.	River	Industry Type	No. of Industries	
1	Dhela River (Tributary of Ramganga River)	Paper	12	
2	Bhela River (Tributary of Ramganga River)	Malt/Distillery	2	
		Paper	2	
		Textile	1	
		Chemical	1	
		Other Industries	40	
3	Kosi River (Tributary of Ramganga River)	Paper	3.37	

	Possible Risk of accidental discharge	Influence of stakeholders	Rationale	Chemical & Pollutants of Concern
	28.6 (Only from 12 GPIs)	High	Due to high quantum of effluent storage / generation	Black Liquor & Effluent having higher BOD & COD Load & Present of toxic metals
	2.57	High	Due to high quantum of effluent storage/generation)	Molasses's & Spent wash
		High	Due to high quantum of effluent storage/ generation	Black Liquor & Effluent having higher BOD & COD Load & Presence of toxic metals
	3.37	Low-medium	Due to Scattered distribution & comparatively less polluting industries	Effluent
	3.87	High	Due to high quantum of effluent storage /generation	Black Liquor & Effluent having higher BOD & COD Load & Presence of toxic metals

As mentioned in Table 13, sugar, paper, distillery, textile and chemical industries are classified as High-risk category while slaughterhouse, electroplating and other industries are classified as Medium to low-risk category. Despite of being ZLD, distillery units are classified in High-risk category because of risk involved in storage of by products (like molasses and spent wash) and possibility of groundwater contamination by the storage of treated water and by products. Recently in year 2018, Sugar mill molasses leak incident happened in Gurdaspur district of Punjab had done huge damage to aquatic life in Beas River (Located in Northern India).

Molasses from this sugar mill started leaking from storage tanks into the storm water drain and management failed to stop the leakage for next 30 hours resulting several hundred fish including giant catfish died due to low oxygen level in Beas River.

This is the one example shows sugar and distillery which stores millions of litre molasses and spent wash are vulnerable for accidental pollution and should categorized in high-risk category. Electroplating industries are also considered a major polluting industry because it discharges toxic materials and heavy metals through wastewater (effluents), air emissions and solid wastes in environment. However, unlike sugar and distilleries units where storage of by-products and generation of wastewater is huge and failure/ accidental discharge from any single unit may pose very high risk within a short span of time, electroplating industries are distributed in a larger area and generation of wastewater quantity from a single unit is also very limited. Therefore, considering the scattered risk sources, electroplating industries are categorized as medium risk category for accidental pollution. Despite of being in medium risk category, electroplating industries may cause serious problems to the aquatic biodiversity (especially fishes) as their wastes may contain toxic chemicals like salts of chromium, copper, cadmium, arsenic, mercury and lead which interact with with aquatic environment and affect the river ecosystem in long run. Bioaccumulation of heavy metals in the food chain may also have serious impacts on human health. Risks and Impacts of bioaccumulation of heavy metals have been reported by many authors (Usmani and Kumar, 2017, Singh et al., 2017, Singh et al., 2018a, Singh et al., 2018b, Sarah et al., 2019 for various Indian rivers including Ramganga.

4.2.2 Impacts from point source pollution – Incidents of fish deaths in Ramganga Basin

Fish deaths are often the first visible signs of environmental stress and pollution in the rivers around the world and a major cause of concern for environmental agencies to determine the real cause of the fish death. Ecological hypoxia (oxygen depletion) is one of the most common causes of fish kills that can be because of natural or anthropogenic reasons. Incidents of fish deaths are common in the Ramganga basin. One such documents hundreds of dead fish that were washed up on shores of Ramganga river in Moradabad district in Uttar Pradesh, India due to excessive water pollution. Particularly in summer season, the oxygen level in the river had reached an extremely low level, due to a large amount of industry waste and domestic sewage being discharged into it.

Pesticides have been found to be highly toxic not only to fish but also to the other organisms, which constitute the food chain. The three major pesticides are herbicides (weed control), insecticides (insect control), and fungicides (Mycotic control), but the more acute toxicity are Insecticides. The contamination of surface waters by insecticides is known to have negative effects on the growth, survival and reproduction of aquatic animals. Different concentrations of insecticides are present in many types of wastewater. Numerous studies have found them to be toxic to aquatic organisms, especially fish species. The insecticidal residues which contaminate the water are mainly due to the intensive agriculture combined with surface runoff and surface drainage, usually within a few weeks after application. The histopathological changes in fish tissues can be used as a biological indicator for pollution with pesticides with special reference to insecticides. Protection of wildlife and water quality is possible when rationalize the use of pesticides. Also, when using Pesticides, they must be chosen judiciously and applied safely. Thus, the surface water pollution and contamination of our aquatic life could be avoided.

Table 14: The Acute Toxicity (LC50) of Some Pesticides against Certain fish species

Name of Pesticide	Fish Species	Duration of Exposure
DDT	Rainbow Trout	96 hrs-8.7 µg/l
Akton	Channel catfish	96 hrs-400 µg/l
Acephate	Feathed M.	96hrs>1000 µg/l
Alaclor	Rainbow trout	96hrs2.4 µg/l
Endosulfan	Channel catfish	96hrs1.5 µg/l
Malathion	Labeo rohita	96hrs15 µg/l
Malathion	Heteropneustess fossilis	96hrs0.98 ppm
Methyl parathion	Catla catla	96hrs 4.8 ppm
Rogar	Puntius stigma	96hrs7.1 &7.8 ppm

After exposure to different concentrations of insecticides in water, the fish absorbs them in its gill, skin or gastrointestinal tract. Due to their lipophilicity, most insecticides easily permeate the biological membranes and it increases the sensitivity of fish to aqueous insecticides. Then, insecticides are rapidly metabolized and extracted and may be bioconcentrated in various tissues of fish.

Bioaccumulation occurs if the insecticides increase, it becomes more harmful to the consumer or animals. The accumulated insecticides can cause death or long-term damage due to bio-concentration of these compounds in different tissues of fish, in addition, since some fish are lower on the food chain, bioaccumulation of insecticides may increase in tissues of their predators and consumers, such as humans and thus affecting their health and survival. So, the bioaccumulation of these contaminants in fish and the potential biomagnifications in human are perceived as threat. Bioaccumulation rate of insecticides in fish depends on the species, life stages, the amount of fat reservation in different tissues and diet of fish, chemical and physical properties of insecticides and the rate of water pollution.

According to an affidavit, filed by the Uttar Pradesh Pollution Control Board (UPPCB), in a 2015 case on pollution in the Ramganga, 23 drains in Moradabad release untreated waste directly into the river. According to the report, 120 Million Litres per Day (MLD) of sewage from Bareilly city were directly or indirectly discharged into Ramganga River without any treatment. (Source: https://www.me- dindia.net/news/fishes-die-of-excessive-water-pollution-in-moradabad-159314-1.htm).

Other than this, heavy metals discharged through industrial wastewater may also pose serious risk to aquatic biodiversity including fishes and humans as well. Bioaccumulation of metals in plants and animals' tissues may lead toxicity in aquatic biota and may affect the entire food chain. Study conducted by Sarah et al 2019 showed extent of heavy metals pollution in the aquatic life of river Ramganga system and suggested that the bioaccumulation of heavy metal in fish species like Channa punctatus has reached above permissible limits indicating potential health risks.

Some of the Incidents of Fish death reported in the Ramganga River are summarized in the table below.

Table 15: Incidents of Fish death reported in Ramganga River

Incidents of Fish Death in Ramganga River	Possible Reasons	Reporting Date	Source
Moradabad Ramganga River UP, Dead fish found again in Ramganga river of Moradabad doubt of death due to lack of oxygen Moradabad Ramganga River UP, Dead fish found again in Ramganga river of Moradabad doubt of death due to lack of oxygen (jagran.com)	Discharges of untreated sewage & Industrial discharges	3rd June 2021	Dainik Jagran News Paper
Pollutants, low oxygen levels kill hundreds of fish in Ramganga http://timesofindia.indiatimes.com/arti- cleshow/64861422.cms?utm_source=conten- tofinterest&utm_medium=text&utm_cam- paign=cppst	Discharges of untreated sewage & Industrial discharges	5th July 2018	Times of India News Paper
Fishes in Uttarakhand Rivers Being bleached, blasted to death Fishes in Uttarakhand rivers being bleached, blasted to death | Dehradun News - Times of India (indiatimes.com)	Blast Fishing & Use of Pesticides Bleaching Powder	5th April 2016	Times of India News Paper
Pollution kills hundreds of fish in Moradabad Pollution kills hundreds of fish in Moradabad - YouTube	Discharges of untreated sewage & Industrial discharges	10th April 2016	Reported by ANI on 17th April 2016
Pollution kills scores of fish in Moradabad's Ramganga river http://timesofindia.indiatimes.com/arti- cleshow/15561253.cms?utm_source=conten- tofinterest&utm_medium=text&utm_cam- paign=cppst	Discharges of untreated sewage & Industrial discharges	10th April 2016	Reported by ANI on 17th April 2016
Contaminated river water causing fish deaths in Uttar Pradesh Contaminated river water causing fish deaths in Uttar Pradesh | TopNews	Industrial discharges	16th October 2009	Top-News Media

The figure below captures a system map to illustrate fish kills in water bodies due to nearby pollution sources. There exists a case of fish deaths which occurred in Bangalore. The key reason for fish kills is the discharge of untreated sewage (both domestic and industrial) into waterbodies, as the system map indicates. Untreated sewage enters the water body by direct discharge, rajakaluves, that were traditionally supposed to carry stormwater. Scientists and local residents blame untreated effluents by industrial units for river pollution. Local residents blame industries dumping chemical into the river while there are many drains in Moradabad, which also release untreated waste directly into the river for being the reason for low oxygen levels and fish deaths. The figure below captures a System Map to illustrate fish kills in water bodies due to nearby pollution sources.

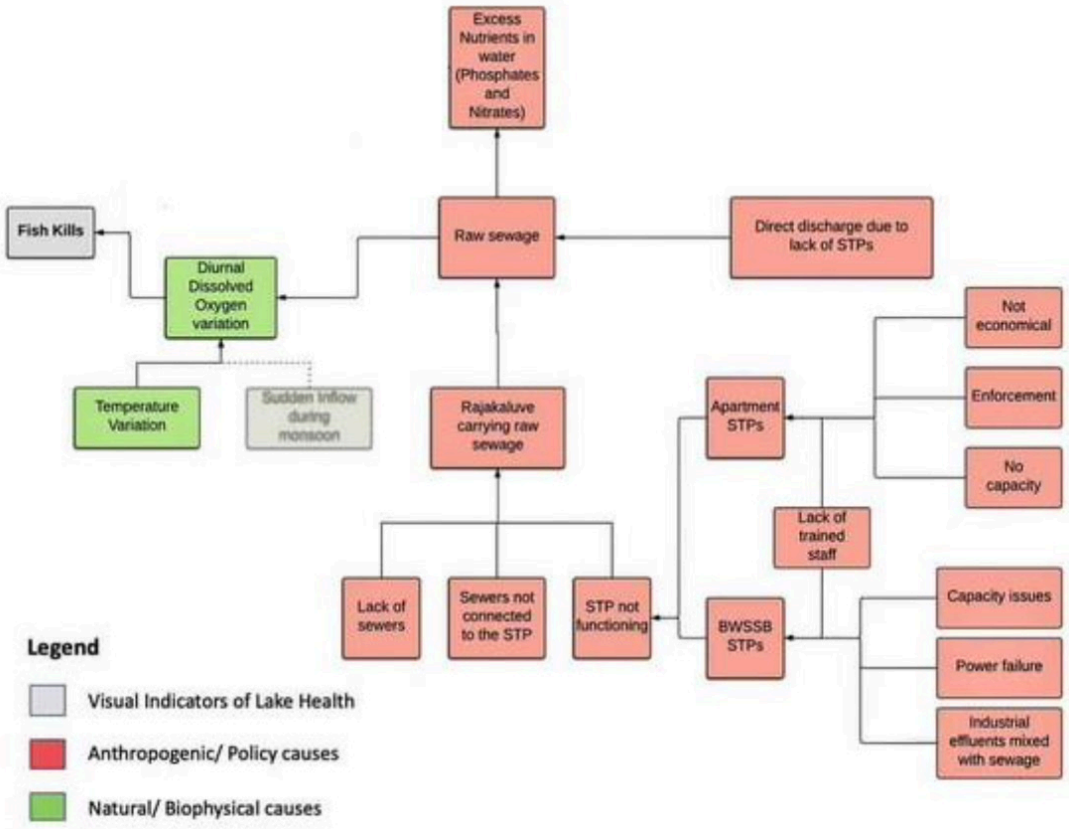

Figure 15: System Map to illustrate fish kills in water bodies due to pollution (Source (Citizen Matters, 2020)

4.2.3 Non-Point Pollution from Agriculture

The pattern of use shows insecticides always dominate the formulations followed by herbicides and at last fungicides. In the insecticide category, organochlorines were predominantly used till 1990, after which the use of organophosphate formulations increased. The consumption pattern of pesticide uses in year 2014 was, insecticide 80%, followed by herbicide 15% and fungicide 2%. Phosphamidon, butachlor, mancozeb, quinalphos, monocrotophos, paraquat, endosulfan, isoproturon are commonly consumed pesticides (Bhushan et al., 2003).

Due this enormous quantity of use possibilities of pesticide transport to the aquatic ecosystem increases by surface runoff, leaching and flash floods. Applied pesticides in the agricultural fields may be present in the rainwater because of their volatilization from soil and crops. Although rainwater is considered as safe and fit for use, the source is also polluted by pesticides as reported by (Sakai 2002; Kumari et al., 2007).

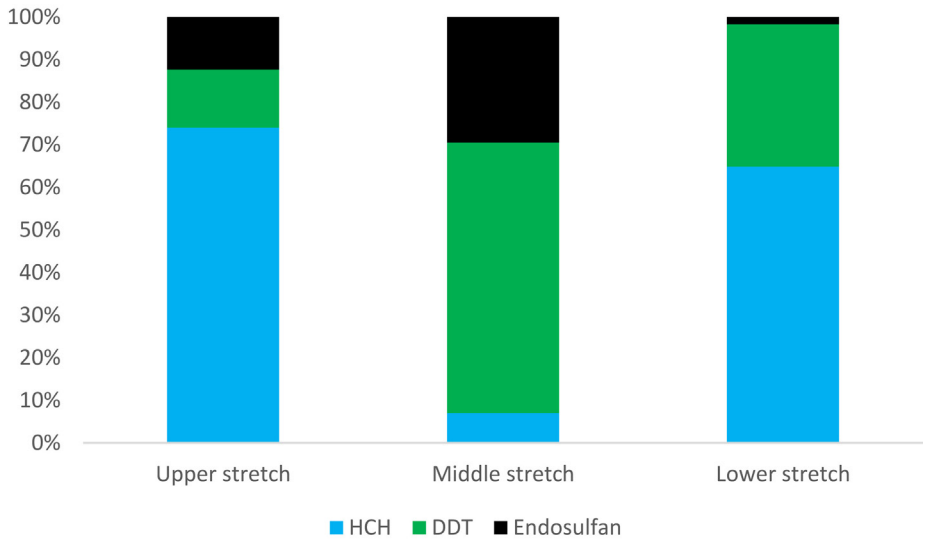

Figure 16: Change in pesticide trend along three stretches of river Ganga. (Source: Shah ZU and Parveen S,2021)

The above documentation clearly suggests that use of pesticides for Agricultural consumption is a concern for non-point source of pollution in the Ganga River Basin. Efforts must be made to so that such diffused non-point sources of pollution are appropriately quantified to prevent threats to environment and aquatic life in the basin. The following figure illustrates the NPK Consumption during the year 2017- 18.

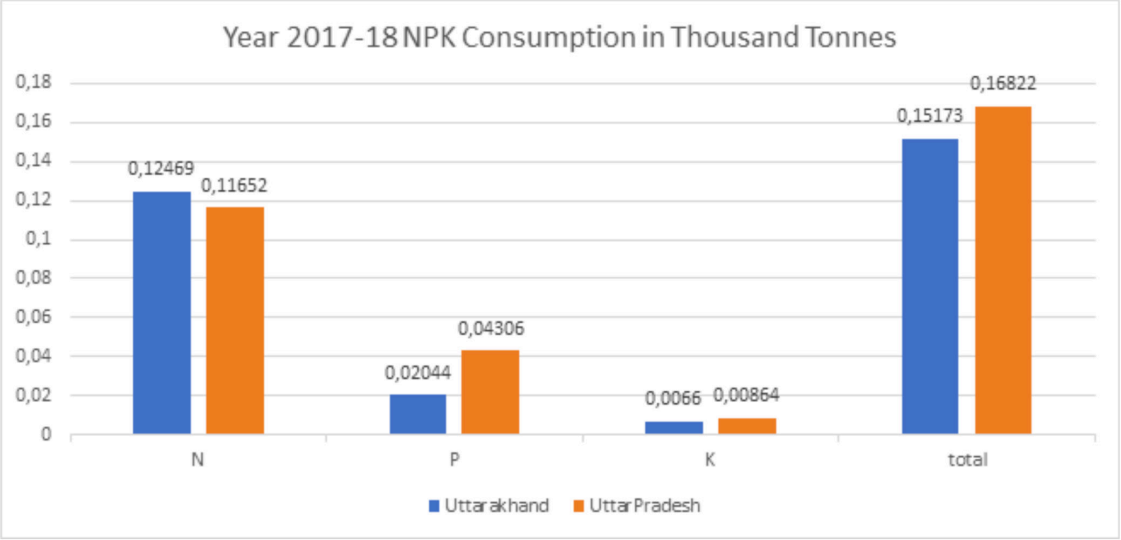

Figure 17: NPK Consumption during the year 2017-18 Source : Department of Agriculture, Cooperation & Farmers Welfare https://agricoop.gov.in/sites/default/files/agristatglance2018.pdf

4.3 Existing and planned strategies including gap analysis

4.3.1 Status of Planning and Management of Sewage Pollution in Ramganga Basin

There are 7 major cities namely Moradabad, Rampur, Bareilly, Shahjahanpur, Farrukhabad, Hardoi, Kannauj located in the Ramganga basin of Uttar Pradesh State. Out of these 7 cities the sewage/effluent of Moradabad, Rampur and Bareilly flows into river Ramganga.

Total sewage discharged into Ramganga river through 28 major drains of these tree towns is estimated to be approximately 421 MLD. Utilization of existing STPs is a major cause of concern as the total installed capacity of 1 STP in Moradabad is 58 MLD of which only 18 MLD is utilized and 3 STPs installed at Rampur having capacity 14 MLD, 15 MLD and 5 MLD are almost non-functional due to non-connectivity of the sewer connection. This indicates that the treatment facility available is not fully utilized, due to incomplete household sewer connections and connectivity of conveyance channel to the Sewage Treatment Plants. However, NMCG, along with state agencies, are giving efforts to fill the gaps of treatment capacity in these three towns and trying to solve the technical and operational issues for smooth functioning of existing STPs. The details of Existing, under construction and planned Sewage Treatment Plants under Ramganga Basin Located in Uttar Pradesh State are mentioned in Table 16.

Table 16: Existing, under construction and planned Sewage Treatment Plants under Ramganga Basin Located in Uttar Pradesh State (Source: SMCG, Lucknow, NMCG, Delhi & CPCB STP Status Report (2021))

S. No.	District	STPs	Capacity STP	Utilization Status of Existing STP (as on Oct 21)	Wastewater Generation (KLD)
1	Moradabad	58 MLD	58 MLD	18 MLD	For Zone 1 STP of 58 MLD constructed & it's partially operational
		Under Construction / Sanctioned	25 MLD	Under Construction	Sanctioned for pollution Abatement works for River Ram Ganga at Moradabad (Sewage Zone-2) under Hybrid annuity - based PPP model - Namani Gange Programme
		Under Planning	2 STPs (40 MLD & 34 MLD)	-	For Zone 3 STP of 40 MLD is proposed for Zone 4, STP of 34 MLD is proposed
2	Rampur	Existing	14 MLD	0.11	Under-utilization / non-operational due to technical & operational issues (non-connectivity of the sewer lines)
			15 MLD	0.07	
			5 MLD	0.003	
		Under Construction / Sanctioned	-		-
		Under Planning			-
3	Bareilly	Existing	-		-
		Under Construction / Sanctioned	4 STPs of 63 MLD Capacity		Sanctioned under Namani Gange Programmer , Govt. of India
			1 STPs of 35 MLD Capacity		Sanctioned under AMRUT, Govt. of India
		UnderPlanning	-		1

In parts of the Ramganga Basin located in Uttarakhand state, 9 STPs having a total capacity of 30.30 MLD are sanctioned in Udham Singh Nagar District under Namami Gange Program to minimise the pollution load in Ramganga River. Dhela and Bhela river are the two key tributaries contribute majority of domestic and industrial pollution load in the Ramganga river which generates at Kashipur area of Udham Singh Nagar District. Six major drains namely – Laxmipur Minor Nala, Kailash Mandap wala Nala, Gabiya Nala, Ice Factory Nala, Beljudi Nala and Gularia Nala, which are carrying sewage from Kashipur town, meet the Dhela River.

Apart from this, two municipal drains of Kashipur town viz. Jaspur Khurd Nala and Hempur Ismail Nala also bring sewage into Bhela river and adversely affect the water quality of the river. For Dhela and Bhela River rejuvenation, 5 STPs having a total capacity of 13.8 MLD are sanctioned under Namami Gange Program. Other than this, 18 MLD STP to treat Laxmipur Minor Nala and Kailash Mandap wala Nala is also sanctioned under AMRUT which is already in advance stage of construction. Summary of Interception and Diversion and STPs works sanctioned at Ramganga Basin located in Uttarakhand state are mentioned in Table 17.

Table 17: Interception & Diversion and STPs sanctioned at Ramganga Basin located in Uttarakhand state (Source: Uttarakhand Peyjal Nigam (January 2022))

S. No.	River Stretch	Description	I&D Works	Capacity of STP (Sanctioned in MLD)	Location of STP	Status
1	Bhela River/ Kashipur to Rajpura Tanda	Rejuvenation of River Bhela				Drain leading to Bhela river
		I&D of Nallas Hempur Ismail	2	2	At Village Hempur, Kashipur	
		Jaspur Khurd	1	1	Near Mahadev Barrage, Jaspurkhurd, Kashipur	
2	Dhela River/ Kashipur to Garhuwala Thakurdwara	Rejuvenation of River Bhela				
		Kashipur Sewerage Scheme (Dhela River) Phase-I	2	10	Near Gabiya Nala, Dhobi Ghat, Kashipur	
		I&D of Nallas Hempur Ismail	1	0.5	Near Belijudi Nali at village Belijui	
		Gulriya Village	2	0.3	Near Gulriya Nali-2 at Village Gulriya	

S. No.	River Stretch	Description	I&D Works	Capacity of STP (Sanctioned in MLD)	Location of STP	Status
3	Kiccha River/ along Kiccha	Rejuvenation of River Kiccha				Drain leading to Bhela river
		I&D of Nallas at Kiccha	6	3	Near Shiv Mandir Nala, Near River Kiccha (Gola River)	
4	Kosi/ Sultanpur to Pattikalan	Rejuvenation of River Kosi				
		I&D Work of Mukundpur Nallas	3	0.5	At Mukundpur Village	
5	Nandhor/ along Nandhor	Rejuvenation of River Nandhor				
		I&D and STP work of Nallas at Sitarganj	1	3	Near Odheri Nala, Sitarganj	
6	Pilakhar/ Down-stream of Bazpur	Rejuvenation of River Nandhor				
		I&D Work for Ghoga Nalla at Bazpur & STP	1	10		
			19	**30.30 MLD**		

Fish stock / fisheries assessment

There is no mention of existing and planned measures to tackle fish deaths in Ram Ganga/Ganges from available literature. However there exists assessment of fish and fisheries of the Ganga River system for developing suitable conservation and restoration plan (https://nmcg.nic.in/writeread- data/fileupload/56_AnnualReport18-19.pdf).

This mentions a comprehensive plan for restoration of sustainable fisheries for a healthy Ganga river system. The preparation of the conservation plan will include seed production of selected fish species and ranching in the depleted river stretches. The project is for five years duration (2016-2021).

A total of 190 fish species have been recorded so far from the entire stretch of river Ganga. Out of total species recorded, 128 are considered to be purely freshwater, while 62 species belong to brackish water environments. Under IUCN ver3.1 Red list (IUCN, 2001), a total of 19 fish species are enlisted under threat status. Status of Fish and Fisheries of River Ganga (Indian Institutes of Technology, 2012)is a report on the status of fishes in River Ganges (2012).

It states that River Ganga supports a large number of indigenous and exotic species of fishes. The fish population is constituted by large groups of carps and catfishes besides mullets, clupeids, feather back and other miscellaneous species. The freshwater population from Gangnani to Farakka is represented by 181 sp. under 89 genus and 37 families. The family Cyprinidae is conspicuous by large numbers and species richness. The Hooghly Matlah estuary is represented by 103 +72 species (72 sp. are common with fresh water), 69 genus and 37 families. The Chondrichthyes (cartilaginous fish) add up another 13 species. About 100 species have high commercial importance. These included Indian Major Carps (IMC), Catfishes, other Carps, Clupeids while Hilsa, Polynemus, Liza, Pama and Harpodon. There has been a remarkable reduction in the production capacity of freshwater fishes due to human indulgence, dams, withdrawal to large quantities of water and pollution due to domestic/ industrial wastes and indiscriminate fishing. The total catch has gone down significantly. The catch composition has also changed.

4.4 Existing systems and institutional mechanisms including gap analysis / Responsibilities for crisis management

This section attempts to identify and analyze available information on existing systems, institutional mechanisms and responsibilities for crisis management in Ramganga Basin, but input from NMCG/GIZ is required to get a comprehensive picture of structures and processes in Ramganga Basin. For this reason in this section information from Ganga Basin is referred to as well.

Stakeholder mapping for Ramganga Basin

Study area: The River Ramganga originates from Doodhatoli ranges in the district of Pauri Garhwal, Uttarakhand state of India. It is the first major tributary joining Ganga on its left bank near Kannauj in Fatehgarh district. The total length of River in 596 Km and having a catchment of 32,493 Sq Km. This River flows from Almora, Pauri, Kalagarh, Bijnore, Moradabad, Rampur, Bareilly, Shahjahanpur and it joins the Ganga from left near Kannauj.

Identification and categorisation of stakeholders

Stakeholders in the Ganges basin are listed by analysing the rich picture, personal observations and experiences, literature review, and media reports. While identifying the stakeholders following guiding questions were kept in mind based on (International Institute for Environment and Development IIED, 2005).

- Who are the potential beneficiaries?
- Who are adversely affected?
- Who has existing rights?
- Who is voiceless?
- Who resent to changes and mobilise resistance?
- Who is responsible for planning?
- Who has money, skill or key information?
- Whose behaviour has to change for success?

Stakeholder Mapping:

Developing a stakeholder platform requires a patient iterative process of identifying stakeholders, their interests, building trust, empowering weak stakeholders and, for powerful stakeholders, to accept new rights and roles for other stakeholders. The significant aspects of multilayered and multiple stakeholders on Ganga River Basin need to be identified.

Namame Gange Programme

The threat and risk analysis for pollution accidents requires to be aware of the potential pollution point sources, the substances, concentrations and loads that may lead to pollution accidents, match critical substances to industries, what actions can lead to accidental pollution and the behaviour of the substances once they have reached the river.

A five-tiered institutional structure (from national to state to district level) was formated to ensure smooth functioning of the Namami Gange Programme (Rajiv Ranjan Mishra, 2021):

- National Gange Council (NGC) under the chairmanship of Prime Minister of India (federal authority).
- Empowered Task Force (ETF) under the chairmanship of Union Minister for Ganga Rejuvenation (ground force appointed by the central ministry).
- National Mission for Clean Ganga (NMCG) as the implementation arm of the federal system.
- State Ganga Committees (SGCs) as state-level agency.
- District Ganga Committees (DGCs) as district-level agency.

Table 18: Members of District Ganga Committees

Stakeholder	Post
Director Collector	Chairperson
Two Nominated representatives from municipalities and gram panchayats	Members
One representative each from ▪ Public works ▪ Irrigation ▪ Public Health Engineering ▪ Rural Drinking Water Department ▪ State Pollution Control Board	Members, ex-officio
Two environmentalists associated with river Ganga protection	Members
One Representative of local industry	Member
One Divisional Forest Officer	Member, ex-officio
One district official to be nominated by DC	Member

Source: NMCG Authority order available at nmcg.nic.in

Under the Namami Gange programme, Pollution hotspot mapping, monitoring of pollution sources i.e. GPIs, drains etc. is being conducted through CPCB/SPCBs. Further, water pollution of river Ganga is measured / assessed via manual monitoring of its water quality at 97 locations by 5 State Pollution Control Boards (Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal) in association with Central Pollution Control Board (CPCB). Besides that, 36 Real Time Water Quality Monitoring Stations (RTWQMS) on river Ganga and its tributaries are set up w.e.f. March, 2017 of which 18 Stations are on main stem of River Ganga, 09 on its tributaries and 09 on drains. In addition to these 36 RTWQMS, installation of 40 new RTWQM stations is under progress. Both manual and real-time monitoring of rivers provide river water quality which is compared to outdoor bathing criteria notified by MoEF &CC

Stakeholders in Ramganga basin with Roles and Responsibilities

In a multiple stakeholder scenario, the stakeholders frame and express objectives in different ways as per their stake and interest. Failure to involve them in equitable manner in decision-making processes leads to sub-optimal, and sometimes unethical, outcomes. Thus, recognition and identification of concerns of stakeholders is much required.

Identified Stakeholders

- **National Mission for Clean Ganga (NMCG):**

  Key agency and main implementation partner for Ganga/Ramganga River Basin Management Plan

- **Central Water Commission, New Delhi:**

  To get Hydrological data, HFL, E-Flow monitoring mechanism and information about Online WQM Stations

- **Uttar Pradesh Pollution Control Board (Regional Office, Moradabad, Kashipur):**

  To get information about industrial pollution, existing status of pollution prevention & its control, Industrial Risk mapping. UPPCB will also be the key source of water quality data

- **Central Pollution Control Board, New Delhi:**

  To understand existing and upcoming policies & action plans for control of pollution in Ramganga river basin and to get Water Quality Data & information about Online WQM Stations

- **Hydropower dam management agency**

  Kalagarh, Baur and Baigul dams - (Uttarakhand Jal Vidyut Nigam): To get Hydrological information/E-Flow Release, frequency of sediment flushing etc.

- **Irrigation and water Resource department, Uttar Pradesh & Uttarakhand:**

  To get Hydrological information, High Food Level & E-Flow Release, Sediment Flushing etc.

- **WWF India, New Delhi (Site Office Located at Moradabad):**

  Actively working on integrated management of Ramganga river and biodiversity conservation. A key data source for biodiversity features & hot spots, basin wetlands and water quality data

- **Municipal agencies (Moradabad, Bareilly, Shahjahanpur, Kannauj, Kashipur):**

  To get Information about landfill sites, drains, other operational issues in managing Ramganga river water quality

- **Industrial associations (Sugar, Pulp & Paper, Electroplating, Textile, etc):**

  Need to visit industries and collect data to assess accidental pollution risks, operational issues during management of industrial liquid and Hazardous waste

- **State Forest Department:**

  To understand LULC changes recorded in the past, ongoing CAT Plan to control soil and silt erosion (if any)

- **Central Ground Water Board- Regional Office:**

  To get information and data related to the groundwater abstraction and variation in GW table and any ongoing scheme for GW management.

Uttar Pradesh Jal Nigam (agency responsible for water supply & Sewage Management: To get information about the existing status of water and wastewater treatment system, augmentation plan, key issues and suggestions.

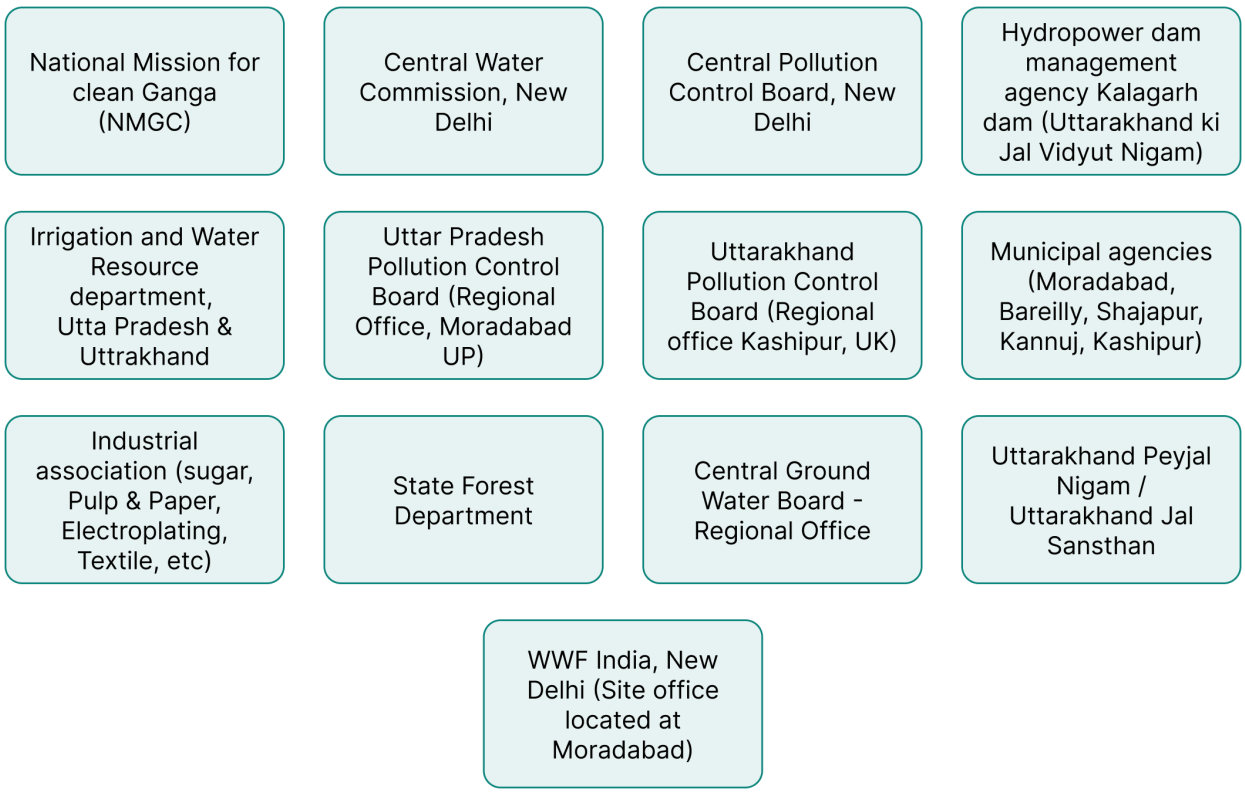

Figure 18: Stakeholder Mapping for Uttar Pradesh and Uttarakhand

Table 19: Ganges basin stakeholders on a macro to micro continuum

Level	Stakeholders	Interest of stakeholders	Influence of stakeholders
National	▪ Central government / agencies ▪ National Ganga River Basin Authority (NGRBA) ▪ National Mission for Clean Ganga (NMCG) ▪ Researchers ▪ Civil society organization (NGOs) ▪ Politicians ▪ Waterways authorities	▪ Tourism ▪ Policy formulation ▪ Ecosystem restoration ▪ Biodiversity ▪ conservation ▪ Advocacy and ▪ awareness ▪ Policy for Water development work ▪ Policy for Waterways development	Policy level
Regional	▪ Government Departments (Water Resources, Fisheries, Mining, Urban Development) ▪ Media ▪ Agribusiness sector ▪ Real estate sector ▪ Protected areas	▪ Water use ▪ Fish resource exploitation ▪ Promotion of intensive farming ▪ Issue identification and highlighting ▪ Construction activities in floodplain	Enforcement through penalty
Local off site	▪ Farmers ▪ Wetland users ▪ Fishermen societies ▪ Religious institutions ▪ Village institutions ▪ Municipal bodies ▪ Industries	▪ Water and land use ▪ Regulating the resource uses ▪ Conflict resolution ▪ Water supply ▪ Waste disposal	Enforcement through penalty
Local on site	▪ Riverine fishing community ▪ Sand miners ▪ Water development sector ▪ Tourism ▪ Riparian farmers	▪ Sand and other physical resources ▪ Fishing and aquaculture ▪ Maintenance of water level ▪ Water diversion and use ▪ Cultural and natural scenic beauty sites	Enforcement through penalty

As per the analysis, sand miners, real estate sector, riparian farmers, water ways authorities, riverine fishing communities, tourists, industries, wetland users, municipal bodies and water development agencies are the primary stakeholders.

After decades of centralized planning in water resources management in India, the long-impending need for devolution of power was fulfilled with the administrative empowerment of the DGCs.

The decision-making has become informed and a sense of ownership has become stronger as evident from the enthusiastic involvement of all local stakeholders in DGC meetings in the key States of Uttarakhand and Uttar Pradesh among others. This structure is futuristic and will be able to lay foundation for further in-depth implementation of rejuvenation activities and also to expand to new integrated activities.

Provisions during emergencies

There are various mechanisms being set up at NMCG at State and district levels, through various executive agencies/stakeholders which are dealing with various unusual accidents /emergencies. NMCG co-ordinates at its various institutional levels such as State level with the State Mission for Clean Ganga (SMCGs) and District Ganga Committees (DGCs) along with the regulatory institutions such as Central Pollution Control Boards and State Pollution Control Board through which the projects related to mon- itoring and regulation of industries, CETPs, STPs and drains and water quality monitoring (manual and real time) are executed.

Further during emergencies, Central Pollution Control Board is in contact and coordinates with State Pollution Control Boards (SPCBs) and its regional offices in case of any emergencies and accidental discharges and also implement certain actions with the help of District Administration whenever required.

Besides, NMCG is also coordinating with Ganga Task Force (GTF) battalion who are also reporting to NMCG about various unusual incidents and appropriate remedial action is taken by the concerned departments of NMCG or various executing agencies. There is system of Real time data transmission from Grossly Polluting Industries (GPIs) through Online Continuous Effluent Monitoring System (OCEMS) which is established for compliance verification. Continuous Real time effluent/ emission data is transmitted to CPCB/SPCBs servers. Online monitoring system alerts are generated through SMS for each exceedance w.r.t. discharge norms. Based on SMS alerts generated for each exceedance w.r.t. discharge norms, CPCB carries out physical inspection of the selected GPIs having high number of alerts and takes necessary action.

Water quality of River Ganga is also carried out through a network of 97 manual and 36 Real Time Water Quality Monitoring Stations (RTWQMS). 40 additional RTWQMS are also being set up. Analysis of manual as well as real time water quality data analysis is being done at regular intervals and data analysis and trends have been generated using last few years data and is also being used in reporting. Instances of trends wherein water quality parameters exceed the standard criteria are examined for reasons of such occurrences and measures are planned accordingly for abatement of pollution from such sources

5. Potential Measures to Address Pollution Accidents In Ramganga River Basin

5.1 Preparedness and preventive actions / Technical, social, and environmental safeguard measures

Preparedness and preventive actions touch on the development of static or temporary measures, re- viewing/creating legal basis, establishing competent bodies, improving procedures, material and equip- ment, capacity building and training and analyses of potential hazards (inventories of hazards, poten- tially affected objects).

A good overview on possible measures and European implementation examples in the area of preven- tive actions and preparedness (crisis management instruments) is given in the following figures and tables (Federal Environment Agency, 2009).

Basic preparations

For the purpose of implementing specific measures in the field of crisis management, it is necessary to identify and assess the possible hazards and to create the legal and organisational requirements for enforcing risk minimisation and crisis management measures at authority and plant operator level (see Figure 19).

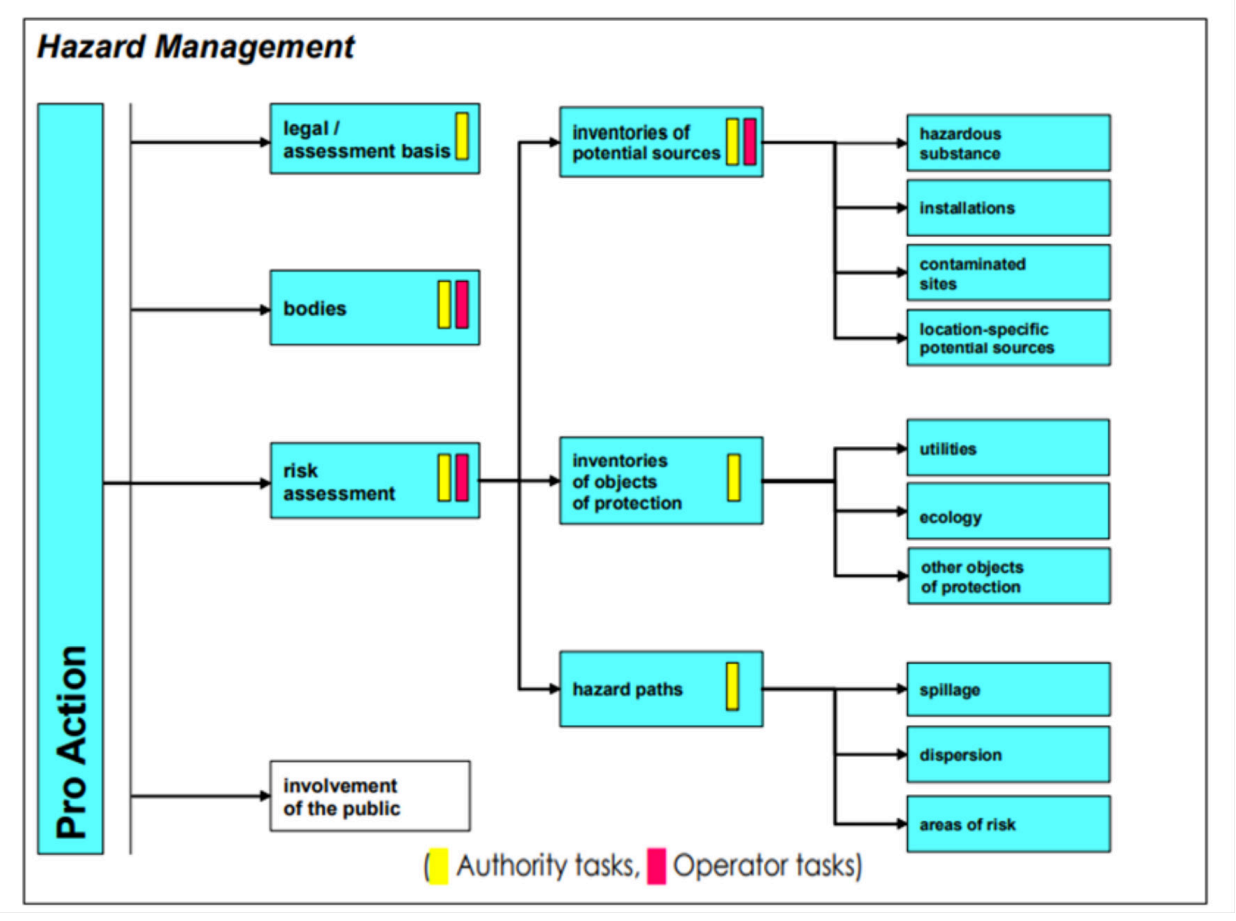

Figure 19: Hazard Precaution Management – Basic Preparations (Federal Environment Agency, 2009)

In Table 20 an overview on possible measures in the area of Basic preparations together with a list of European implementation examples is given.

Table 20: International practices for Hazard Management – Basic Preparations: Measures and European examples (Federal Environment Agency, 2009)

Hazard Precaution Management - Basic Preparations (Pro Action)	
Measures	**Implementation Examples**
Reviewing/creating the necessary legal basis	Seveso Directive, IPPC Directive, Water Hazard Classes, Facilities Ordinance (VAwS)
Creating the necessary assessment criteria	WFD, 2006/11/EG, Seveso Directive, REACH, GHS, Water Hazard Classes, EASE
Reviewing/creating basic technical safety requirements	Recommendations of river basin commissions, BREF, Technical Rules (DVGW, VDI)
Establishing/engaging competent institutions and bodies	Expert groups (river basin commissions, national, international), industry associations, JRC
Analysis of potential hazards ▪ Making an inventory of safety hazards for ▪ Substances ▪ Plant Location ▪ Contaminated site location ▪ Local safety hazards Inventory of potentially affected objects of protection with regard to ▪ Human use ▪ Ecology ▪ Other objects of protection Assessment of risk with regard to hazard paths ▪ Release of Substances ▪ Dispersion ▪ Areas of Risk	ICPER - list of potentially hazardous plants ICPDR - potential accident risk spots ICPDR - old contaminated sites Flood maps / Earthquake maps Land use maps, CORINE Protected area maps (water, nature) Implementation of Art. 6 WFD: List of protected areas GIS- based damage forecasting / modelling

Prevention

Prevention measures should, on the basis of the assessment of "basic preparations", comprise those measures which ensure that crisis management is tailored to the specific conditions of the individual river basin district. In Figure 20 a distinction is made between district-related and plant-related measures. Crisis management must have at its disposal both technical (planning) instruments and precautionary measures of an organisational, constructional or plant-specific nature.

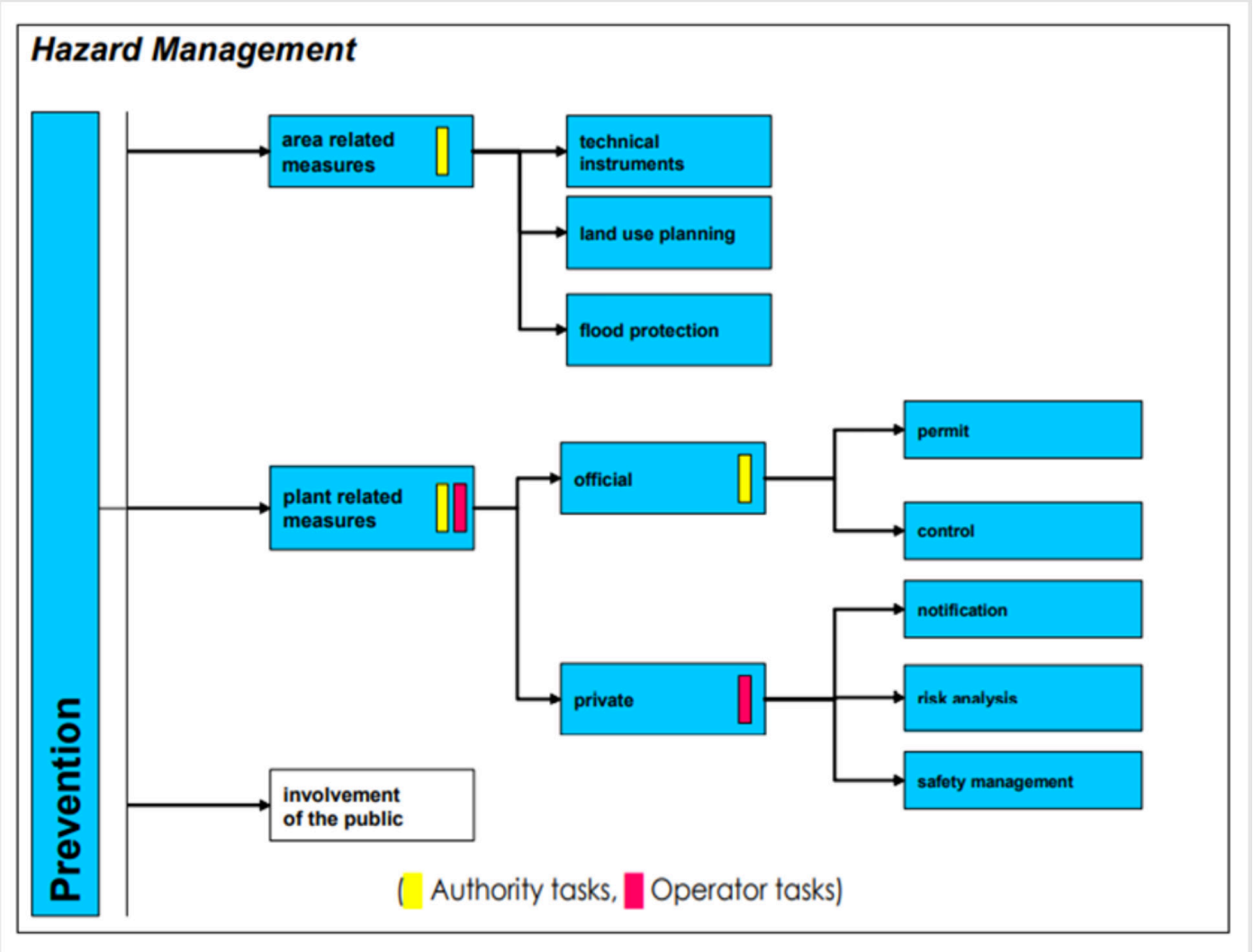

Figure 20: Hazard Precaution Management – Preventive Measures (Federal Environment Agency, 2009)

In Table 21 an overview on possible measures in the area of Prevention together with a list of European implementation examples is given.

Table 21: Overview on Hazard Precaution Management - Preventive Measures and European examples (Federal Environment Agency, 2009)

Hazard Precaution Management - Preventive Measures (Prevention)	
Measures	**Implementation Examples**
Provision of technical (planning instruments	Precautionary planning software (VPS), pollutant spread models (ALAMO, data from UNDINE, for example)
Obligation to include the requirements of Article 11 (3) | WFD in regional-policy and land-use planning District related check for sensitive and deficits, see article 11 (3) | WFD	Land use planning (Seveso Directive) Implementation of Directive 2007/60/EC (EC Flood Directive) Flood action plans, UBA F+E 20348362
Obligation on licensing authorities to include the requirements of Article 11 (3) | WFD in plant approval procedures	Approvals / Conditions / prohibitions
Inspection and monitoring of plants with regards to implementation of and compliance with technical requirements resulting from Art. 11 (3) | WFD (inspection intervals)	Safety requirements of ICPER and ICPR, Checklist method - ▪ Federal Environmental Agency, ▪ Onsite Checks, ▪ Reporting requirements, ▪ Reports by independent experts, ▪ Manual on performing in-plant water conservation inspections (Hesse)
Encouraging / promoting voluntary measures at plant and higher levels ("responsible care")	Transport accident and assistance system (TUIS), VDI cooling water concept

Preparedness

In (Federal Environment Agency, 2009) "crisis management" covers the range of measures from "preparedness" to "immediate response" and is subdivided primarily into the sections on "Instru- ments for preparedness" and the actual "Response to a specific event". In this chapter only measures in the area of preparedness are described. In general, crisis management will only func- tion efficiently if hazard precaution management has created a viable structural foundation. To en- sure "preparedness" it is necessary to create both a technological and an organisational basis. In Error! Reference source not found. relevant instruments for "preparedness" are described.

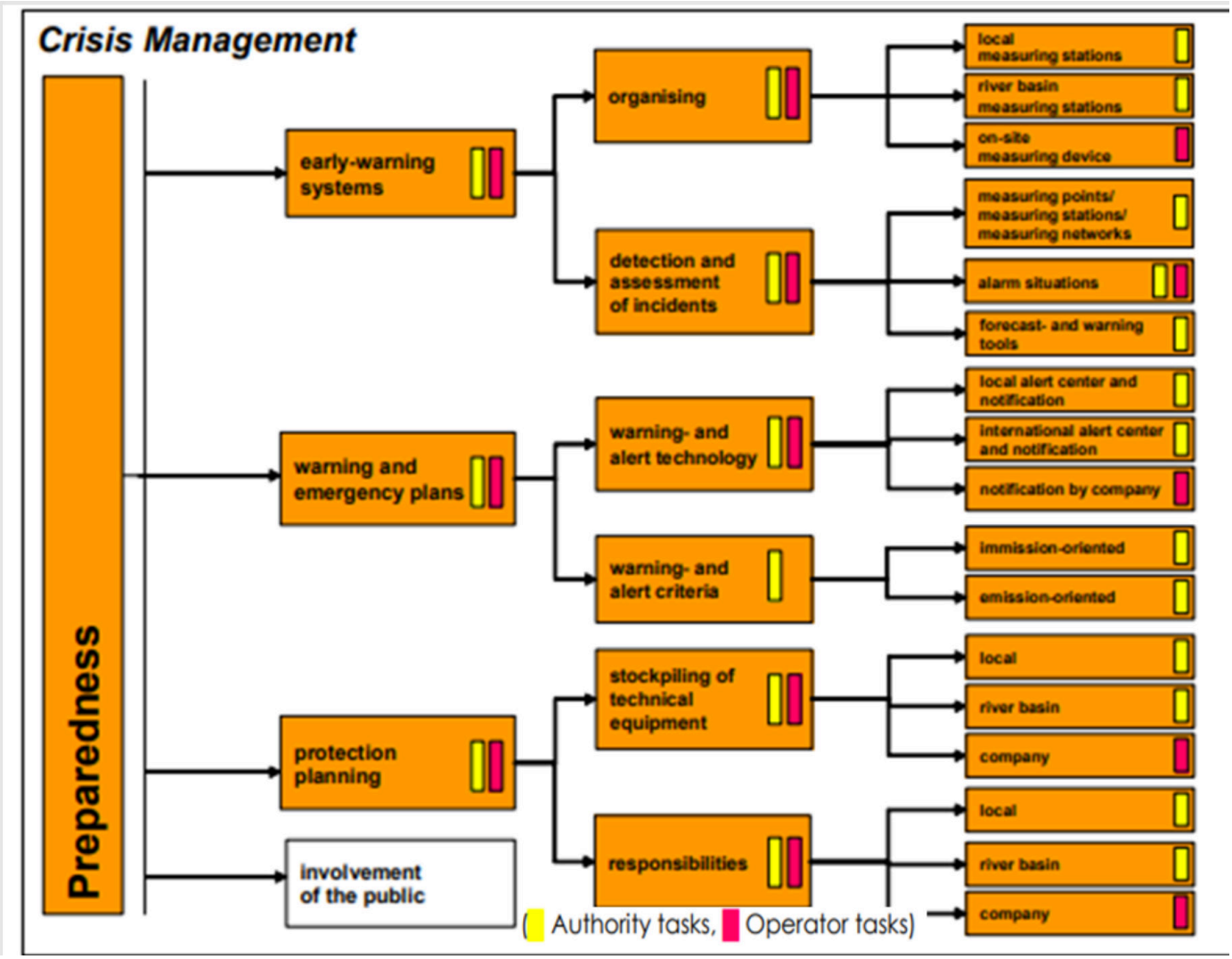

Figure 21: Crisis Management – Instruments - Preparedness (Federal Environment Agency, 2009)

In Table 22 an overview on possible measures in the area of Preparedness together with a list of Euro- pean implementation examples is given.

Table 22: Overview on Crisis management instruments – Preparedness and European examples (Federal Environment Agency, 2009)

Crisis management - Crisis Management Instruments	
Measures	**Implementation Examples**
Design and establishment of immission - related (river-related) early warning system ▪ Establishment of continuously operating monitoring stations ▪ Establishment of monitoring and communication networks for entire river basin district ▪ Development/implementation of event detection technology, evaluation and forecast instruments	EASE water surveillance System Hamburg (WGMN Hamburg) Early warning system Netherlands (Rhine/ Maas), UNDINE, VPS, ALAMO Aqualarm (NL), Guidance for Chemical Monitoring under the WFD (EU Draft)
Design and establishment of emission-related (Plant-specific) early warning facilities linked to the monitoring and communication network for the river basin	Seveso-II plants, eg. Bayer, BASF
Design and Implementation of warning and emergency plans for the entire river basin ▪ Establishment of warning and emergency centers ▪ Definition and technical realization of warning and emergency paths ▪ Definition and emission-related and immision-related warning and emergency thresholds	Infra-web (NL) International warning and emergency plans of the ICPER(Elbe), ICPDR (Danube), ICPR (Rhine) EASE
Establishing/engaging competent institutions and bodies	Regional disaster control plans, Hamburg oil pollution control rules Police, Plant fire brigade, THW(Federal Agency for the Technical Relief), oil barriers, “Central provision, mutual assistance”
Ensuring readiness and functioning of crisis management instruments ▪ at public level ▪ at plant level crisis communication (across all levels)	QM, training, exercises for entire river basin district BMI Guidelines on “Crisis communications”

The following are examples of preventive and preparedness measures required from an operator's point of view (Lohr & Peterson, 2014). This shows the necessary level of detail to be embedded in Emergency and Preparedness Plans.

Standard monitoring procedures:

A description about the monitoring procedures including the parameters and reading intervals should be provided. It should be documented if any post-processing of the data is carried out as well as the organisation in charge.

Surveillance at not continuously attended sites

At unattended or not permanently manned sites, it should be considered to install a remote surveillance system. However, when an emergency situation is developing, it may be necessary to send an observer to the site and not to rely on the instrumentation alone.

Power failure and alternatives

It must be listed which emergency related structures need power supply and what kind of alternatives are available in case of a power failure. This applies to the Emergency Operations Centre, too. If the alternative power supply system requires special instructions and/or specialised operators, the day and night phone numbers should be included as well as instructions about the mode of operation. In case no backup power supply system exists, a course of action for establishing one should be prepared.

Adverse weather

Description of access to the site and to relevant gauging stations must be given. As it is essential for the timing of actions, expected travel time and response time is needed considering adverse weather con- ditions. In case no access to the site or reading procedure is possible, such a statement should prompt a joint initiative by responsible authority and the site operator to plan the implementation of an auto- mated reading system.

Systems of communication

As a precautionary measure, alternative communication systems must be discussed and - if not available - an implementation plan should be scheduled. Technically feasible facilities could be: e-mail, SMS, ra-

dios, social media. However, depending on the location of the site, emergency sirens could be an option, too. As past hazards have shown, regular communications systems like mobile phone networks cannot be taken for granted and failure is more likely during emergencies. This is particularly true for flood events and related pollution accidents.

Material and equipment

A description of material for repair and emergency equipment is required. It should be complemented with location, instructions how to use and personnel who will use it. The instructions may be best doc- umented in a separate file.

Training

Emergency preparedness requires training to gain or to remain familiarity with the procedures. Two types of exercises exist: discussion-based or operations-based.

The discussion-based exercise could be workshops, table-top exercises or even games and role-plays. In opposition to the academically related discussion-based approach stands the operations-based training. It contains tests of single operations or functions such as conducting reading procedures of parameters including its interpretation or operating equipment, boats, oil barriers, hydraulic structures, etc. This is referred to as drill exercise.

The next higher level of operations-based approach, referred to as functional exercise, is reached when the focus is on inter-agency coordination like processing the chain of notification or coordinating the sequence of actions to be taken for a potential failure level, for instance. A full-scale exercise involves all stakeholders and is conducted in near real time with simulated field activities. Regular training is essential to keep the key-stakeholder familiar with the process.

5.1.1 Preventive

Prevention measures should, on the basis of the assessment of "basic preparations", comprise those measures which ensure that crisis management is tailored to the specific conditions of the individual river basin district.

Measures under this topic are:

- Legal Basis, competent institutions and bodies,
- Analyses of potential hazards (Inventories, substances, plant location, potentially affected objects, hazard paths)
- Assessment criteria (e.g. Water Hazard Classes)
- Technical safety requirements, design standards, provision of technical (planning) instruments
- Inspection and monitoring with regard to implementation of and compliance with technical requirements

5.1.1.1 Legal Basis, competent institutions and bodies

Crisis management must have at its disposal both technical (planning) instruments and precautionary measures of an organisational, constructional or plant-specific nature. For the purpose of implementing specific measures in the field of crisis management, it is necessary to identify and assess the possible hazards and to create the legal and organisational requirements for enforcing risk minimisation and crisis management measures at authority and plant operator level.

The basis for creating legal foundations should be existing law, which is already implemented in practice in form of Directives. Indian legal acts and policies, which are relevant to implement water resources and river basin management, are for example

- Water (Prevention and Control of Pollution) Act, 1974
- The Water (Prevention and Control of Pollution) Cess Act of 1977 (amended 2003)
- Environmental (Protection) Act, 1986
- Model Groundwater (Control and Regulation) Bill, 1992 (last revision in 2016)
- National Disaster Management Act, 2005

An example for the organisational structure of cooperation between the responsible water authorities in India is given in Figure 22.

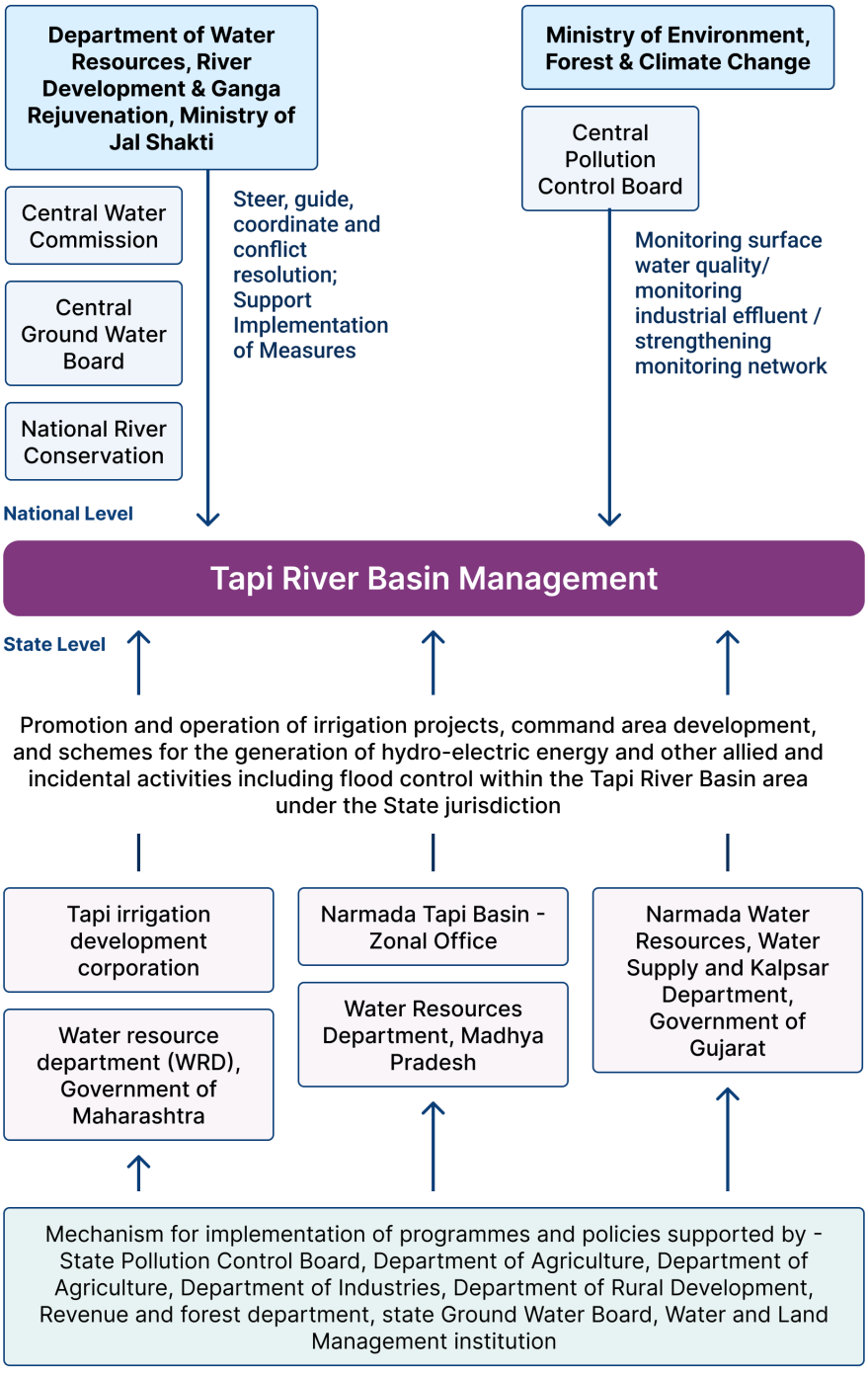

Figure 22: Organisational structure of cooperation between the responsible water authorities in India (Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, 2020)

It is also necessary to set up institutions and bodies which handle preparation and implementation of the proposed action strategies, and which follow up by assessing the results and investigating whether the objecitves set were achieved and wether there is a need for changes. The extent to which the nec- essary technical competence exists depends on the state of implementation of the relevant Directives. It can however be assumed that it is possible to build on existing structures.

The structural requirements will have to be linked with the structures of the public authorities. Bodies need to take action in the field of cooperation between authorities, in order to discuss questions of structural and workflow organisation and to create information sources and evaluation methods. The international river basin commissions show how this requirement is already being implemented in prac- tice today (Federal Environment Agency, 2009).

5.1.1.2 Analyses of potential hazards

In the Ramganga Basin, flood events occur regularly and play a big role. Depending on meteorological and hydrological conditions, flood events have a high variety over the years. However, some flood scenarios are more likely than others. For detailed results, hydrological analyses must be conducted for the basin and coupled with 2D hydrodynamic numeric modelling. As a result, detailed maps of flooded areas, including the probability of the event, can be generated. These maps are available for most European rivers, including Rhine (Figure 23). The main purpose of these maps is civil protection. However, they are also basis for preventive measures within pollution accident prevention. Potential hazardous substances used in agriculture, such as e.g. fertilizers, pesticides or fungicides and their degradation products are remaining, at least partly, in the soil. In case of flood events, these substances will be washed away and are entering the river eco-system.

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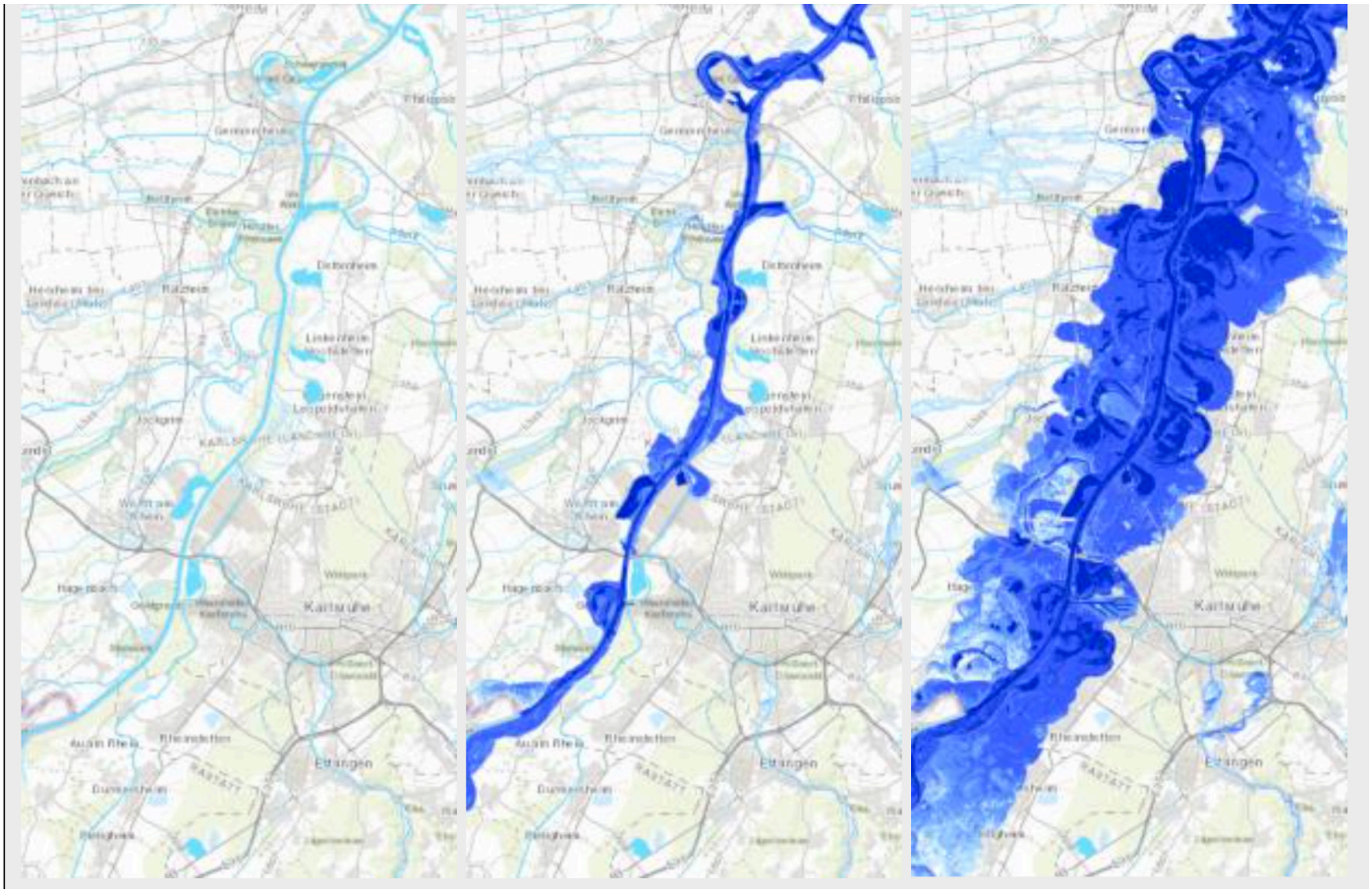


Figure 23: Map of Rhine in area of the city of Karlsruhe, Germany on normal flow (left), with flooded areas (based on numerical hydraulic modelling results) considered to be flooded regularly (middle) and at rare intervals (right). Maps provided by: https://geoportal.bafg.de

Analyses of potential hazards form industry is much more complex. As a basis for analyses, a list of input data needs to be available:

- Detailed list (and map) of all industries, where potential hazardous substances are available.
- Detailed list of potential hazardous substances available. Those covers not only substances used within the industrial process, but also in the overall running of the industrial plant, including such things substances required for cleaning or stored externally
- Concept of securing these substances against leakage, developed, implemented, regularly updated and maintained by industry and checked by authorities.
- Based on the previously mentioned criteria, individual risks could be assess based on substance, location, type of industry or specific industry. The issues can be addressed and specific countermeasures developed.

Based on the previously mentioned criteria, individual risks could be assess based on substance, location, type of industry or specific industry. The issues can be addressed and specific countermeasures developed.

5.1.1.3 Assessment criteria (e.g. Water Hazard Classes)

As a first overall task, objectives of a possible measure should be clearly defined. Following the Rhine Alarm Plan, the first step is the setup of General criteria. As the Ramganga catchment is mostly influenced by agriculture, pollution from these areas is expected to be a major driver for the overall pollution in the catchment. These non-point pollution sources emit hazardous substances regularly (rainfall and surface runoff), which leads to mostly rain event driven level of substances such as e.g. fertilizers, pesticides and more in the Ramganga and its tributaries. Additionally, events such as flood may cause additional pollution, as larger amounts of substances are washed into the river system or storage of these substances might be flooded. The first general criteria to discuss is, at which point, pollution from hazardous substances from agricultural areas, are to be considered as accident. For enabling further assessment of this question, the next step is a detailed inventory, review and assessment of potentially available hazardous substances that could occur in the catchment. This analysis includes inventories of safety hazards of potentially affected objects of protection and hazard paths as well. For assessing possible impacts of pollution, a crucial step is to map potential risks as a first step. Within this first step, the following base information should be mapped using GIS software:

- Type of possible pollutant (e.g. industry, agricultural, re-mobilization, ...)
- Hazardous substances possible emitted during accident
- Map of drainage paths

This information enables a quick base assessment of risks by displaying potential hot spots and expected impacts. This means, for example, in case of flooding of a specific part of the catchment, it can be easily seen if possible hazardous substances are located within this area, which will allow a first impact assessment.

On this basis, maps showing travel time from source of pollution and extent of pollution, distribution of pollutants, affected infrastructure, etc. can be generated. These maps have the same meaning like inundation, travel time and flow velocity maps for flood emergency plans. They inform about a process and enable stakeholders to identify risk zones, tailor preventive actions and take/make better informed policy decisions.

An example of such a potential approach is shown from Figure 24: Map of measured BOD in mayor Drains in Ramganga Basin to Figure 25. As a first step, all industries in the Ramganga Basin where mapped, giving an overview of location and type of industry. This map can be used as indicator of potential pollution accidents, by indicating which hazardous substances could be expected in which region and already indicate potential clusters (e.g. metal surface treatment industry around Moradabad). If the mayor drains are also mapped, this information indicates where to expect emittance of potential hazardous substances in the river system (see Figure 10). From information on concentration of the substances, either by measurement (see Figure 24) or by estimation on best practise, models can be applied for modelling travel time and dissolving within the river, if further information (such as e.g. flow velocity, runoff, water temperature, ...) are available as model input. With these maps as a basis for preventive measures, possible worstcase scenarios could be generated, which help achieve a better identification of hot spots and enhance supervision and enforcement in the most vulnerable spots.

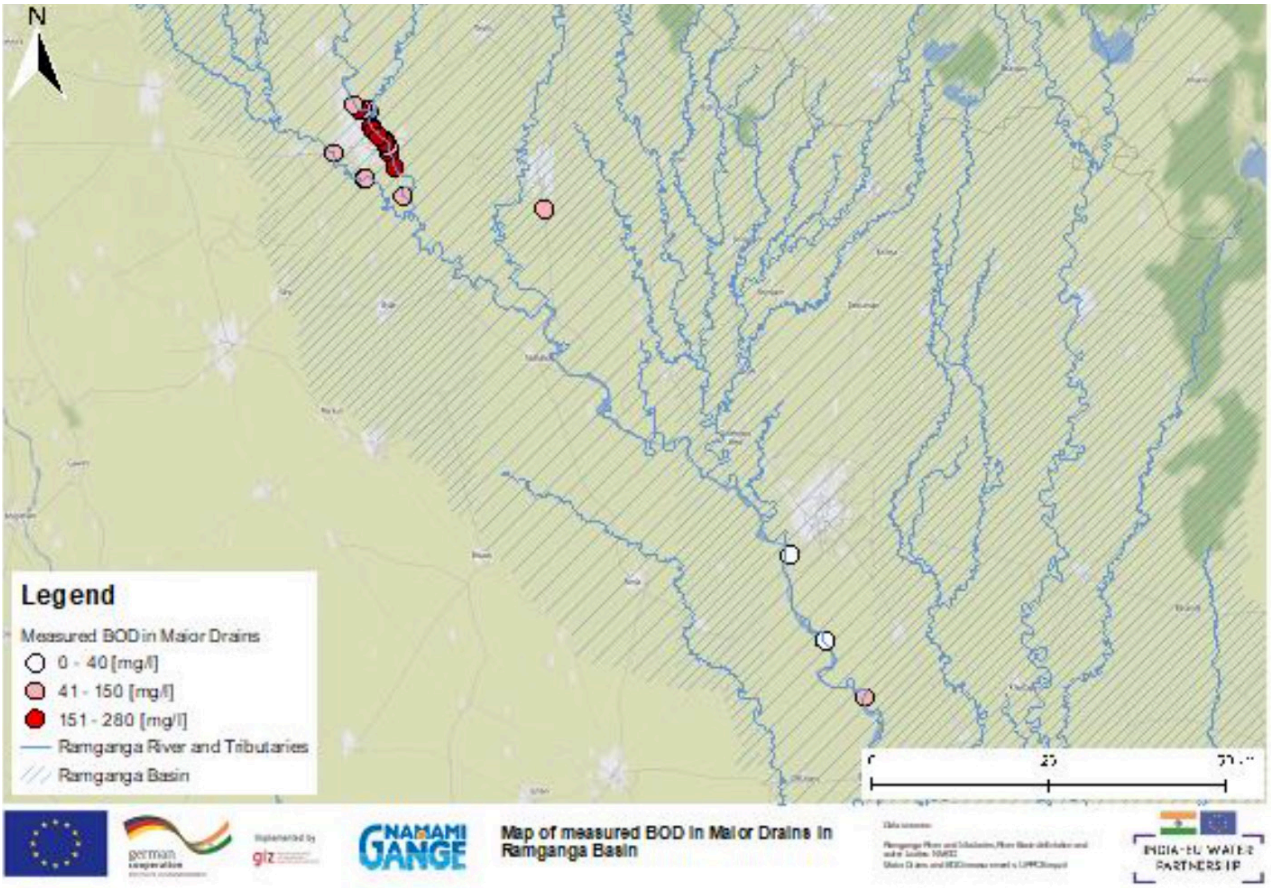


Figure 24: Map of measured BOD in mayor Drains in Ramganga Basin

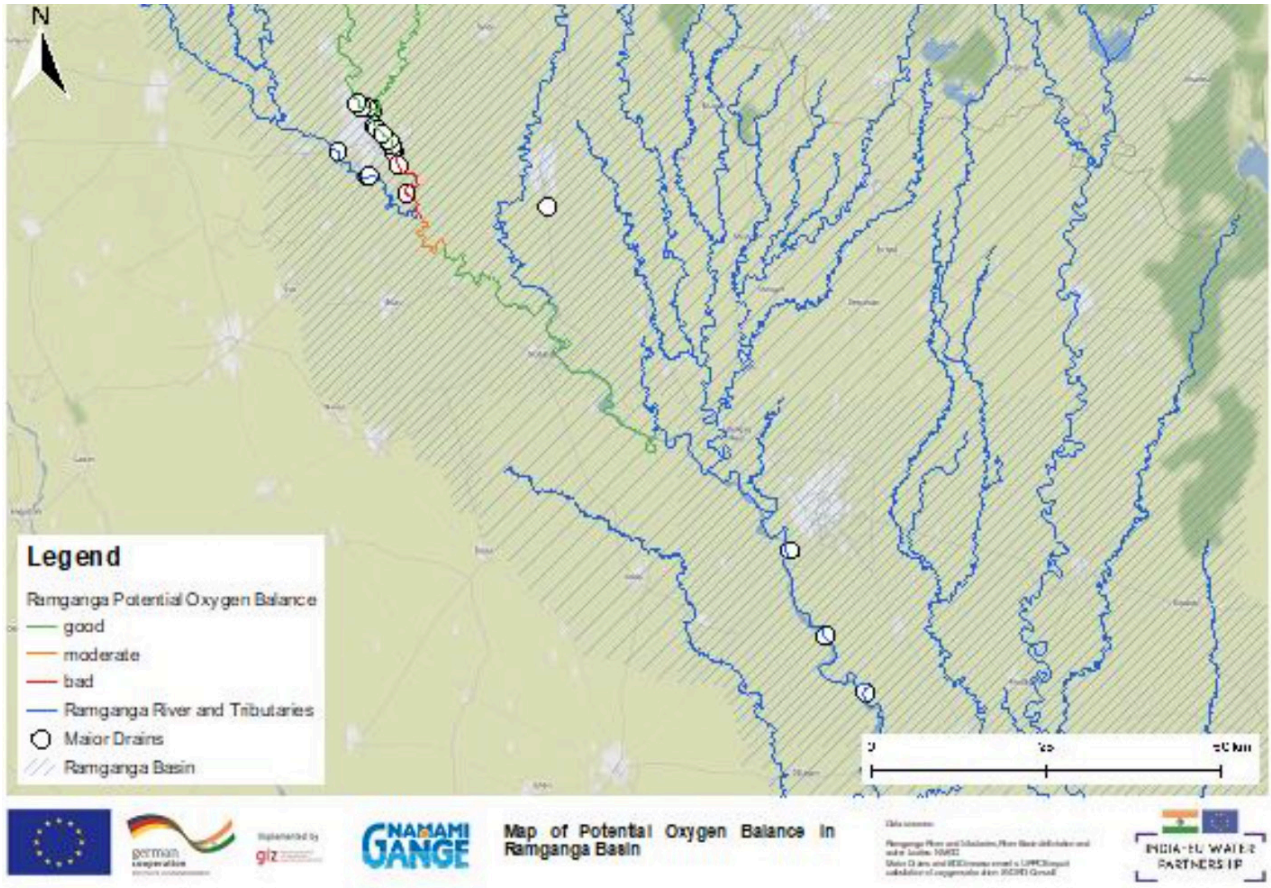


Figure 25: Map of Potential Oxygen Balance in Ramganga Basin

Based on the previous learnings, the next step is setting Guidance values for accidents. Setting these guidance values is based on the following points and individual (political) decisions:

- **Inventory:** At least all hazardous substances that are expected to be available in the catchment should be available in the list and reasonable guidance values should be assigned. Based on the detailed knowledge of these substances (e.g. chemical characteristics), effects such as e.g. dilution or toxicity (human, plant, animal) can be taken into account and maximum values set. Once these values are exceeded, the definition of an accident is fulfilled.
- **General criteria:** Based on the definition of an accident, suitable values should be assigned to each substance. The minimum is hereby defined as the general minimum agreement on which situation is considered to be an accident.

Guidance values should be set both for concentration and discharge load, as the example from Alarm Plan Rhine shows.

Guidance values for concentrations in excess

Parameter	Daily mean concentration value	
	Value	Unity
pH	< 6,5 > 9,5	
Conductivity	1000	µS/cm
Oxygen	< 5	mg/l
Heavy metals		
Arsenic	10	µg/l
Lead	20	µg/l
Cadmium	3	µg/l
Chromium total	50	µg/l
Copper	20	µg/l
Nickel	20	µg/l
Mercury	1	µg/l
Zinc	500	µg/l
Organic Micro-pollutants		
PAH (individual substances)	0,1	µg/l
Sum of PAH	0,5	µg/l
Biocides (individual substances)	0,3	µg/l
PCB (individual substances)	0,1	µg/l
Plant protective agents (individual substances)	0,3	µg/l
Pharmaceutical substances (individual substances)	0,3	µg/l
Other organic micro-pollutants (individual substances)	3	µg/l
Further inorganic parameters		
Cyanide	5	µg/l
Chloride	300	mg/l
Sum parameters		
TOC	**15**	**mg/l**
AOX	**25**	µg/l
Radioactivity		
Parameter	**Activity**	
Total-γ (total-Gamma)	**25**	**Bq/L above ≥ 2 h**
Tritium	**100**	**Bq/L**

Guidance values for discharged loads

Parameter	Daily loads	
	Value[1]	Unity
Heavy metals		
Arsenic	0,5	t
Lead	1	t
Cadmium	0,15	t
Chromium total	2,5	t
Copper	1	t
Nickel	1	t
Mercury	50	kg
Organic micro-pollutants		
PAH (individual substances)	5	kg
Sum of PAH	25	kg
PCB (individual substances)	5	kg
Biocides (individual substances)	15	kg
Plant protective agents (individual substances)	15	kg
Pharmaceuticals (individual substances)	15	kg
Other organic micro-pollutants (individual substances)	150	kg
Further inorganic parameters		
Cyanide	250	kg
Sum parameters		
TOC	**750**	**t**
AOX	**1,25**	**t**
Radioactivity		
Parameter		
Total-γ (total-Gamma)	**1.250**	GBq
Tritium	**5.000**	GBq

5.1.1.4 Technical safety requirements, provision of technical (planning instruments)

Technical safety requirements, provision of technical (planning instruments)

In areas being used as agricultural area most of the year, but flooded frequently, hazardous substances will be frequently washed away into the Ramganga river. This can be easily prevented by zoning these regions to areas where agriculture is still allowed, but only without applying of these substances. A separate layer of preventive measures should be applied on industrial plant level. This level should include the following relevant safety aspects, taken from "Prevention of Industrial Accidents and Safety of Industrial Plants" from Rhine Alarm Plan:

- Definition of substances hazardous to water
- Mapping of installations of industrial accident relevance
- Authorisation procedures for installations of industrial accident relevance
  - → Written application for authorisation
  - → Application documents include the following:
    - a description of the project
    - plans and maps
    - information on the substances handled (quantity, hazardousness, etc.)
    - the technical, organisational and personnel safety measures planned
    - a description and assessment of potential impacts on the public and the environment
  - → Co-ordinating body responsible for the conduct of the authorisation procedure
  - → Disclosure of application documents for inspection by the public
  - → Participation of technical and territorial authorities
  - → Written notice of approval
  - → Right of appeal for public and applicant
- Overfill safety systems
  - → Scope
  - → Exceptions
  - → Technicalrequirements
  - → Inspection
- In-plant pipeline safety
- Aspects of joint storage
- Sealing systems
- Wastewater split flows

This does not only apply for industrial plants as possible pollution point-sources but does also for farmers and other participants of the agricultural sector in a reduced version. The fundamental doctrine behind it is the same as within the design standards for industrial plants: prevent hazardous substances from reaching water bodies. This idea can be obtained by two basic rules in agriculture:

- Ban of hazardous substances generally from use in agricultural sector where possible and reduce amount of these substances to a minimum by allowing maximum amounts (exact definition in kg or g) of these substances over time (mostly on yearly basis) to be used.
- Apply a mass balance accounting system for hazardous substances, including a follow up documentation of substances from producer to end user.

5.1.1.5 Inspection and monitoring of plants with regard to implementation of and compliance with technical requirements

If these rules are followed, danger of pollution accidents from the agricultural sector (which is the main non-point pollution) can be cut down to a minimum. Of course, application and compliance of this rules must be followed up in the same manner as within the industrial sector, which means: The final rules must be handed over to all farmers in the catchment and its compliance for all obligatory, within a reasonable time. After this transition period, compliance must be regularly controlled by authorities and farmers fined by authorities in case on non-compliance.

Standards must be clearly defined and elaborated, with the final goal of a guideline for building and maintaining industrial plants, when hazardous substances are used or stored within the plants. These guidelines should also give information on operation and handling of such substances. The final document must be handed over to all operators in the catchment and its compliance for all obligatory, within a reasonable time. After this transition period, compliance must be regularly controlled by authorities and operators and owners fined by authorities in case on non-compliance.

5.1.1.6 Measures to tackle death of fish from pollution

Fish kills in general are difficult to predict, because of the various toxic substances that could cause them. Fish deaths caused from drop of oxygen level in the river, however, are much more easier to predict, as they are a function of temperature and (if available) amount of substances causing oxygen depletion, such as untreated municipal sewage and industrial wastewater

Learning from the incidents happened in the past, government authorities are putting serious efforts to prevent mass fish killing and heavy metal contamination/bio-accumulation in the Ramganga river and some the important ongoing measures taken by the authorities are summarized below:

- Tapping & diversion of the drains having high sewage load to STPs to be constructed on I&D model
- Untapped drains to be provided with modular treatment facilities/ In-Situ bio-remediation or Phytorid-SWAB (CSIR/NEERI) based treatment
- Monitoring of water polluting industries and ensuring closure of industries which are operating without consent or noncompliance
- Installation of OCEEMS, Flow Meter & Web Cams in large and medium category of GPIs with connectivity to the server of CPCB and UPPCB to monitor industrial discharges
- Closure and legal action against the illegal water polluting industries operating in non-confirming /residential area
- Prohibition on blast fishing (explosives), use of pesticides bleaching powder, lime, and electrocution etc.
- Strict actions and fines imposed on violators as per the prevailing wildlife and environmental laws.
- Adoption of cleaner technology in electroplating industries such as phasing out usage of cyanide and Proper segregation of metal bearing effluent streams
- Using of counter current rinsing systems; recycling rinse waters to the process after treatment in electroplating industries
- To control over heavy metal discharges, ETP must be provided with tertiary treatment units like Reverse Osmosis Plant, Ultra Filtration, Ion Exchange etc, to enable recycling of treated effluent in the process

5.1.2 Preparedness

Measures under this topic:

- Immission/river-related and Emission-related/plant specific Monitoring
- Early Warning Systems including definition of emission-related and immission-related warning and emergency thresholds

5.1.2.1 Monitoring

To ensure "preparedness" it is necessary to create both a technological and an organisational basis. Relevant measures in the area of preparedness are the design of immission-related (river-related) as well as emission-related (plant specific) early warning systems by establishment of monitoring stations and communication networks

To monitor pollution in the Ganga on a real time basis, the Central government has installed 44 Real-Time Water Quality Monitoring Stations in the river to provide data on pollution in Delhi (Water Network, kein Datum). The monitoring stations provide real-time water pollution data for seven to 17 parameters. In the future, water quality will be provided from all centres for all 17 or more parameters.

The stations are installed in in various cities situated on the bank of the river. In case, there is an unusual increase in pollution in any city, action can be taken immediately. In Figure 26 an example for a monitoring station and the parameters observed is given.

Figure 26: Real time water quatliy monitoring system: UP17-Allahganj Bridge, Kannauj-Farrukhabad

No further information is yet available on the following questions, but they have to be adressed to provide a good basis for appropriate management:

- Why was this location chosen? The stations are installed in cities, but would there be more locations where monitoring is necessary – industrial site etc.?
- Why are these parameters specially monitored? The current list of parameters contains mostly organic substances (BOD), but site- and maybe process specific substances should be monitored at well.
- In which time step is the measurement carried out? Is the databasis sufficient to detect an accidental pollution?

Another questions is how reliable monitoring stations in the river are, eg. how is monitoring ensured in dry seasons, is there enough water in the area of the monitoring station to enable measuring of substances?

European example for (river-related) monitoring networks, communication is the Undine information platform (https://undine.bafg.de/index_en.html) which is maintained by the Federal Institute of Hydrology and funded by the Federal Ministry for the Environment. This platform covers recent measurements as well as historical values for comparison. One focal point is the representation of the water quality during extreme events. The website links and presents information from different fields and across regions. In the figure an example for monitoring station Karlsruhe for the river Rhine is given.

As a preventive measure, maps with information on location and type of industry, potential substances, travelling time and dissolving within the river were created from additional hydrological and hydraulic information of the river. These maps can serve as a first estimation and worst-case scenario prediction. Once the models for creating these maps are applied, the models can be run both for forecasting potential threats, as well as for estimating impacts of current, ongoing pollution accidents. By running these models with actual hydrological information and additional information on time, type and location of the pollution accident as well as load (if information is available) precise maps of travelling time can be generated for various time steps. These maps will enable authorities for easy identification of areas for possible counter measures (e.g. evacuation, warning, ...).

5.1.2.2 Early Warning Systems including of warning and emergency thresholds

Objectives of Early Warning Systems in general are to increase public safety and protect the environment in the event of an accidental pollution by providing early information for potentially affected riparian countries. Parts of EWS are establishing of warning and emergency centres, definition and technical realisation of emergency paths and the definition of emission-related and immission-related warning and emergency thresholds. The system of crisis management established by emergency centres is described in Chapter 5.2.

An example for immission-related warning thesholds is given in the Warning and Alarm Plan of the River Rhine.

The following guidance values are recommended for concentrations and pollutant loads leading to an information, warning or search report within the International Warning and Alarm Plan Rhine.

The concentration guidance values concern the following monitoring stations along the Rhine:

- Weil am Rhein (CH,D) - Göppingen (D,F)
- Worms (D)
- Bad Honnef (D)
- Düsseldorf/Flehe (D)
- Bimmen/Lobith (D,NL)

If values are in excess of these guidance values, and depending on the pollutant concentration and present knowledge, an information, a warning or search report is issued within the Warning and Alarm Plan.

Guidance values for concentrations in excess		
Parameter	**Daily mean concentration value**	
	Value	**Unity**
pH	< 6,5 > 9,5	
Conductivity	1000	µS/cm
Oxygen	< 5	mg/l
Heavy metals		
Arsenic	10	µg/l
Lead	20	µg/l
Cadmium	3	µg/l
Chromium total	50	µg/l
Copper	20	µg/l
Nickel	20	µg/l
Mercury	1	µg/l
Zinc	500	µg/l
Organic Micro-pollutants		
PAH (individual substances)	0,1	µg/l
Sum of PAH	0,5	µg/l
Biocides (individual substances)	0,3	µg/l
PCB (individual substances)	0,1	µg/l
Plant protective agents (individual substances)	0,3	µg/l
Pharmaceutical substances (individual substances)	0,3	µg/l
Other organic micro-pollutants (individual substances)	3	µg/l
Further inorganic parameters		
Cyanide	5	µg/l
Chloride	300	mg/l
Sum parameters		
TOC	**15**	**mg/l**
AOX	**25**	µg/l
Radioactivity		
Parameter	**Activity**	
Total-γ (total-Gamma)	**25**	**Bq/L above ≥ 2 h**
Tritium	**100**	**Bq/L**

5.1.3 Response / During an accident

Measures under this topic are:

- Notification chain
- Actions on site
- Alarm coordination
- Rescue

These measures include the process of giving the alert, plus the immediate responses such as damage containment, measures to protect uses and other objects of protection, and also immediate damage remediation. The measures that have to be set in motion for a specific incident may involve the mobilisation of massive human and material resources in the individual case. In the strict sense, they are not management planning measures. Their prospects of success do however depend to a very large extent on the quality of the design and implementation of the preceding packages of "hazard management" and "preparedness" measures. In Figure 27 an overview on response meausures is given.

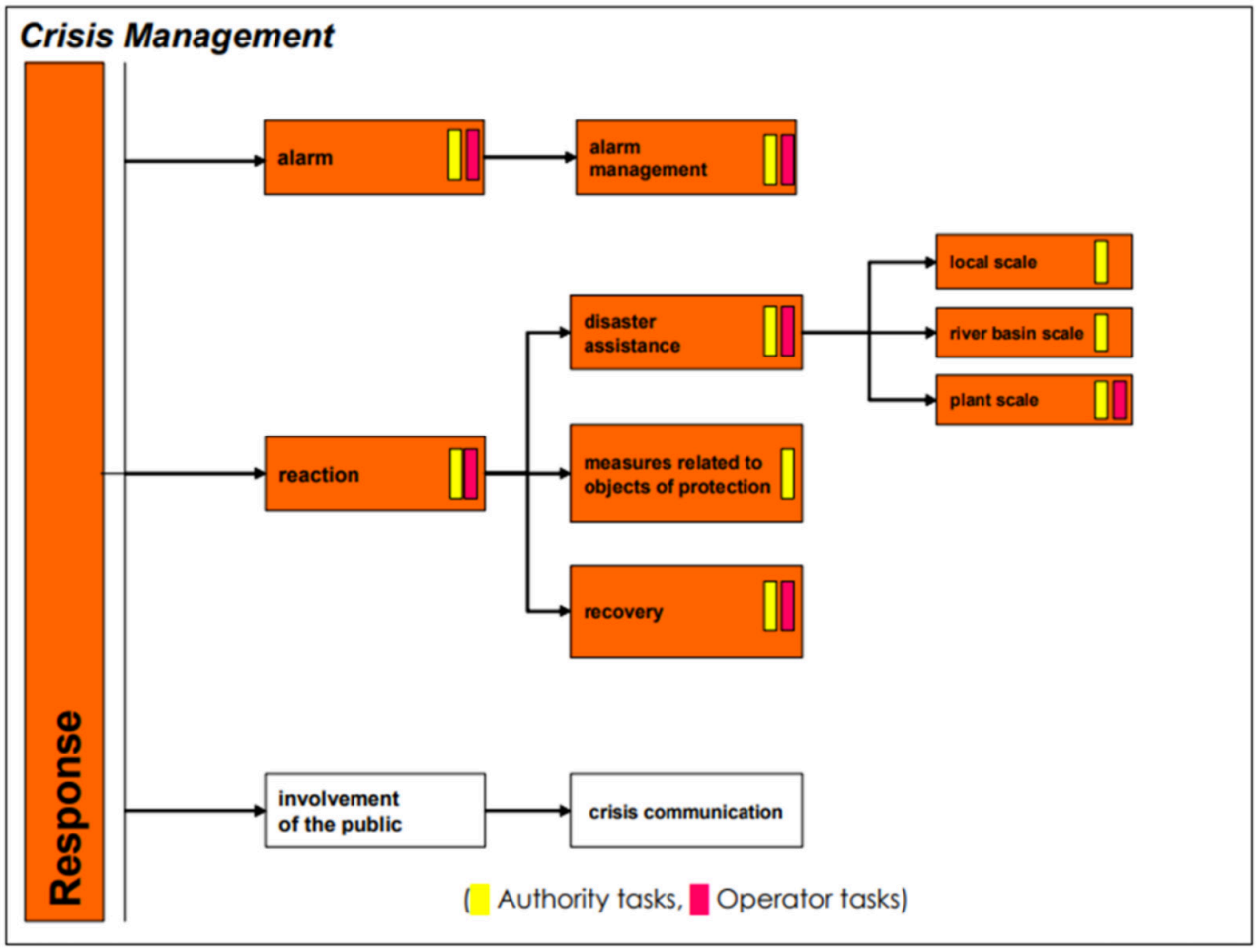


Figure 27: Crisis Management – Response Meausures (Federal Environment Agency, 2009)

5.2 Crisis management system at institutional/organizational level

This structure of warning and emergency plans for entire river basins includes clear instructions for both communication infrastructure (telephone, e-mail, SMS ...) and specific way of communication. An example for such a structure can be found the Warning and Alarm Plan Rhine:

International main warning centres

- Office for Environment and En- ergy Basel-Stadt (R1);
- Préfecture du Bas-Rhin, Stras- bourg (R2);
- Police Headquarters Operations Göppingen (R3);
- Wiesbaden Water Police (R4);
- Ministry of the Interior, Mainz (R5);
- Düsseldorf District Government (R6);
- Watermanagementcentrum Nederland, Lelystad (R7);

plus Secretariat of the International Com- mission for the Protection of the Rhine (S).

- Seven international main warning centers are implied. Each center is labeled with a center specific abbreviation, which can be used for fast communication and easy display on mas.
- The international main warning centre, in the area of competence of which the accident or pollution event occurs, is in charge of the initial report. This competence is only transferred to another international warning centre, when coordination per telephone is not possible or the location of the accident is unknown. If the responsibility is not obvious, the warning centres in charge are obliged to come to a rapid agreement on who will take over the responsibility for following up the case in question.
- A report can be passed on as a “warning“ or as “information”. In case of serious water pollution, a “warning“ will always be issued.
- Reports by fax and by telephone must always follow the exact pattern of reports (annex 3).
- In case of first reports, at least the points A to F of the report pattern must be included. If the pollutants are not known, E of the initial report need not be indicated, so that delayed reporting can be avoided. If required, reports on points G to I must follow as rapidly as possible.
- In case of a warning, the international warning centres must at all times dispose of sufficient qualified personnel familiar with the proceedings. The documents belonging to the Warning and Alarm Plan and a manual or a database on dangerous goods and pollutants accompanied by a list of identifications (CAS) must always be at hand (see annex for manuals on dangerous goods and pollutant databases).

- All international main warning centres keep a chronological reporting book of each warning. This reporting book includes:
  a. Time and content of all incoming and outgoing telephone calls, fax reports and emails,
  b. List of persons reported to
  c. Measures, investigations,
  d. Monitoring results.
- The International 'Warning and Alarm System Rhine does not alter existing regional and national warning services. Reports within the international Warning and Alarm System Rhine are immediately passed on by the international warning centres to the regional and national warning authorities.
- The telephone numbers of the international warning centres and of the secretariat and the international dialling codes are listed in annex. Modifications of fax and telephone numbers must immediately be reported to the international warning centres and to the secretariat.
- When monitoring data are in excess of the guidance values listed in annex, information according to the Warning and Alarm Plan will be released.

The indicated structure is completed by a clear structure of communication templates, both for written and oral communication. This includes standardizes structure (e.g. clear e-mail subjects) and wording. Finally the structure should also include information on a clear signal, such as e.g.

- As soon as the danger is over after a „Warning", it will be cleared per fax for the different sections (reporting scheme, points I to J). The all-clear signal is passed on to all up - and downstream international main warning centres which received the fax report and to the secretariat of the International Commission for the Protection of the Rhine. The addressees should be recognizable.
- For river sections in the area of responsibility of two international main warning centres, the centres concerned will first decide on which centre gives the all-clear signal.
- As soon as the all-clear signal has been given for a river section, the next downstream international main warning centre takes over.

5.3 Emergency Preparedness Plan

The previous chapters listed a wide range of possible accidents or accidents already happened in Ramganga basin. To deal with these accidents, in case they occur, appropriately, fixed and well implemented emergency responses are to be prepared for Ramganga.

In general, emergency response consists of three elements which have a clear order:

In general, emergency response consists of three elements which have a clear order:

This can be manifested in the preparation of an Emergency Preparedness Plan (EPP) or Emergency Action Plans (EAP), which enable the stakeholders to be clear about the following key aspects:

- Threats and risks
- Roles and responsibilities of stakeholders including their organisational structure and qualification
- Definition of objectives in preparing for and dealing with a crisis situation
- Monitoring of the system and triggers activating warning and emergency levels
- Emergency response mechanisms
  - → Emergency identification,evaluation and classification, response actions
  - → Notification trees or call-down trees
  - → Emergency/response actions
- Preparedness and preventive actions Emergency response mechanisms

The indicated structure is completed by a clear structure of communication templates, both for written and oral communication. This includes standardizes structure (e.g. clear e-mail subjects) and wording. Finally the structure should also include information on a clear signal, such as e.g.

- As soon as the danger is over after a „Warning“, it will be cleared per fax for the different sections (reporting scheme, points I to J). The all-clear signal is passed on to all up - and downstream international main warning centres which received the fax report and to the secretariat of the International Commission for the Protection of the Rhine. The addressees should be recognizable.
- For river sections in the area of responsibility of two international main warning centres, the centres concerned will first decide on which centre gives the all-clear signal.
- As soon as the all-clear signal has been given for a river section, the next downstream international main warning centre takes over.

These key terms guide the development of a strategy paper that can finally lead to the development of an EPP or EAP. The terms are also in line with the measures that have been adopted in European rivers to cope with pollution accidents.

The table of contents of an Emergency Preparedness Plan depends on the level at which it is to be prepared, e.g. at the level of a river basin or e.g. a specific facility such as an industrial plant. There are many international examples that can be applied directly to the Ramganga basin or to installations in the river basin. Two examples are shown below.

The following is an example of a possible table of content for EPP from the perspective of a plant operator (from (Lohr & Peterson, 2014)):

1	Document Information
1.1	Purpose of Document
1.2	How to Use This Emergency Preparedness Plan (EPP)
1.3	Notification Flowcharts
2	Facility and Operator
2.1	General Information
2.2	Facility Information
2.3	Access to The Facility
2.4	Downstream Area
3	Emergency Response Process
3.1	Emergency Identification, Evaluation and Classification
3.2	Notification Flowcharts and Communication
3.3	Emergency Actions
4	Preparedness and Preventive Actions
4.1	Standard Monitoring Procedures
4.2	Surveillance at Not Continuously Attended Facilities

4.3	Power Failure and Alternatives
4.4	Adverse Weather
4.5	Alternative System of Communication
4.6	Material and Equipment
4.7	Training
5	Inundation Maps, Pollution Travel Time and Dilution Maps
6	Appendices
6.1	General Responsibilities
6.2	Monitoring Operations
6.3	Information and Data Access

Another example for a table of content of an Accident Emergency Warning System Manual is from the international River Basin Danube (ICPDR, 2018).

1	Introduction
2	Objectives and Set-Up of The Danube AEWS
2.1	Objectives of The Danube AEWS
2.2	International AEWS Structure
2.2.1	ICPDR Secretariat
2.2.2	Principal International Alert Centre (PIAC)
3	International Warning Procedures
3.1	General
3.2	Description of International Warning Procedures
3.2.1	Case A: An Incident is Reported That May Cause a Serious Water Pollution; Source and Incident Location as Well as The Character and Quantity of Polluting Substance are Known.

3.2.2	Case B: A Serious Water Pollution is Reported; Source and Location of The Incident That Has Caused The Pollution as Well as The Character and Quantity of Polluting Substance are Unknown.
3.2.3	Informal Messaging
3.2.4	Testing of The Danube AEWS
3.3	Routing Of AEWS-Messages
ANNEX A:	AEWS Quickstart Reference Sheet
ANNEX B:	Addresses Of PIACS 17
ANNEX C:	Standard AEWS Form
ANNEX D:	Alert Thresholds For Extraordinary Water Pollution in The Framework of The International Danube Accident Emergency Warning System

Pollution in the framework of the international danube accident emergency warning system

6. Conclusions and Recommendations

A set of recommendations was developed to ensure progress in implementation of a strategy to deal with pollution accidents:

1. Data access and dissemination

- Setup an online platform (either open access or only for all involved authorities), where data are implemented and constantly updated
- For awareness raising open access data portals are state of the art tools to ensure data and result dissemination. The open access data portal should be developed including viewer and download functionality as well as potentially scenario analysis options.
- The portals could be dynamically linked to trigger measurements (and/or operational modelling tools) that generate and send warnings according to the notification flowchart.
- Alerts may be sent by email or SMS depending on necessary reaction times.
- Next to the top-level alert group, the portal could provide possibilities for the interested public to sign up for an alert service.
- The platform should include:
  - → Data visualization through GIS implementation
  - → Mapping of location of potential hazardous substances, directly linked with
  - → Data base with detailed information on hazardous substances
  - → Implementation of live and legacy monitoring data
  - → Predictionandhandbookforpotentialpollutionaccidentscenarios
  - → The main aim of this platform is to link all relevant data in a visual and easy to access platform, including preventive, preparedness and action plans.

2. Monitoring and observation system

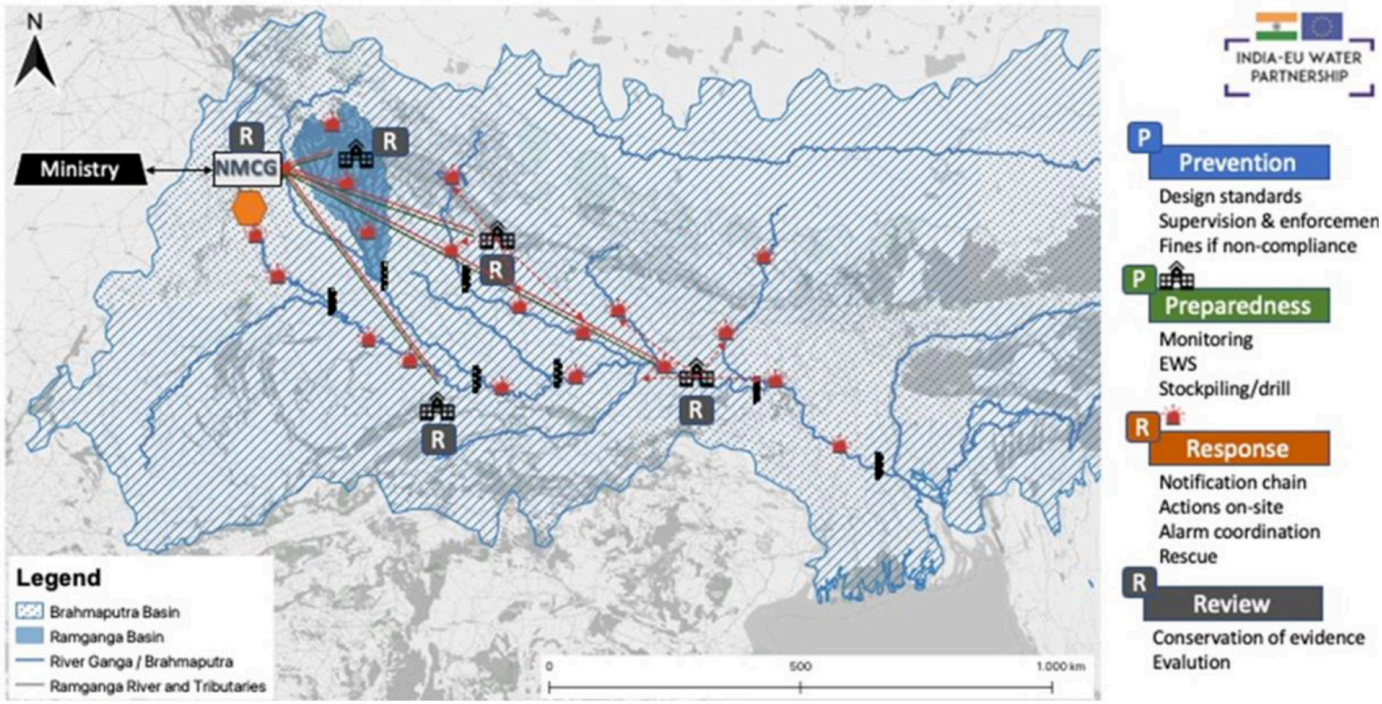
- The monitoring and observation system, in particular the types of parameters, spatial extent and temporal resolution, density and accuracy of logged data is an important aspect as the utilisation of good input and calibration data has a significant effect on the quality of model results.
- Setup and maintain an appropriate monitoring system that can monitor most relevant parameters. That includes selection of suitable sensors, overall design and location, based on hotspot mapping. For emergency warning it is advisable to utilize automated real time monitoring stations that transfer data to the analysis centre at short notice.

- Monitoring systems hereby means not only live data, provided by automated monitoring stations, but also includes setup of a fast response monitoring team (structure). In case of accidents with substances not monitored by the monitoring station or for getting better spatial and temporal resolution of the concentration of an accident, these teams must be sent out for manual sampling.
- This also includes setup of a team infrastructure, most importantly communication strategies, transportation (both on land and water) sampling equipment and laboratory availability. This infrastructure must be setup and evaluated for a certain alarm time.

3. Implementation of a pollution accident management structures

- Design and implementation of emission and immission-oriented early warning systems for the Ramganga River Basin.
- Design and implementation of warning and emergency plans.
- Ensuring river basin emergency plans (provision of technical facilities and equipment and creation of responsibility structures).
- Implementing structures for event accounting and for assessing the scale of Damage.
- Implementing structures for ensuring that assessment findings are incorporated in future hazard and crisis management ("lessons learnt").

Example for location of pollution accident management structures in Ramganga Basin:



4. Legal basis, design standards – improve basis, control of implementation, e.g. fines

- The basis for creating legal foundations should be existing law, which is already implemented in practice in form of Directives.
- Ensuring compliance with the legal and organisational requirements for the implementation of concrete measures in the field of crisis management (legal basis, assessment criteria, safety requirements etc.).
- Ensuring official inspections and monitoring of plants.

5. Improvement of Sewage Treatment Plants (STPs), infrastructure

- STPs must be built, run and maintained according to quantity of expected sewage at the relevant locations.
- Sewer net work must be fully developed and constantly maintained. Correct connections must be checked to avoid losing sewage in dead ends.
- STPs function must be regularly approved and checked if treatment is fitting the specific needs of the sewage.

6. Reducing pollution from agricultural areas

- Enforcement of limit of agrochemical use
- Regulation for dose recommendation, long-term shift for organic farming
- Simple off-farm techniques, such as riparian buffer strips or constructed wetlands, can cost-effectively reduce loads entering surface water bodies
- Add Conservation Buffers to Catch Runoff
- Implement Nutrient Management Techniques
- Have a Manure Management Plan
- Grass planting and laying of straw around construction sites help reduce runoff and associated nonpoint source pollution.
- On-farm responses/ off farm responses

7. Knowledge transfer of best practices

- Interdepartmental and inter-state knowledge exchanges
- Development of e-platform for continues knowledge exchanges from international and national experiences

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Annexure

Table A1 - Inventory of industries

S. No.	District	Name & Address of Industry	Latitude (N)	Longitude (E)		Type	Treatment Mech-anism (ETP/ CETP)	Effluent Dis-charge (KLD)	Effluent Discharge Drain
1	Moradabad	A to Z Exports, Lakrifazalpur, Delhi Road, Moradabad	28.83775	78.745892		Metal Surface Treatment	ETP	5	Delhi rd. Left Side drain-Gagan- Ramganga
2	Moradabad	A.C. Brothers Exports, Delhi Road, Moradabad	28.825081	78.721933		Metal Surface Treatment	ETP	10	Ramganga
3	Moradabad	Laxmi Ji Sugar Mills Co. Ltd. (Old Name:Ajudhya Sugar Mills), Raja Ka Sahaspur, Bilari, Moradabad	28.622	78.774194		Sugar	ETP	300	Ramganga
4	Moradabad	Akansksha International Lakri Fazalpur, Delhi Road , Moradabad	28.824164	78.4436		Metal Surface Treatment	ETP	5	Ramganga
5	Moradabad	Al Haq Foods, Bhojpur, Dharampur, Moradabad	28.954572	78.813419		Slaughter House	ETP	35	Ramganga
6	Moradabad	Al Nasir Agro Foods, Bastaur, Moradabad	28.822444	78.748303		Meat Processing	ETP	20	Ramganga
7	Moradabad	Anand Enterprises, Harthala, Moradabad	28.877781	78.7363		Metal Surface Treatment	ETP	4	Vivekanand hospital drain(R)- Ramganga
8	Moradabad	Art & Craft Valley,Transport Nagar, Moradabad	28.800072	78.722917		Metal Surface Treatment	ETP	5	Ramganga
9	Moradabad	Asian Handicraft, Pandit Nagla, Mini By Pass, Moradabad	28.815858	78.789908		Metal Surface Treatment	ETP	4.5	Prabhat nagar drain-Ramganga
10	Moradabad	Bansal Impex, Rampur Road, Moradabad	28.821044	78.792161		Metal Surface Treatment	ETP	5	Katghar railway station drain-Ramganga
11	Moradabad	Bhatia Silver Wares, Behind Akansha Automo-biles, Delhi Road	28.826853	78.724503		Metal Surface Treatment	ETP	5	Ramganga
12	Moradabad	BKP Enterprises, Harthala, Moradabad	28.876422	78.737058		Metal Surface Treatment	ETP	5	Vivekanand hospital drain(R)- Ramganga
13	Moradabad	Brasage, Minibypass, Lakri Fazalpur, Mo-radabad	28.818314	78.735892		Metal Surface Treatment	ETP	5	Ramganga
14	Moradabad	Brasco International, Katghar, Moradabad	28.822292	78.773233		Metal Surface Treatment	ETP	2	Katghar railway station drain-Ramganga
15	Moradabad	Brassex India, Rampur Road, Moradabad	28.820903	78.790442		Metal Surface Treatment	ETP	5	Katghar railway station drain-Ramganga
16	Moradabad	Commet Handicrafts, Lodhipur Rajput, Delhi Road, Moradabad	28.820867	78.634006		Metal Surface Treatment	ETP	10	Delhi Road (L) Gagan

S. No.	District	Name & Address of Industry	Latitude (N)	Longitude (E)		Type	Treatment Mech-anism (ETP/ CETP)	Effluent Dis-charge (KLD)	Effluent Discharge Drain
17	Moradabad	Dapper Exports, Lakri Fazalpur, Moradabad	28.817786	78.735136		Metal Surface Treatment	ETP	3	Delhi Road (L) Gagan
18	Moradabad	Decorative Crafts, Lakri Fazalpur, Mini By Pass, Moradabad	28.816919	78.731533		Metal Surface Treatment	ETP	5	Delhi Road (L) Gagan
19	Moradabad	Decorative Crafts, Lakri Fazalpur, Mini By Pass, Moradabad	28.82575	78.726631		Metal Surface Treatment	ETP	5	Delhi Road (L) Gagan
20	Moradabad	Deepak Corporation, Delhi Road,, Moradabad	28.82575	78.726631		Metal Surface Treatment	ETP	5	Delhi Road (L) Gagan
21	Moradabad	MH Export, Sambhal Road, Moradabad	28.82575	78.726631		Metal Surface Treatment	ETP	5	Delhi Road (L) Gagan
22	Moradabad	Deewan Sons Exports, Lakrifazalpur, Delhi Road, Moradabad	28.825667	78.720567		Metal Surface Treatment	ETP	20	Delhi Road (L) Gagan
23	Moradabad	Deewan Sugar Ltd., Agwanpur, Kanth Road, Moradabad	88.62195	78.774169		Metal Surface Treatment	ETP	250	Ramganga
24	Moradabad	Designco, Lakrifazalpur, Delhi Road	28.825333	78.774194		Metal Surface Treatment	ETP	15	Delhi Road (L) Gagan
25	Moradabad	Designer Impex, Pandit Nagla, Mini By pass, Moradabad	28.817317	78.4436		Metal Surface Treatment	ETP	5	Prabhat nagar drain Ramganga
26	Moradabad	Moradabad Dugdh Utpadak Sahkari Sangh Ltd., Dalpatpur, Rampur Road, Moradabad	28.823986	78.813419		Milk Processing	ETP	10	Ramganga
27	Moradabad	Dynamic Exports, Lakrifazalpur, Delhi Road, Moradabad	28.819536	78.748303		Metal Surface Treatment	ETP	15	Ramganga
28	Moradabad	Dynatech Exports, Prem Nagar, Kanth Road, Moradabad	28.889278	78.7363		Metal Surface Treatment	ETP	2	Vivekanand hospital drain(L)-Ramganga
29	Moradabad	East Coast Industries, Pandit Nagla, Moradabad	28.804858	78.722917		Metal Surface Treatment	ETP	5	Karula drain Ramganga
30	Moradabad	Ellen Export, Lakrifazalpur, Delhi Road, Mo-radabad	28.821181	78.789908		Metal Surface Treatment	ETP	5	Delhi Road (L) Gagan
31	Moradabad	Exotic India, Delhi Road , Moradabad	28.828433	78.734233		Milk Processing	ETP	5	Delhi Road (L) Gagan
32	Moradabad	Fantasy Export, Delhi Road, Moradabad	28.828522	78.734069		Metal Surface Treatment	ETP	5	Delhi Road (L) Gagan
33	Moradabad	Ganga Handicraft, Delhi Road, Moradabad	28.804886	78.694025		Metal Surface Treatment	ETP	5	Delhi Road (L) Gagan
34	Moradabad	Garg Sons Exports, Delhi Road, Moradabad	28.821256	78.784617		Metal Surface Treatment	ETP	5	Prabhat nagar drain Ramganga
35	Moradabad	Genus Paper & Boards Ltd., Agwanpur, Mo-radabad	28.918028	78.7139		Paper	ETP	ZLD	Ramganga

S. No.	District	Name & Address of Industry	Latitude (N)	Longitude (E)		Type	Treatment Mechanism (ETP/ CETP)	Effluent Discharge (KLD)	Effluent Discharge Drain
36	Moradabad	Globe Artware Impex Pvt. Ltd., Niryat Nagar, Delhi Road , Moradabad	28.827017	78.731939		Metal Surface Treatment	ETP	5	Delhi Road (L) Gagan
37	Moradabad	Goel India, Delhi Road, Moradabad	28.827919	78.728325		Metal Surface Treatment	ETP	12	Delhi Road (L) Gagan
38	Moradabad	Great City & Manufacturing Co., Pan- dit Nagla, Mini By Pass, Moradabad	28.813175	78.787303		Metal Surface Treatment	ETP	5	Prabhat nagar drain-Ramganga
39	Moradabad	Gyaneshwar Saran & Sons, Delhi Road, Moradabad	28.827825	78.727139		Metal Surface Treatment	ETP	10	Delhi Road (L) Gagan
40	Moradabad	Hansa Handicraft, Lakrifazalpur, Delhi Road, Moradabad	28.822753	78.723864		Metal Surface Treatment	ETP	20	Delhi Road (L) Gagan
41	Moradabad	Hemkund Exports, Lakri Fazalpur, Moradabad	28.819675	78.732783		Metal Surface Treatment	ETP	5	Delhi Road (L) Gagan
42	Moradabad	Horizon Impex, Lakrifazalpur, Delhi Road, Moradabad	28.8227	78.703928		Metal Surface Treatment	ETP	5	Delhi Road (L) Gagan
43	Moradabad	Hyland Export, Delhi Road, Moradabad	28.825158	78.703928		Metal Surface Treatment	ETP	10	Delhi Road (L) Gagan
44	Moradabad	Impression India Export,Lakri Fazalpur mini by pass, Moradabad	28.829186	78.730789		Metal Surface Treatment	ETP	2	Delhi Road (L) Gagan
45	Moradabad	India International Exports, Delhi Road, Moradabad	28.829186	78.733011		Metal Surface Treatment	ETP	5	Delhi Road (L) Gagan
46	Moradabad	International Link, Harthala, Moradabad	28.876422	78.737339		Metal Surface Treatment	ETP	5	Vivekanad hospital drain(R) Ramganga
47	Moradabad	Interseas Traders, Delhi Road, Moradabad	28.829969	78.739106		Metal Surface Treatment	ETP	3	Delhi Road (L) Gagan
48	Moradabad	J.O. Exports, Pandit Nagla, Mini By Pass, Moradabad	28.812472	78.788014		Metal Surface Treatment	ETP	5	Prabhat nagar drain Ramganga
49	Moradabad	Jade Export, Lakri Fazalpur, Moradabad	28.825747	78.726628		Metal Surface Treatment	ETP	5	Delhi Road (L) Gagan
50	Moradabad	Kapani Deco, Delhi Road, Moradabad	28.48578	78.628483		Metal Surface Treatment	ETP	5	Ramganga
51	Moradabad	Kishori Ji Exports, Delhi Road, Moradabad	28.832561	78.744375		Metal Surface Treatment	ETP	7.5	Delhi Road (L) Gagan
52	Moradabad	Koohinoor Craft, Sambhal Road, Moradabad	28.836814	78.779369		Metal Surface Treatment	ETP	5	Chandaushi Road (L) Gagan
53	Moradabad	Kumar International, Lakrifazalpur, Delhi Road, Moradabad	28.822144	78.724675		Metal Surface Treatment	ETP	5	Delhi Road (L) Gagan
54	Moradabad	Leeza International, Manoharpur, Delhi Road, Moradabad	28.826056	78.709236		Metal Surface Treatment	ETP	5	Ramganga

S. No.	District	Name & Address of Industry	Latitude (N)	Longitude (E)		Type	Treatment Mech-anism (ETP/ CETP)	Effluent Dis-charge (KLD)	Effluent Discharge Drain
55	Moradabad	Lohia Brass Pvt. Ltd.,(Unit-3), Lakri Fazalpur, Mini By Pass	28.8258	78.720725		Metal Surface Treatment	ETP	10	Delhi Road (L) Gagan
56	Moradabad	Mahesh Chandra & Brothers, Delhi Road , Moradabad	28.832167	78.743833		Metal Surface Treatment	ETP	2	Ramganga
57	Moradabad	Manju Shree Export, Prem Nagar, Kanth Road, Moradabad	28.888969	78.728822		Metal Surface Treatment	ETP	5	Vivekanad hospital drain(L)-Ramganga
58	Moradabad	Marque Impex, Sambhal Road, Mora- dabad	28.833244	78.767278		Metal Surface Treatment	ETP	5	Chandaushi Road (L) Gagan
59	Moradabad	Meba Brass, Pandit Nagla, Mini By Pass, Mo-radabad	28.805324	78.769219		Metal Surface Treatment	ETP	3	Chandaushi Road (L) Gagan
60	Moradabad	Mehrotra Impex , Niryat Nagar, Mora- dabad	28.826342	78.730944		Metal Surface Treatment	ETP	5	Delhi Road (L) Gagan
61	Moradabad	Meraj Exports, Lodhipur Rajput, Delhi Road	28.822111	78.6726		Metal Surface Treatment	ETP	5	Chandaushi Road (L) Gagan
62	Moradabad	MHSC, Peetal Basti, Moradabad	28.820242	78.794958		Metal Surface Treatment	ETP	5	Prabhat nagar drain-Ramganga
63	Moradabad	Milk Food Ltd., Agwanpur, Moradabad	28.914194	78.723167		Dairy	ETP	375	Ramganga
71	Moradabad	Pashupati Acrylon Ltd., Kashipur Road, Thakurdwara, Moradabad	29.197242	78.877939		Dyeing and Textile Syn-thetic Fiber	ETP	1500	Ramganga
72	Moradabad	Quality Products of India, Delhi Road, Mo-radabad	28.828253	78.274		Metal Surface Treatment	ETP	7.5	Delhi Road (L) Gagan
73	Moradabad	R.H. International, Zero Point, Rampur Road , Moradabad	28.832494	78.844736		Metal Surface Treatment	ETP	5	Ramganga
74	Moradabad	R.S. Exports, Rampur Road, Morada- bad	28.820664	78.784453		Metal Surface Treatment	ETP	5	Prabhat nagar market-Ramganga
75	Moradabad	Rajan Oversease, Lakri Fazalpur, Mini By Pass, Moradabad	28.817439	78.836281		Metal Surface Treatment	ETP	10	Delhi Road (L) Gagan
76	Moradabad	Rajkamal Overseas, Prabhat Market, Rampur Road	28.022097	78.785297		Metal Surface Treatment	ETP	5	Katghar railway station drain-Ramganga
77	Moradabad	Rana Sugar Ltd. (Unit 3), Belwara, Manpur, Moradabad	28.926742	78.872808		Sugar	ETP	650	Ramganga
78	Moradabad	Rashid Exports, Pandit Nagla By Pass,, Mo-radabad	28.805756	78.770025		Metal Surface Treatment	ETP	5	Karula drain- Ramganga
79	Moradabad	Rozi International, Peetal Nagri, Ram- pur Road, Moradabad	28.808967	78.795325		Metal Surface Treatment	ETP	5	Prabhat nagar drain-Ramganga

S. No.	District	Name & Address of Industry	Latitude (N)	Longitude (E)		Type	Treatment Mech-anism (ETP/ CETP)	Effluent Dis-charge (KLD)	Effluent Discharge Drain
80	Moradabad	Sainik Enterprises, Khushalpur Road, Mo-radabad	28.834486	78.834486		Metal Surface Treatment	ETP	5	Ramganga
81	Moradabad	Saurabh Sagar Builder & Developers Pvt. Ltd., Moradabad	28.819175	78.637714		Metal Surface Treatment	ETP	5	Ramganga
82	Moradabad	Shri Krishna Impex, Lakri Fazalpur, Mo-radabad	28.822	78.724967		Metal Surface Treatment	ETP	5	Delhi Road (L) Gagan
83	Moradabad	Shri Nathji Export, Opposite Hotel Park Square, Delhi Road	28.8333	78.746483		Metal Surface Treatment	ETP	5	Delhi Road (L) Gagan
84	Moradabad	Kishoriji Exim Pvt. Ltd., Niryat Nagar, Delhi Road, Moradabad	28.8273	78.732194		Metal Surface Treatment	ETP	5	Delhi Road (L) Gagan
85	Moradabad	Stallwart Trendz, Delhi Road, Morada- bad	28.8292	78.733383		Metal Surface Treatment	ETP	5	Delhi Road (R) Gagan
86	Moradabad	Sunbeam Art Metal Export, Majholi, Mo-radabad	28.837247	78.743925		Metal Surface Treatment	ETP	3	Ramganga
87	Moradabad	Tanishka International (Formerly- Shaurya International), Kanth Road, Moradabad	28.937542	78.689483		Metal Surface Treatment	ETP	5	Ramganga
88	Moradabad	Trade Link, Peetal Basti Rampur Road, Mo-radabad	28.820747	78.795028		Metal Surface Treatment	ETP	5	Prabhat nagar drain - Ramganga
89	Moradabad	Triveni Engineering & Ind. Ltd.(Sugar Unit), Rani Nagal, Tehsil Thakurdwara, Moradabad	29.132172	78.761972			ETP	500	Ramganga
90	Moradabad	Universal Arc Enterprises, Rampur Road, Moradabad	28.833831	78.83235			ETP	3	Chandaushi Road (L) Gagan
91	Moradabad	Usha Exports, Lakri Fazalpur Mini By Pass, Moradabad	28.824333	78721419			ETP	10	Delhi Road (L) Gagan
92	Moradabad	Vallabh Metal Ink, Delhi Road, Moradabad	28.820958	78.725214			ETP	15	Delhi Road (L) Gagan
93	Moradabad	Venus India, Lakrifazalpur, Delhi Road, Mo-radabad	28.828244	78.728825			ETP	3	Chandaushi Road (R) Gagan
94	Moradabad	Xebac India, C-18, Harthala, Moradabad	28.876956	78.739008			ETP	10	Vivekanand hospital (R) drain Ramganga
95	Moradabad	Zakaria Shahid & Sons, Sambhal Road, Mo-radabad	28.797631	78.763303			ETP	13	Chandaushi Road(L)
96	Moradabad	Zed Impex, Ekta Vihar, Rampur Road, Mo-radabad	28.836756	78.836347			ETP	5	Ramganga

S. No.	District	Name & Address of Industry	Latitude (N)	Longitude (E)		Type	Treatment Mech-anism (ETP/ CETP)	Effluent Dis-charge (KLD)	Effluent Discharge Drain
97	Rampur	Chaddha papers Ltd., Bilaspur Rampur	28.912639	79.314417			ETP	2228	Ramganga
98	Rampur	Fair Exports (India) Pvt. Ltd., Vill Ahmad Nagar, Pahari, Rampur	28.794583	79.055472			ETP	980	Rampur drain Ramganga
99	Rampur	Khaitan Fertiliser's (A Unit of Rampur Fertil-iser's Ltd.), Judgeg Road, Rampur	28.779194	79.038639		Sulphuric Acid	ETP	ZLD	Ramganga
100	Rampur	Radico Khaitan Ltd., Rampur	28.774167	79.035778		Distillery	ETP	ZLD	"Rampur drain Ramganga"
101	Rampur	Rana Sugar Ltd. (Unit 4), Karimganj, Sha-habad, Rampur	28.583722	78.971556		Sugar	ETP	500	Ramganga
102	Rampur	Rudra Bilas Kisan Sahkari Chini Mill, Bilaspur, Rampur	28.928139	79.34125		Sugar	ETP	200	Ramganga
103	Rampur	Triveni Engineering & Ind. Ltd.(Sugar Unit), Milak Narayanpur, Tanda, Ram- pur	29.031561	78.490328		Sugar	ETP	500	Ramganga
104	Rampur	Varun Steel Processors, Ajitpur Industrial Area, Ajitpur, Rampur	28.762931	78.01855		Metal Surface Treatment	ETP	2	Rampur drain Ramganga
105	Rampur	Zam Zam Frozen Foods, Kemri Road, Vill Pahadi, Rampur	28.795814	79.052011		Meat Processing	ETP	30	Rampur drain Ramganga
106	Bareilly	Brindavan Beverages Pvt. Ltd., Parsakhera, Bareilly	28.425833	79.358333		Beverages	ETP	1200	Industrial
107	Bareilly	D.S.M. Sugar , Meerganj, Bareilly	28.549722	79.213889		Sugar	ETP	1000	Drain→West
108	Bareilly	Dwarikesh Sugar Industries Ltd. Faridpur, Ba-reilly	28.525	79.385		Sugar	ETP	1500	Drain →East
109	Bareilly	IFFCO Ltd., Aonla, Bareilly	28.223333	79.249444		Fertilzer	ETP	5712	Aril River → Ramganga
110	Bareilly	M/S B.L Agro Oiles Ltd.(Vgitable Oil), B-4, In-dustrial Area Prasakhera, Bareilly.	28.427222	79.356333		Other	ETP	200	Industrial drain → Shankha Rive
111	Bareilly	Kesar Enterprises Ltd. (Distillery Unit), Baheri, Bareilly	28.780833	79.506111		Distillery	ETP	ZLD	Ramganga
112	Bareilly	Kesar Enterprises Ltd. (Sugar Unit), Baheri, Bareilly	28.780833	79.506111		Sugar	ETP	1250	Drain →
113	Bareilly	Kisan Sahkari Chini Mills Ltd. Semi- khera, Bareilly	28.615278	79.47		Sugar	ETP	1000	Drain→
114	Bareilly	Rehber Food Industries pvt. Ltd., Mohanpur, Shahjahanpur Road, Bareilly	28.322083	79.464611		Slaughter House	ETP	1000	Nakatiya Drain

S. No.	District	Name & Address of Industry	Latitude (N)	Longitude (E)		Type	Treatment Mechanism (ETP/ CETP)	Effluent Discharge (KLD)	Effluent Discharge Drain
115	Bareilly	Nagar Nigam Slaughter Houe, (Oprator Marya Frozen Agro foods Pvt. Ltd) Mohanpur Thiriya, Bareilly	28.321306	79.463833		Slaughter House and Meat processing	ETP	303	Nakatiya Drain
116	Bareilly	Oswal Overseas Ltd. (Sugar Unit) Nawabganj, Bareilly	28.506111	79.615833		Sugar	ETP	590	Drain → East
117	Bareilly	Premier Agri Foods Pvt.Ltd. Vill. Andharpura, Faridpur, Bareilly	28.339722	79.413611		Milk Processing	ETP	500	Nakatiya Drain
118	Bareilly	Rama Shyama Paper Ltd., Faridpur, Bareilly	28.289167	79.503333		Paper	ETP	280	Nakatiya Drain
119	Bareilly	Superior Industries Ltd. (Distillery) C.B. Gang, Bareilly.	28.393611	79.376667		Distillery	ETP	ZLD	Deveraniya Drain
120	Bareilly	M/S Oriental Aromaties (Formerly Campher & Allied products Ltd) C.B. Ganj Bareilly	28.396111	79.3825		Other	ETP	600	Deveraniya Drain
121	Bareilly	Vardilal Industries	28.429861	79.35825		"Ice Cream Manufacturing	ETP	600	"Industrial drain→Shankha

Source: Action Plan for Restoration of Polluted Stretch Of River Ramganga From Moradabad To Kannauj, UPPCB, Year 2019-20

Table A2-List of other water pollution industries located in catchment of river Bhela, Kashipur

S.No.	Industry Name	Address		Water Consumption (KLD)	Wastewater Generation (KLD)	Wastewater Treatment System
1	Bharat Metal Enterprises	Khasra No-1203- Nanad Nagar Industrial Estate, Phase-Ii, Kashipur		6.2	3	ETP
2	F & S Enterprises	Ideb Industrial Estate, Mahukheraganj		6.2	3	ETP
3	Gama Infraprop Private Limited	Mahuakhera Ganj-Kashipur		600	100	ETP
4	Himalayan Food Park Pvt Ltd	Kh No-282 To 319- Mahuakheraganj, Kashipur,		125	100	ETP-CUM-STP
5	India Glycol Ltd, (Lignocellulosic Biomass Pilot Project)	A-1 Industrial Area, Bajpur Road, Kashipur		31	19	ETP
6	Lohia Auto Industries	N.N.I.E. Mahuakhera Ganj Kashipur.		49	28	ETP
7	Mentha & Allied Product Ltd	Plot No.- 1 To 6- Shree Balajee Industrial Area, Mahuakheragunj		7	3	ETP
8	Sravanthi Energy Pvt. Ltd.	Khaikhera, Kshipur		1500	462	ETP & STP
9	Aarna Healthcare	Nand Nagri, Industrial Estate Mahuajhera Ganj Kashipur.		95	35	ETP
10	Agrich Foods	Nand Nagar Industrial Estate,Mahuakhera Gunj, Kashipur.		53	27	ETP
11	Apex International	Nand Nagar Industrial Estate Mahuwakheraganj		29	23.5	ETP
12	Ashish Agri Food Pvt Ltd	Plot No 11-Ideb, Industrial Estate, Kashipur		113	55	ETP
13	B.P Frozen Foods	Dhabora Mustkham, Dhabora Mustkham, Kashipur		75	43	ETP
14	Bajpai Refrigeration & Bakers Co	Ideb Industrial Estate Phase-I, -Kashipur		77	31.5	ETP
15	Bakers Circle (India) Pvt. Ltd.	Nand Nagar Industrial Estate,Mahuwakhera Ganj, Kashipur		46	16	ETP
16	Canadian Speciality Vinyls	Plot No.- 437-Shree Developers, Industrial Estate, Mahukheraganj		19	10	ETP
17	Cheema Frozen Foods	Jaitpur, Kundes Hwari Road, Shivlalpurdallu, Kashipur		60	39	ETP

S.No.	Industry Name	Address		Water Consumption (KLD)	Wastewater Generation (KLD)	Wastewater Treatment System
18	Devarpan Foods Pvt. Ltd	Vill-Kunddeswara, Kkp- Kashipur		53.5	48	ETP
19	Dr. Oetker India Pvt.	Pratapur, Pratappur, Kashipur		55	45	ETP
20	Flexituff International Ltd.	Near Idgah, Pipalgaon Road, Kkp-Kashipur		180	80	ETP
21	Gupta Power Infra-structure Pvt Ltd	Nand Nagar, Kashipur		30	4	STP
22	Hotel Ananya Regency	Ramnagar Road, Neejhra, Kashipur		18	15	STP
23	India Glycols Ltd-Bot-tling Plant	A-1 -Industrial Area, Bazpur Road, Kashipur, Kkp- Kashipur		150	150	ETP
24	Jai Mata Di Industries	Nand Nagar Industrial Estate, Mahuwakhera Ganj, Kashi-pur		28	7	ETP
25	Jindal Research Labs Ltd	Plot No 1-Nnie Phase I, Kkp- Kashipur		48	4	STP
26	Jindal Frozen Foods Private Ltd.	Village - Narain Nagar, Bazpur Road, Kashipur.		17	13.5	ETP
27	Just In Agri Food (P) Ltd	Ideb Industrial Estate Phase-I, -Kashipur		44	21	ETP
18	Devarpan Foods Pvt. Ltd	Vill-Kunddeswara, Kkp- Kashipur		53.5	48	ETP
19	Dr. Oetker India Pvt.	Pratapur, Pratappur, Kashipur		55	45	ETP
20	Flexituff International Ltd.	Near Idgah, Pipalgaon Road, Kkp-Kashipur		180	80	ETP
21	Gupta Power Infra-structure Pvt Ltd	Nand Nagar, Kashipur		30	4	STP
22	Hotel Ananya Regency	Ramnagar Road, Neejhra, Kashipur		18	15	STP
23	India Glycols Ltd-Bot-tling Plant	A-1 -Industrial Area, Bazpur Road, Kashipur, Kkp- Kashipur		150	150	ETP
24	Jai Mata Di Industries	Nand Nagar Industrial Estate, Mahuwakhera Ganj, Kashipur		28	7	ETP
25	Jindal Research Labs Ltd	Plot No 1-Nnie Phase I, Kkp- Kashipur		48	4	STP

S.No.	Industry Name	Address		Water Consumption (KLD)	Wastewater Generation (KLD)	Wastewater Treatment System
26	Jindal Frozen Foods Private Ltd.	Village - Narain Nagar, Bazpur Road, Kashipur.		17	13.5	ETP
27	Just In Agri Food (P) Ltd	Ideb Industrial Estate Phase-I, -Kashipur		44	21	ETP
28	Konark Industries	Nand Nagar Industrial Estate,Mahuwakhera Ganj, Kashipur		60	42	ETP
29	M/S Adoratex (Formerly Rizwan Export House)	Plot No.- 437-Shree Developers, Industrial Estate, Mahukheraganj		155	88	ETP
30	Numix Industries Private Limited	Jaitpur,Kundes Hwari Road, Shivlalpurdallu, Kashipur		12	8.5	ETP-CUM-STP
31	Pmv Maltings Pvt. Ltd.(Former The Malt Company)	Vill-Kunddeswara,Kkp- Kashipur		2156	1475	STP
32	Pmv Nutrient Products Pvt. Ltd.	Pratapur, Pratappur, Kashipur		104	78	ETP
33	Prakash County (A Unit Of Ashish Builder)	Near Idgah, Pipalgaon Road,Kkp-Kashipur		86	80	STP
34	Shanti Frozen Food	Nand Nagar, Kashipur		77	48	ETP
35	Solitaire Drugs & Pharma (P) Ltd (Food & Beverrage Div)	Ramnagar Road, Neejhra, Kashipur		59	53	ETP
36	Srf Ltd.	A-1 -Industrial Area, Bazpur Road, Kashipur,Kkp- Kashipur		1.5	2	STP
37	Srf Ltd.Unit-Ii	Nand Nagar Industrial Estate, Mahuwakhera Ganj, Kashipur		45	32	STP
38	Sri Shandar Snacks Pvt Limited	Plot No 1-Nnie Phase I,Kkp- Kashipur		42.5	32	ETP
39	Stellar Cold Chain Inc	Village - Narain Nagar, Bazpur Road, Kashipur.		84	49.5	ETP
40	Vivimed Labs Ltd (Formerly Creative Health Care Pvt. Ltd).	Kundeshwari, Kashipur		14	6.4	ETP

Source: Uttarakhand Pollution Control Board

S.No.	Industry Name	Address		Water Consumption (KLD)	Wastewater Generation (KLD)	Wastewater Treatment System
26	Jindal Frozen Foods Private Ltd.	Village - Narain Nagar, Bazpur Road, Kashipur.		17	13.5	ETP
27	Just In Agri Food (P) Ltd	Ideb Industrial Estate Phase-I, -Kashipur		44	21	ETP
28	Konark Industries	Nand Nagar Industrial Estate,Mahuwakhera Ganj, Kashipur		60	42	ETP
29	M/S Adoratex (Formerly Rizwan Export House)	Plot No.- 437-Shree Developers, Industrial Estate, Mahukheraganj		155	88	ETP
30	Numix Industries Private Limited	Jaitpur,Kundes Hwari Road, Shivlalpurdallu, Kashipur		12	8.5	ETP-CUM-STP
31	Pmv Maltings Pvt. Ltd.(Former The Malt Company)	Vill-Kunddeswara,Kkp- Kashipur		2156	1475	STP
32	Pmv Nutrient Products Pvt. Ltd.	Pratapur, Pratappur, Kashipur		104	78	ETP
33	Prakash County (A Unit Of Ashish Builder)	Near Idgah, Pipalgaon Road,Kkp-Kashipur		86	80	STP
34	Shanti Frozen Food	Nand Nagar, Kashipur		77	48	ETP
35	Solitaire Drugs & Pharma (P) Ltd (Food & Beverrage Div)	Ramnagar Road, Neejhra, Kashipur		59	53	ETP
36	Srf Ltd.	A-1 -Industrial Area, Bazpur Road, Kashipur,Kkp- Kashipur		1.5	2	STP
37	Srf Ltd.Unit-Ii	Nand Nagar Industrial Estate, Mahuwakhera Ganj, Kashipur		45	32	STP
38	Sri Shandar Snacks Pvt Limited	Plot No 1-Nnie Phase I,Kkp- Kashipur		42.5	32	ETP
39	Stellar Cold Chain Inc	Village - Narain Nagar, Bazpur Road, Kashipur.		84	49.5	ETP
40	Vivimed Labs Ltd (Formerly Creative Health Care Pvt. Ltd).	Kundeshwari, Kashipur		14	6.4	ETP

Table A3-Pollution Source Mapping of River Ramganga from Moradabad to Kannauj (UP)

S. No.	District	Name of Drain	Latitude (N)	Longitude (E)	Domestic/ Industrial/ Mixed		Tapped/ Un-tapped/ Partially Tapped	Industries		Sewage Discharge (MLD)		
								Number	Treated Effluent (MLD)	Treated	Untreated	Total
1	Moradabad	Katghar	28°49'29.8	78°47'54.6	Mixed		Partiall tapped	04	0.017	11	1	18
2	Moradabad	Prabhat Market	28°53'39.9	78°48'19.5	Mixed		Partiall tapped	10	0.022	1	0.73	1.73
3	Moradabad	Jamamasjid (L)	28°50'07.4	78°47'40.7	Mixed		Untapped			-	3.46	3.46
4	Moradabad	Barbalan	28°4959.7	78°47'44.2	Mixed		Untapped			-	1.73	1.73
5	Moradabad	Karula	28°48’25.3	78°46’54.2	Mixed		Untapped	02	0.01	-	32	32
6	Moradabad	Kudaghar	28°49’44.7	78°47’46.9	Domestic		Untapped	-	-	-	11.70	11.70
7	Moradabad	Jamamasjid (R)	28°50’03.5	78°47’42.3	Domestic		Untapped	-	-	-	0.9	0.9
8	Moradabad	Ghosiyan	28°50’02.3	78°47’44.0	Domestic		Untapped	-	-	-	1.16	1.16
9	Moradabad	MIT	28°52’16.8	78°45’20.6	Domestic		Untapped	-	-	-	18.36	18.36
10	Moradabad	Nawabpura-1	28°56’49.3	78°47’02.5	Domestic		Untapped	-	-	-	18.14	18.14
11	Moradabad	Nawabpura-2	28°50’38.9	78°47’09.9	Domestic		Untapped	-	-	-	4.32	4.32
12	Moradabad	TDI City	28°52’44.7	78°45’33.9	Domestic		Untapped	-	-	-	4.83	4.83
13	Moradabad	Mokshdham	28°52’53.1	78°45’08.9	Domestic		Untapped	-	-	--	15.74	15.74
14	Moradabad	Vivekanand (L)	28°53’26.3	78°44’36.9	Mixed		Untapped	4	0.22	-	0.114	0.114
15	Moradabad	Vivekanand (R)	28°53’25.3	78°44’38.0	Mixed		Untapped	4	0.24	-	7.96	7.96
16	Moradabad	Chakkar ki milak	28°52’28.1	78°46’12.1	Domestic		Untapped	-	-	-	1.036	1.036
17	Moradabad	Jigar Colony	28°51’14.6	78°46’26.6	Domestic		Untapped	-	-	-	11.405	11.405
18	Moradabad	Lal Bagh	28°50’27.4	78°47’22.2	Domestic		Untapped	-	-	-	4.90	4.90
19	Moradabad	Daheria	28°50’19.9	78°47’24.3	Domestic		Untapped	-	-	-	20.40	20.40
20	Moradabad	Jhabbu Ka Nala	28°84’71.4	78°78’25.4	Domestic		Untapped		-	-	24.70	24.70

S. No.	District	Name of Drain	Latitude (N)	Longitude (E)	Domestic/ Industrial/ Mixed		Tapped/ Un-tapped/ Partially Tapped	Industries		Sewage Discharge (MLD)		
								Number	Treated Effluent (MLD)	Treated	Untreated	Total
21	Moradabad	Chandausi Road (L)	28°47'40.1	78°45'48.7	Mixed		Untapped	06	0.034	-	0.85	0.85
23	Moradabad	Delhi Road (L)	28°49'33.6	78°43'06.7	Mixed		Untapped	38	0.281	-	3.32	3.32
24	Moradabad	Delhi Road (R)	28°49'34.2	78°43'06.3	Mixed		Untapped	02	0.01	-	2.32	2.32
25	Rampur	Rampur Drain	28°45'20.7	79°01'18.7	Mixed		Untapped	06	1.012		34.31	34.31
26	Bareilly	Nakatiya Drain	28°15'01.6	79°26'10.6	Mixed		Untapped	03	1.6		24.13	24.13
27	Bareilly	Deveraniya Drain	28°20'58.5	79°22'42.1	Mixed		Untapped	03	0.75		102.28	102.28
28	Bareilly	Chaubari Drain	28°17'41.4	79°23'33.7	Domestic		Untapped	-		-	50.47	50.47

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