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INDIA-EU WATER PARTNERSHIP

Advisory Support to NMCG on the Development of the Water Information System Ganga

(Focus: Water Quality Dashboard)

Prepared under
the India-EU Water Partnership's Priority Area 3

Implemented by

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Concept Note on NMCG Dashboard development & Guidance on Basic Requirements to Datasets

1 Introduction

One of the priority topics for the India-EU Water partnerships (IEWP) is under the Ganga Rejuvenation project to develop online dashboards displaying overviews of river water quality monitoring results combined with hot-spots for pollution pressures.

Considerable monitoring campaigns are taking place by key institutions in India both for receiving water quality and for pollution pressures, e.g., discharges of effluents from sewage treatment plants (STPs) and industries as well as untreated wastewaters via urban drains. Presentation of monitoring results via such dashboards can be very useful for both stakeholders with a policy making or technical-scientific-practical background and for the public with a general interest in environmental and public health issues.

This document presents some conceptual examples from the Ganga river basin to illustrate some options for NMCG in the development of Water Information System for Ganga (WIS-G).

In the context of IEWP, it is the intention to share and transfer some of the experiences gained by EU institutions during recent decades to Indian institutions for implementation in the Ganga river basin.

During the recent decades as part of European environmental regulations, European institutions and member states have put much effort into communicating similar overviews to the public, e.g., as part of implementation of the Water Framework Directive (WFD) and the Urban Waste Water Treatment Directive (UWWTD), respectively. Some of the popular online dashboards include as communication and planning tools interactive map-viewers with spatial display of environmental information as well as data-viewers with tabular summary information applicable for direct use in assessment reports. A few examples shown are based on the Water Information System for Europe platform (WISE) freely available for public view at the website of the European Environment Agency (EEA). These examples have been compiled into an appendix to this document.

2 Display of information related to river water quality

A few examples prepared for the River Ganga are shown below to illustrate options.

Some simple exercises were made by EWP for the main course of Ganga in earlier missions, working with CWC monitoring stations. The map below presents the results of the water quality index for drinking purposes in 2014, attributing the classification colour code of the monitoring station to the stretch upstream.

[1] Map presenting WQI (drinking water) in river stretches on the main Ganga, determined from the data of 15 CWC monitoring stations.

Such a map provides an immediate overview of water quality and clearly shows clean parts versus polluted parts. Optionally, other water quality indices could be used for similar display and data from more data providers may be combined.

Information related to river water quality can be displayed in many ways such as:

- Display of monitoring results per
    - Monitoring station (in GIS terms a centroid - a point as the geographical unit)
    - Section of river stretch, a Water Body in WFD terms (in GIS terms: a vector)
    - Aggregated for monitoring stations or waterbodies for a region or a river basin district (in GIS terms: a polygon)
- Display of monitoring results per
    - Individual analytical parameter (BOD, NO_3, DO, Faecal coliforms …)
    - Indexed result (in WFD terms: ecological status, chemical status; in India terms: drinking water Class A or Class C, bathing water class B...)
- Display of

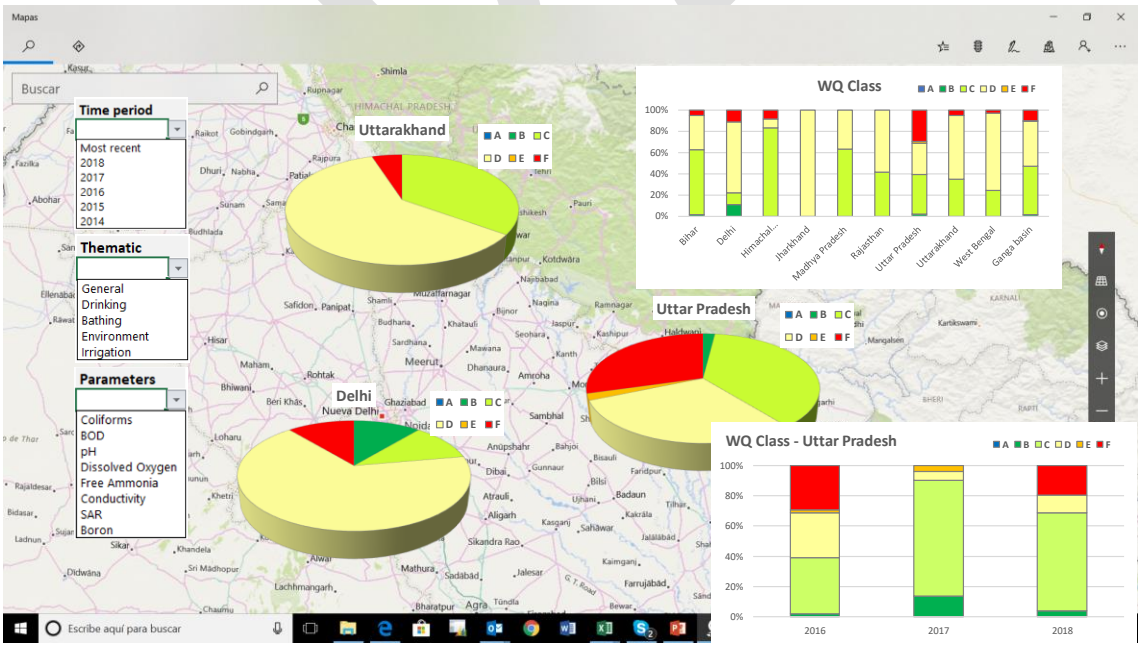
- aggregated values; e.g. annual / seasonal mean values
- individual measurements; e.g. most recent value, max. or min. value during calendar year,..

A display by river stretches (vectors) rather than points has a higher public appeal being more visual. However, in the case of Ganga, the underlying monitoring takes place at monitoring stations. So for displaying as vectors, it is necessary to create consistent logical rules for the transposition, at least as a temporary solution.

- One option could be to allocate the value from a monitoring station to the upstream river stretch (vector) – as used ig Fig [1]
- Another option could be
  - In the case of upstream and downstream monitoring stations having the same indexed value to use the corresponding colour for the whole stretch
  - In the case of 2 different values to use a striped vector legend for the whole stretch with the 2 corresponding colours.

A long term solution for displaying river water quality by stretches would be to prepare a genuine river segmentation into water bodies based on a pressure-impact analysis, and to conduct and report monitoring results representative for these water bodies. An example from EU WISE is included in the Appendix based on reporting to the WFD.

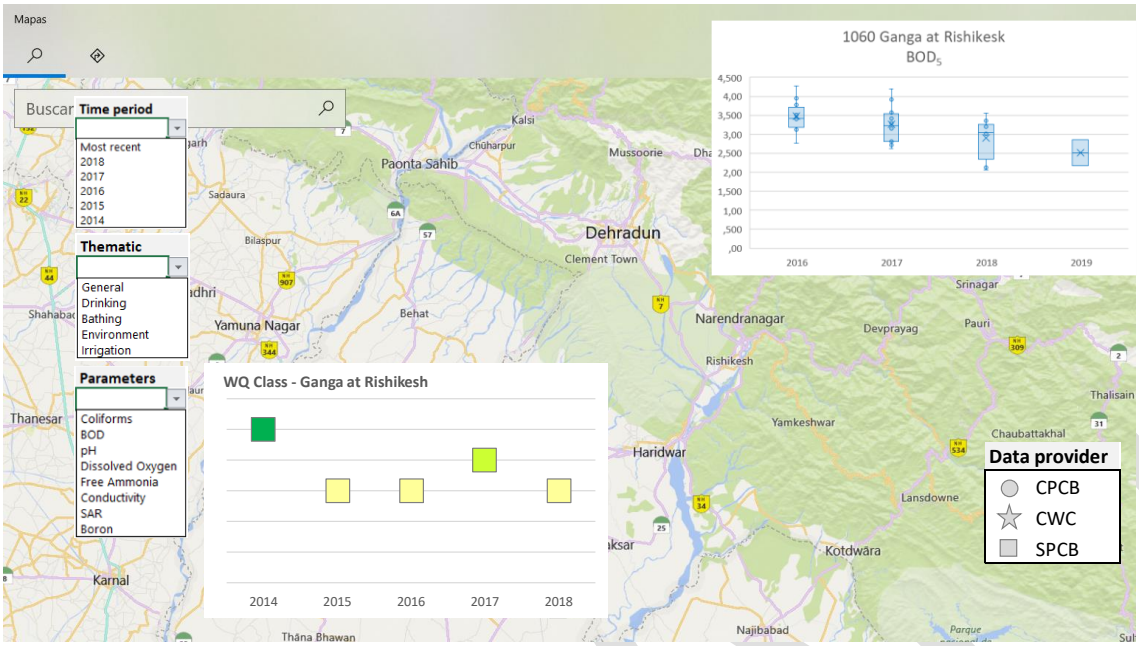
As options for integrating aggregated values from the same underlying dataset, the images below are mock examples presenting potential summary representations of water quality datasets, classified based on the Indian WQI. In the first one, menus to select “time period”, “intended use – thematic” and “wq parameters” would be included in the map-viewer and some illustrations for the presentations of summary data per State are proposed. The second one suggests representations of the evolution of water quality at monitoring station level (Ganga at Rishikesh).



[2] The pie charts illustrate the percentage of monitoring stations falling under each WQ class per State. of WQI classification. Bar chart above also presents the same kind of information for all the States in the Ganga basin, while the lower one would present the evolution in one State (Uttar Pradesh) from 2015 to 2018.

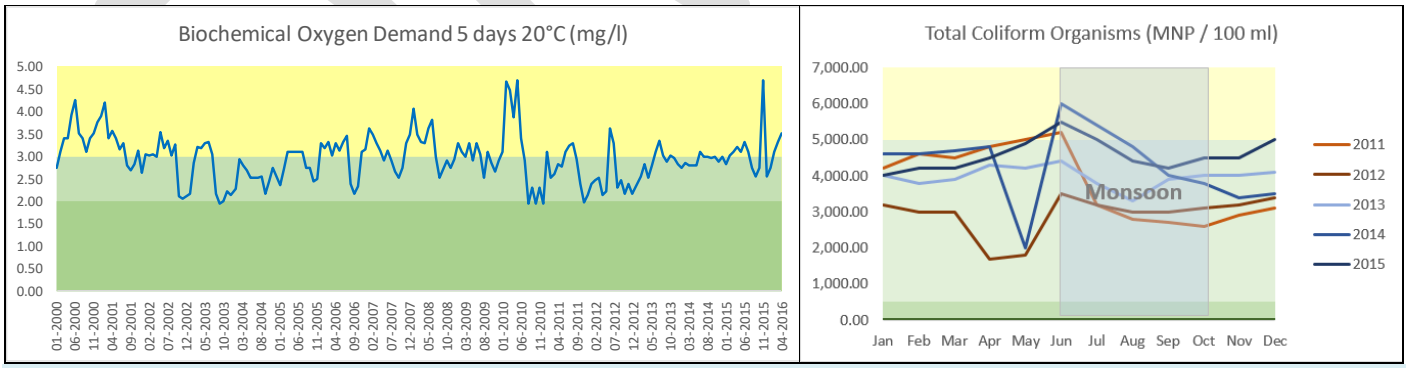
Such aggregated presentations on distributions within states as well as development over time also provide good snapshot overviews and can be applicable for insert in assessment reports.

For individual monitoring stations a web-based map-viewer can get added value by displaying time trends for the given station as shown in Fig . [3]. Here, the pop-up diagrams should reflect the optional choices interactively made by the user.



[3] Suggested ways of presenting the evolution of WQ at monitoring station level.

Other options for representing the evolution of water quality parameters are presented below. Coloured areas to graphically show if the parameter is within acceptable standard values (green) or below / above them to facilitate interpretation of the observed trends. Such displays are considered useful, e.g., to include in reports as background for assessments.



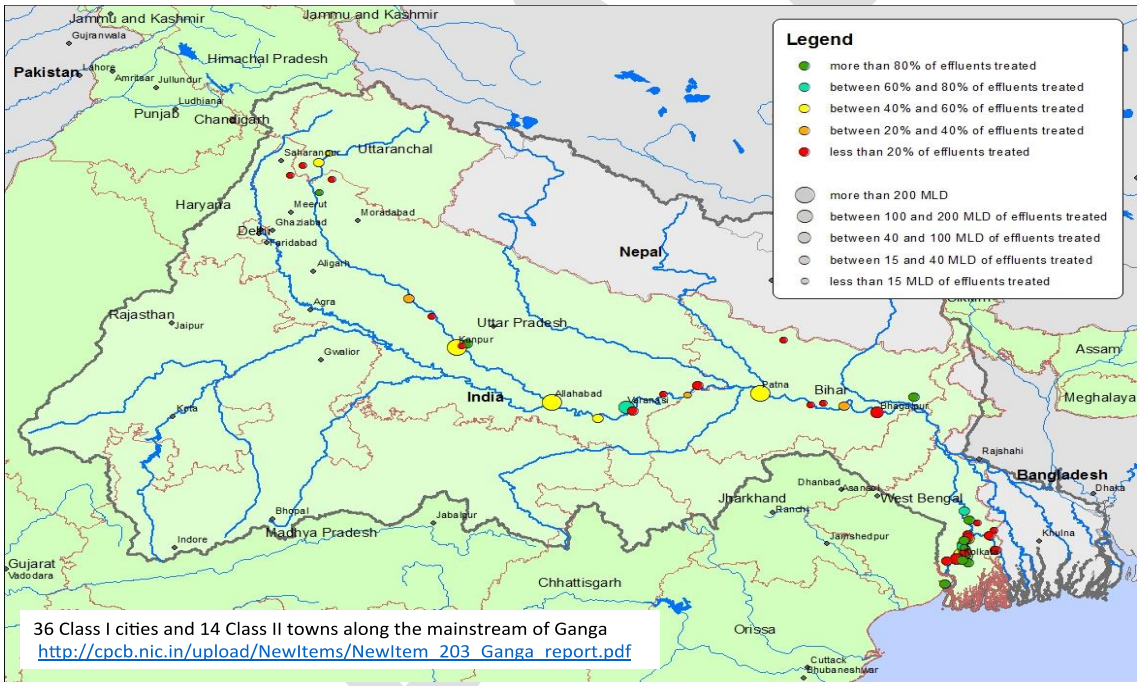
[4] Evolution of BOD_5 and faecal coliforms in the river Ganga at Shahzdapur (CWC): two different representations of monthly time series are proposed.

Together with this document, two excel files are attached presenting structured data and the related graphic formats that have been used for the generation of the figures shown above. These excel files, once completed and expanded, can be used for the organization of datasets and may evolve as a component of future map-viewers / dashboards:

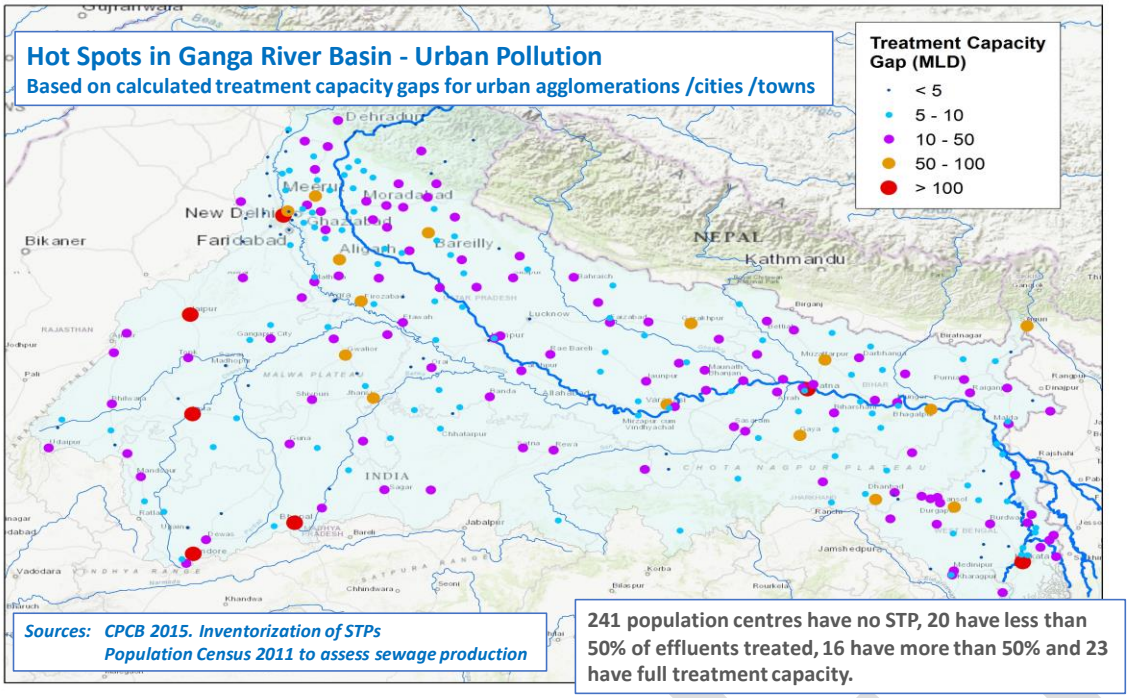
- **mock_MS.xlsx** organize and presents data at monitoring station level in the CPCB station 2498 - Ganga at Kala Kankar (Raebareli), including and automatized assessment of the classification according to Indian WQI standard. Actual observations have been completed with mock data to fill the gaps. Representations such as those shown above 4 are possible, as well as the suitability to use in monitoring points (eventually, in associated river stretches as in illustration [4]).
    - As a detail should be mentioned that a data error (outlier value) has been noted for DO for observation 06-2011, probably a factor 10 error. Such type of outlier value could have been detected earlier if a logical rule (e.g., max 20 mg/l) had been installed for initial check of data.
- **mock_WQ_summary.xlsx** starts from water quality and in all CPCB stations in 2016, that have been completed with mock data whenever needed. Similar mock series have been built for years 2017 and 2018, so that graphics [2], [3] and [4] can be produced.

3 Display of information related to urban wastewater generation and treatment

At earlier stages of the IEWP, a database of STPs and population centres was built whose main product was a hot-spot map showing the current sewage treatment gap in the major cities and towns discharging into Ganga that was later expanded to cover the whole Ganga basin.

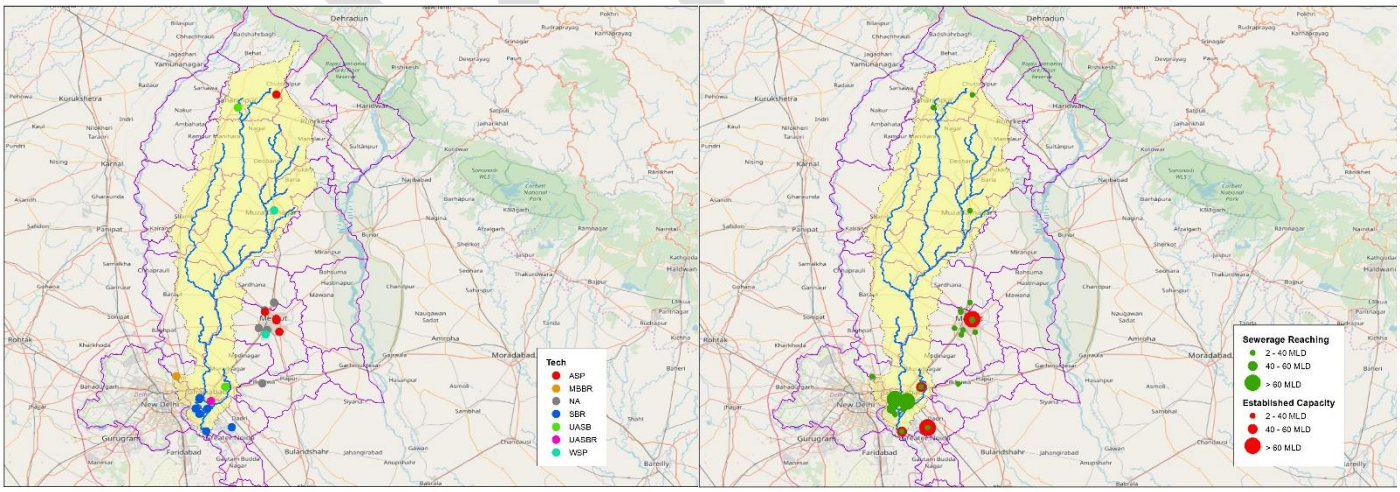


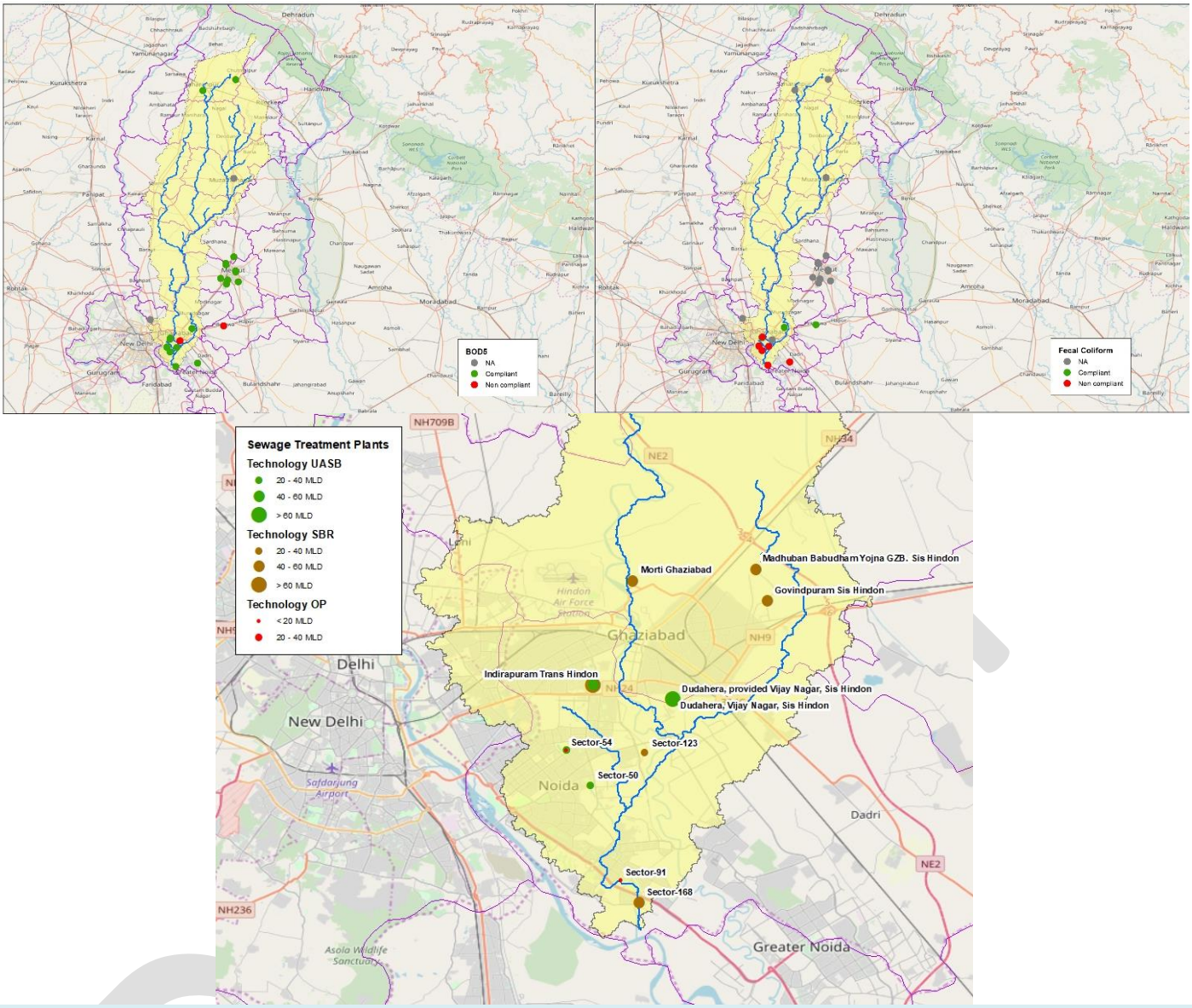
36 Class I cities and 14 Class II towns along the mainstream of Ganga
http://cpcb.nic.in/upload/NewItems/NewItem_203_Ganga_report.pdf



[5] Examples of hot spot maps estimating the sewage treatment gap in the main Ganga (above) and expansion to the entire Ganga basin (below). The database behind this second map was delivered to the NMCG in our last mission.

In the Hindon sub-basin, benefiting from more detailed information on STPs provided by http://www.jalshodhan.com/data.php -including quality data (inlet & outlet)- and the report *Assessment of Excreta Management* (CSE 2019) that includes factsheets on how wastewater is managed in 66 cities in UP (https://www.cseindia.org/assessment-of-excreta-management-9269), a similar database has been substantially improved to produce a variety of maps and graphs.





[6] Different illustrations generated under the Hindon initiative, from top to down and left to right: technology of STPs; capacity vs sewage reaching the installation; BOD compliance; coliforms compliance; detail of the location of STPs.

The next step is to develop a beta version of a database for Hindon that will follow, as much as possible, the structure of EU reporting database, which include coding of both STPs and population centres and determining the sewage coverage of the later, as well as clarifying the linkages between STPs and population centres. The estimation of the pollution load, compliance and treatment efficiency, the consideration of "individual appropriate systems", and the expected impact of the programmed actions, are other aspects that should be factored in.

This version could be later expanded to the whole Ganga working jointly with the NMCG team and incorporating the information provided in our previous mission[1]. It must be noted that, currently, there is a significant lack of information on sewage collection and its linkage to STPs. Unambiguous coding of the different entities (STPs and agglomerations) is fundamental for getting a clear understanding of the problems and for the development of a consistent action plan that should be extremely facilitated by the provision of such a well-designed database. Appropriate actions can be more easily identified: connection of sanitation networks to underutilized STPs;

[1] Table ***STP status based on latest inspection 2018 (Dec 2018) 08.03.2019*** (word and excel formats with similar content);
Excel file ***COMPILED Existing STPs***;
Excel file ***STPs-list-14-03-219*** [***List of 110 STP Projects being monitored Under NMCG (Out of total 151 Sewerage Projects***)].

improvements and / or extensions in overloaded STPs that are unable to discharge within the regulatory limits; new sanitation networks in agglomerations wherever wastewater is not safely managed.

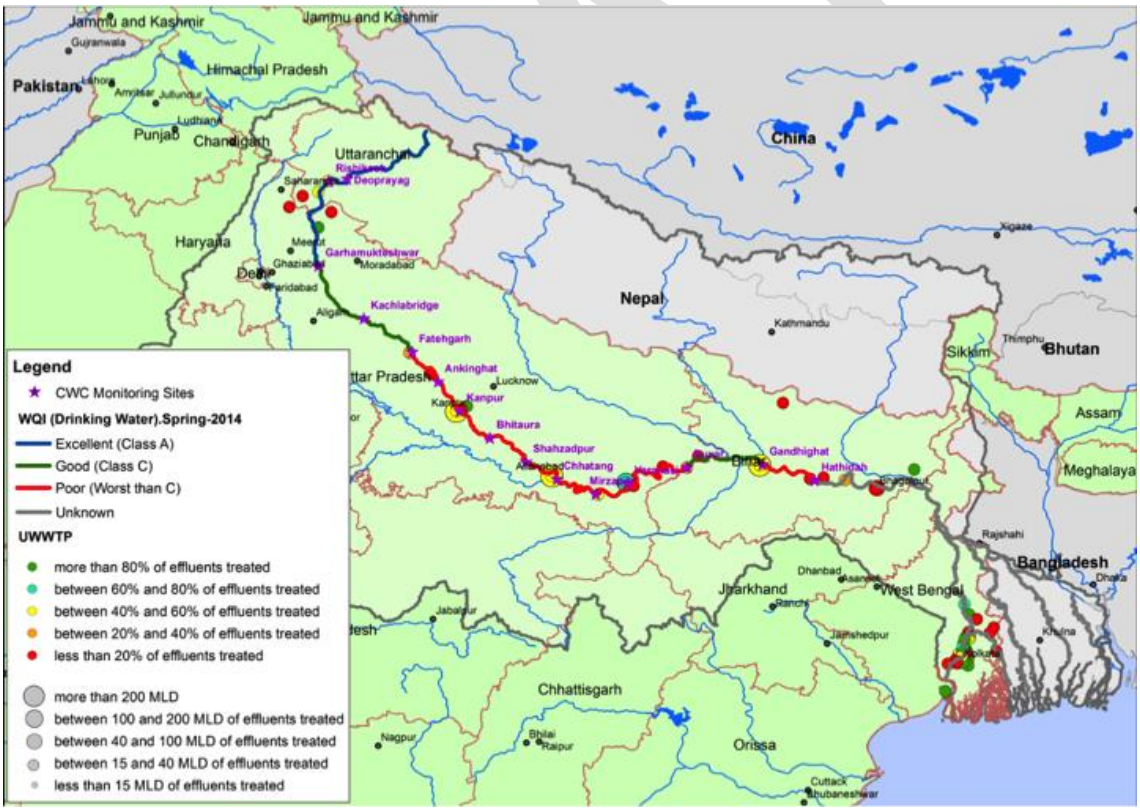
Examples from EU WISE of map-viewers prepared on the basis of reporting under the Urban Waste water Treatment Directive (UWWTD) is included in the Appendix. An important dual concept used in the UWWTD includes features for both:

- agglomerations (= population centres: cities, towns...) for which there are criteria to the waste water collection and type of treatment installed depending on agglomeration size and sensitivity of receiving waters
- waste water treatment plants (WWTPs = STPs) with criteria for the effluent quality or % removal of pollutants, also depending on plant size and the sensitivity of receiving waters.

The agglomerations and corresponding STPs are interlinked with unique ID codes in the data sets.

4 Combined displays of river water quality and urban wastewater pollution pressures

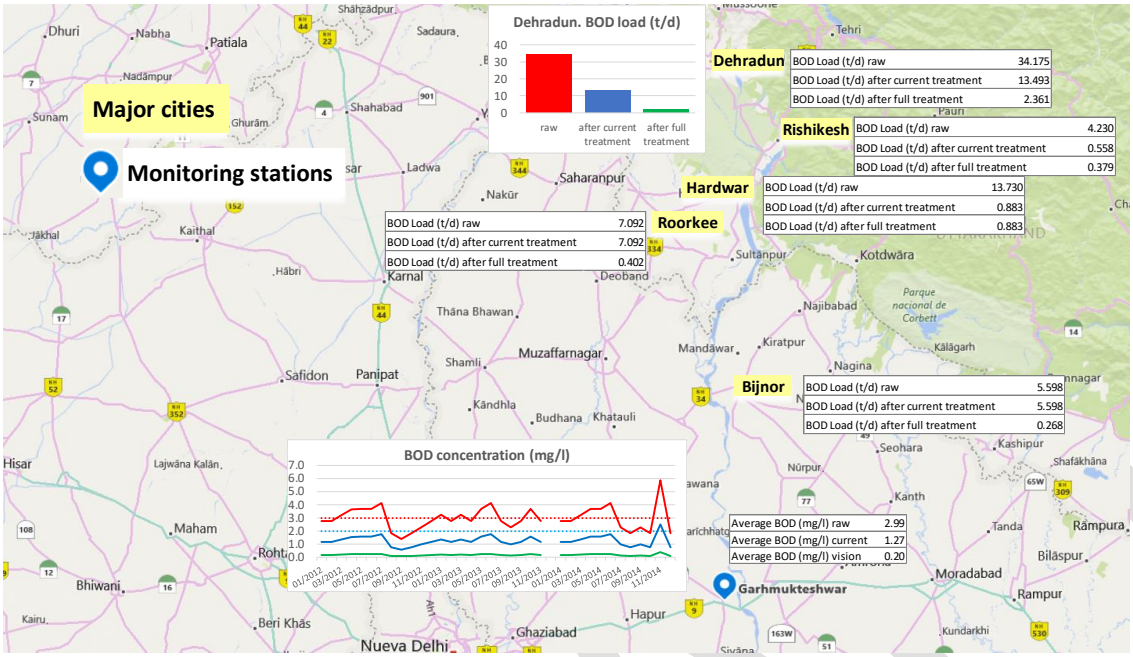
The use of combined displays of different thematic GIS-layers may give added value in the direction of cause-effect relationships. As an example, a combined display of water quality in the main Ganga and the magnitude of sewage treatment gap was prepared at the first stages of the IEWP for the main Ganga.



[7] Water quality in river stretches and the magnitude of sewage treatment gap in the main cities - towns discharging into Ganga are presents together. Combination of maps [1] and [5]

It is evident from the combined display that many stretches with poor WQI occur where there are main cities with a relatively low degree of wastewater treatment. Such a map could be further developed with scenarios for future improved treatment, e.g. when current investment plans or upgraded treatment have been implemented.

Finally, in the debriefing meeting of the last IEWP mission some mock-up examples were provided combining information on load reduction under different scenarios and water quality observation in the river monitoring network. Proper pressure-impact analysis would be needed to ensure that all relevant polluting sources are considered and water quality modelling could help to understand the effects of different action scenarios in water quality.



[8] Three levels of BOD urban polluting pressures are established for the main cities upstream Garhamukteswar (raw / current level of treatment / full treatment). Expected evolution of BOD in the river under the three scenarios is graphically represented below.

5 Some basic requirements for datasets to support WIS-G

Some shortcomings have been experienced with the current datasets used by NMCG. This includes:

- Consistent data formats;
    - e.g. for indication of sampling date (25.09.2019; 25-09-2019; 25 Sept. 2019,..) or
    - for coordinates to locations indicated as decimal degrees or by decimal numbers for latitude and longitude with indication of which reference system
- Unique ID codes for objects; e.g. for sampling stations or STPs
- Harmonised parameter names and corresponding meaning

This is particularly important for NMCG as several datasets will arise from different institutional data providers not necessarily using same formats and terminology.

A harmonisation of date formats may take place by choosing one and cleaning up existing datasets using other formats. Since there will be a 1:1 relationship, a transformation from any used data format into the chosen one may take place by programming.

For the ID codes some institutions/states may use an ID-number, which is unique within that geographical reference but may be duplicate with the same ID-number in another institution/state. This may be solved by programming the addition of a prefix, e.g., 2-letter code for the state or CPCB, CWC, CGWB,.. to the local ID-code, which then will make it unique across India.

Currently, there are no definitions or explanations to the parameters used in the datasets. In many cases, this is evident; e.g., pH or dissolved oxygen (DO) but for a commonly used parameter as BOD it is not clear if this refers to BOD(3) at 27 ^{o}C (as mentioned during joint working session in April to be typical) or to BOD(5) at 20 ^{o}C as used by CPCB in the Water Quality Index.

In the two mock-up excel files attached to this document there are “data_table” sheets integrated ; this shows a way to prepare the data definitions. In case that certain ways of preparing data definition tables already exist (e.g., within India-WRIS WebGIS) this should be adopted.

It is strongly recommended to NMCG to prepare data definition tables as part of the documentation of existing datasets, including data formats, for all the datasets on managed by NMCG. This will facilitate all communication related to the use of the data and will provide transparency, as well. The names used in the datasets for the elements/parameters can freely be set by the owner of the dataset. It is proposed to select meaningful short-names easy to understand; this will make a display in a pop-up window in a map-viewer (shown in the examples) easier and will require less explanations to an external user. It is crucial that the same data element has a consistent data format (e.g., for dating, location by coordinates) and also strongly recommended that objects (monitoring stations, STPs,..) have a unique code ID.

The datasets may be divided into tables with static data (monitoring stations identifier, location ...) and dynamic data (values from monitoring as disaggregated and aggregated, respectively) . Examples from EU WISE for data definition tables are included in the appendix Especially the dynamic data include several data elements with supplementary information (analytical method, Limit of Quantification, flags from testing by logical rules for the data quality, etc.) Such information is not strictly needed for the generation of the map-viewer, however, they are very useful for the quality assurance/quality control (QA/QC) of the reported data.

6 Joint working session framework

For the planned joint working session in October 2019 with NMCG, GIZ PMU and EU Advisors, it is proposed to focus on the development of map-viewers on Ganga river water quality combined with pressures and measures for pollution control via urban wastewater treatment plants.

In preparation from NMCG's side it is proposed to:

- Consider the options for building datasets and map-viewers in WIS-G as described in this document & appendix.
- Establish unique ID-coding for GIS objects, such as monitoring stations, STPs – preferable based on the ID-codes already used by the relevant institutional data providers with an addition of a prefix.
- Prepare an inventory of WIS-G relevant datasets currently available to NMCG
- Prepare data tables for description of the contents of the datasets, the meaning and data formats for all the parameters; this could be with inspiration from the sheets "data_table" included in the two attached mock-up excel files.

Overall objectives:

- To assist NMCG in solving recognised challenges in the management of datasets and development of display products
    - To discuss possible map viewer products for point pollution sources and their current treatment (STPs, ETPs and CETPs).
    - To review current data table definitions for datasets related to River water quality, sewage treatment plants (STPs) and industries in combination with raw/cleaned corresponding datasets developed by or provided to NMCG
    - To conduct a feasibility assessment of the concept of "crowd sourcing" of influent/effluent data from STPs as earlier suggested by NMCG
    - fine-tune / finalise map-viewer product on Water Quality almost ready for display via NMCG website

Expected outputs:

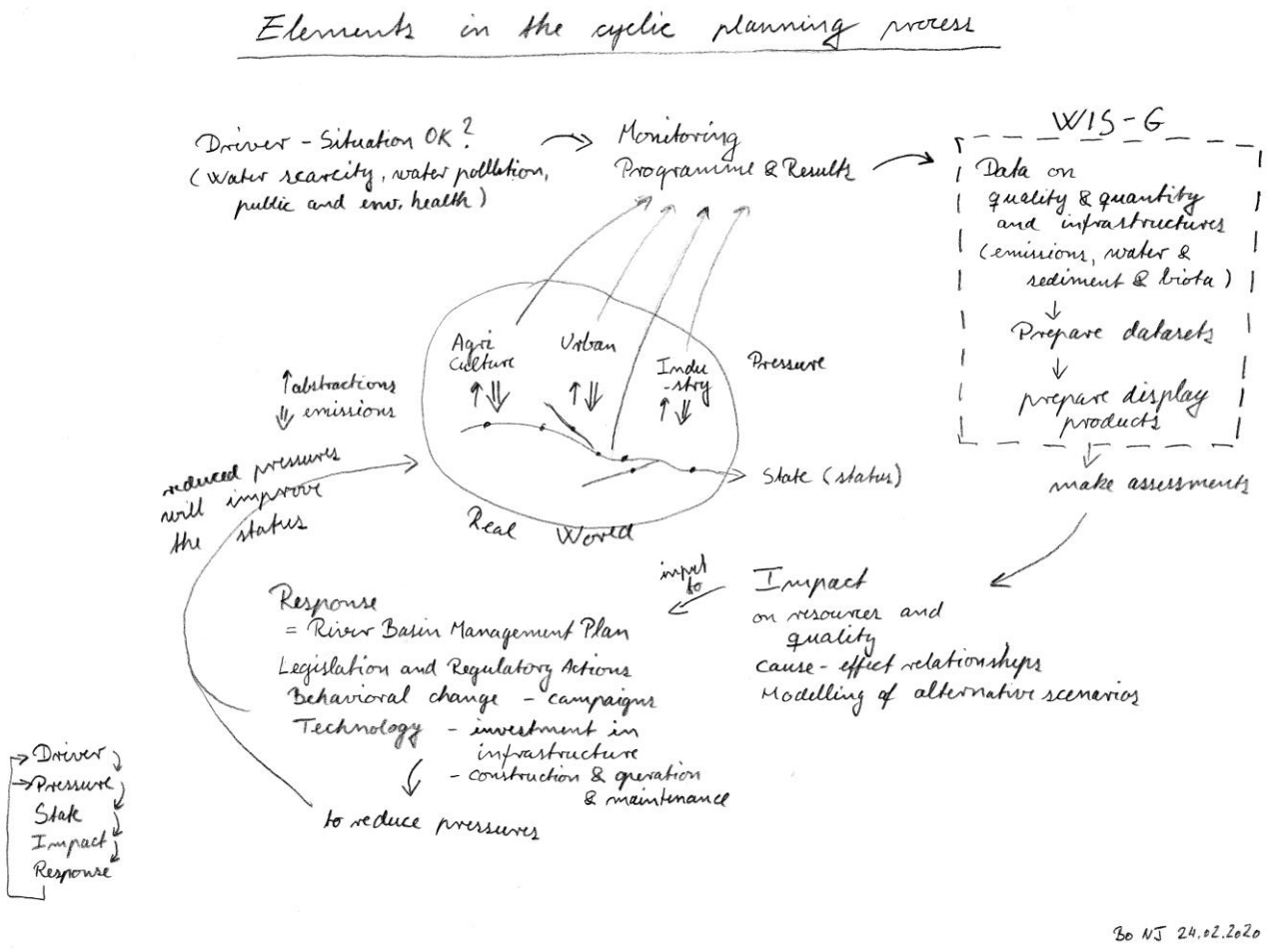
- Facilitated process of preparing data table definitions, clean-up of datasets, development of new WIS-G products by NMCG – improved by assistance from GIZ PMU and EU Advisors
- Some finalised WIS-G products
- Clarification of feasibility of "crowd sourcing" concept with influent/effluent data from STPs
- Updated version of Roadmap for development of WIS-G

Bo NJ 24.02.20120

Technical Note

On WIS-G in the River Basin Management Planning process

This concept note aims in visualising an overview by 2 simple diagrams on the cyclic environmental planning process and the linear data flow production process, respectively. The note raises questions to the existence of planning documents and corresponding inventories for document retrieval.



The cyclic **D**river – **P**ressure – **S**tate- **I**mpact – **R**esponse (DPSIR) approach starts with a reflection whether the (environmental) situation is considered OK or not ? – and if not takes a series of steps to quantify the pressures from , e.g., agriculture, urban or industrial sources as water abstractions or emissions via drainage / wastewater.

A direct quantification may take place via monitoring programmes specifying which measurements are made at which monitoring sites / stations, at which frequency for which parameters and by whom.

Is there an inventory where various monitoring programmes in the Ganges basin on emissions and river water quality are described – to provide overview ?

The results from the various monitoring programmes are managed by the individual institutions conducting the monitoring exercises and are filed in datasets owned by these institutions. In some cases, data display products are already operational, e.g., as map-viewers or data-viewers via web platforms of the same institutions. By establishing the Water Information System for Ganges (WIS-G) it is the intention to make all the relevant monitoring data results available to the users; this may range from inter-institutional professional users (via protective password access) to free public access to display products and/or corresponding data.

It is the focus for assistance of GIZ PMU and EU advisors to help in the planning, organising and implementation of WIS-G, however many other elements in the cyclic planning process will influence this.

Is there a planning document describing the visions, strategy, data policy and implementation plan for WIS-G ?

A document "PROPOSED DASHBOARDS –INDIA STATES' WRIS" (2019 or before) described examples of map-viewer displays based on a template for specifications; any use of this or update ?

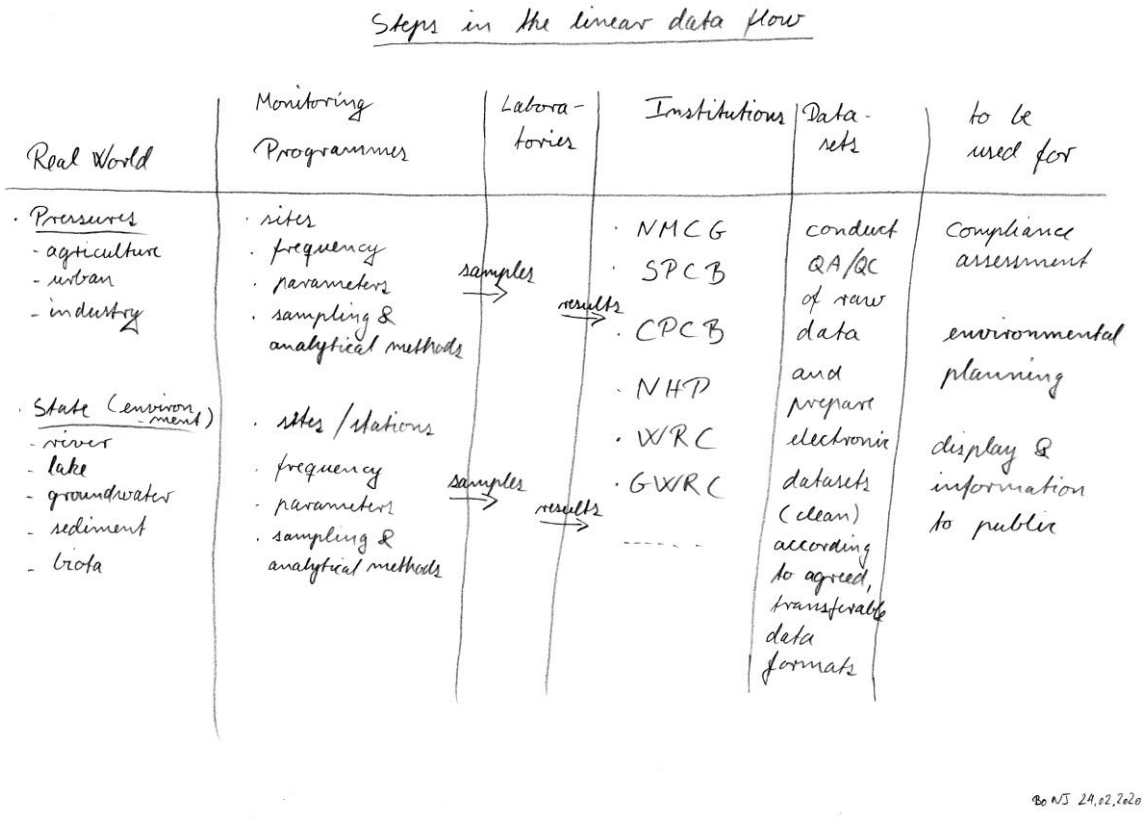
The environmental impacts occurring as a consequence of the pressures and status characteristics of the water bodies may be quantified for several types of pollution, e.g., oxygen depletion, eutrophication, pathogenic microorganisms, silting/desilting, etc. This requires knowledge of the cause-effect relationships and the compilation of this knowledge into mathematical models may provide powerful planning tools. Via modelling, it is possible to simulate alternative scenarios for new policies and interventions where the levels of ambition may be balanced between the environmental benefits to be expected versus the corresponding economic costs.

The outcome of such impact analyses may give input to a River Basin Management Plan (RBMP), where both upstream and downstream stakeholders are involved in the political process of defining any necessary new legislative initiatives and regulatory actions, as well as measures to be taking to reduce the environmental pressures. Programme of Measures could both be based on behavioral changes (e.g., stop open defacation, clean drains,..) and technological solutions by investing in infrastructure (treatment plants, cleaner industrial production, sustainable agriculture). The financing of the RBMP is an integral part of it.

A RBMP for Ganges has already been developed with comprehensive documentation of current pressures and current state as well as visions for future improvements.

Has this been updated / expanded to include programme of measures ?

It mentioned that overview and easy access to key plan documents may facilitate the cooperation among stakeholders – however, real improvements in river water quality will only happen when measures have been implemented for reduction of the pressures.



The design of monitoring programmes should aim in obtaining representative data for environmental situations for an analytical programme characterising the pressures / state for the types of pollution causing recognised problems. Reference datasets for location of monitoring stations operated by various institutions are already on display on web platforms.

Are plan documents available for description of basic data in ongoing or future monitoring programmes, such as sampling frequency, analytical parameters as well as the sampling & analytical methods ?

Laboratories deliver the analytical results based on the samples taken and specified analytical programme. In case that the results are forwarded on paper sheets to the ordering institutions, it may be considered to shift to electronic reporting. This may make the data flow chain more efficient (saving time for simple typing by the institutions) and may also facilitate the Quality Assurrance / Quality Checks (QA/QC) against potential data outlier errors already at the step of result delivery from the laboratory.

The institutions responsible for conduct of the monitoring programme(s) should also include a QA/QC step in their data managent procedures for creating datasets. This may to a high degree be conducted by installing “logical rules” when reading in the raw data to ensure consistent data formats as well as reasonable limits for the analytical results (could be max, or min values not to be exceeded as well as given ranges for relations between the parameters).

Are there any examples of installation of “logical rules” for check of raw data ? – could be developed in the context of the Namami Gange – PTB study

The use of the (clean) datasets include a number of stakeholder purposes all to be contained within the WIS-G:

- Compliance assessment. The relevant environmental authority will conduct a compliance assessment based on the current regulation, e.g., criteria for river water quality or treated wastewater effluent quality
    - *Is there a repository for updated version of environmental regulations (statutory orders, etc.), e.g., from platforms of ministeries / institutions ?*
        - *E.g., the CPCBplatform link does not mention recent statutory orders on improved wastewater treatment*
- The datasets from the monitoring programmes are also crucial for the environmental planning process, e.g. to quantify the pollutant fluxes (mass flows) both for the emissions but also for the in-river fluxes; trends over time are the most reliable indicator for improvement or deterioration of the environmental situation
- Display of the monitoring data to the public is very useful both for raising environmental awareness, for documenting improvements, e.g. after expansion of wastewater treatment as well as to build confidence to the river basin management process based on transparency. The display products need to be easy to understand for laypersons and often the use of map-viewer displays are strong communication tools.

The WIS-G will be an important element in the cyclic environmental planning process and should be subject to continuous improvements. However, there are also other related elements which all together contribute to the development of RBMPs and implementation of Programme of Measures.

Summary of joint working session 1-5 April 2019 NMCG – EU Advisors

Key findings and next steps:

Before documenting and describing details, key findings and agreed next steps are flagged here upfront:

- Form a Task Force on the Dashboard/Water Information System Ganga that will be chaired by DG NMCG. The following members have been proposed:
    - **Focal Points:** ED-Technical and ED-Projects
    - **Potential Task Force Members** (as discuss with NMCG on 5 April at the GIZ SGR Planning Mtg): Dr Bhardwaj, Dr Pravin, Dr Hema Patel, Mr Peeyush, Mr Manish, Mr Santosh, IEWP/GIZ PMU, EU environmental advisors and other to be determined (e.g. ESRI; CPCB, CWC, etc).
- Follow the attached Road Map to develop the Dashboard/Water Information System Ganga
- Develop a mechanism for communication and sharing among various relevant agencies/departments for ensured data flow: For example- CPCB, CWC, NHP, NWM, SMCGs etc.

Introduction

As agreed with Mr. Mathuria by the end of February 2019 mission, the EU environmental advisors (Carlos Benitez and Bo Jacobsen) should be located and working closely with NMCG staff during this week, working on the 3 key areas highlighted by Mr. Mathuria:

A. Further development of map-viewer for river water quality
B. Display of performance of sewage treatment plants/demonstration of implementation success
C. Display of industries – location and emissions from manufacturing industries

Mr. Bhardwaj (formerly Additional Director at CPCB) had replaced Mr. Sundeep at NMCG and Peeyush Gupta (GIS specialist) were the main contacts during the week. A good insight on the water related environmental datasets available at NMCG was obtained and major issues regarding data exchange with other institutions (CPCB, CWC) were outlined.

Main challenges identified

Regarding the development of map-viewer for river water quality:

- To foster the interchange of data among relevant institutions while ensuring ownership and ultimate control by the data provider.
- To properly document the data tables to facilitate understanding, comparability and transparency.
- To harmonize data formats in a way that enables computer-based reading and analyses of the data.
- To improve the dashboard options currently available so that they transmit useful information to the public and facilitate the decision of policy makers.

Regarding the collection and display of information for STPs and their performance:

- To create an STP Inventory (based on previous attempts by CPCB) and create protocols for constant updating in contact with relevant stakeholder institutions.
- To compile historical data of water quality (influent -effluent) from STPs and to establish regular reporting protocols for updating.
- To define a consistent methodology to acknowledge the positive impact of STPs both in terms of pressure abatement and improvement of river quality.

Overall achievements:

- Draft NMCG dashboard on river water quality has been reviewed and proposals for modifications have been specified. These are considered ready to be implemented via IT support contract (e.g., ESRI, KPMG)
- Current GIS reference (static) and thematic (dynamic) layers available at NMCG have been discussed and useful combinations (overlays) selected for presentation by NMCG. This includes positioning of agglomerations (cities, towns, villages, etc), STPs and industries along with rivers. Current pop-up information reflects underlying dataset parameters in a raw form; there is a potential to customise these for more user-friendly display of parameters
- Examples of integrated use of the cross-cutting data available for river water quality & quantity and STP effluent quality & quantity illustrate the added value of collected data beyond use for compliance assessment. Below Figure 1 illustrates the use of simple pollutant load mass balances with effluent loads discharged into the river flow at the monitoring stations. This clearly illustrates that wastewater treatment has a significant impact in reducing the BOD concentration in downstream rivers.
- Based on discussions on strategic IT management it is recommended that:
  - Immediate efforts are made for preparation of documentation for current and future datasets (clear definition of tables, parameters and formats)
  - In design of dataset parameter names, their use in pop-up windows is foreseen to be understandable
  - clean-up exercise to be conducted for some datasets to be used by NMCG

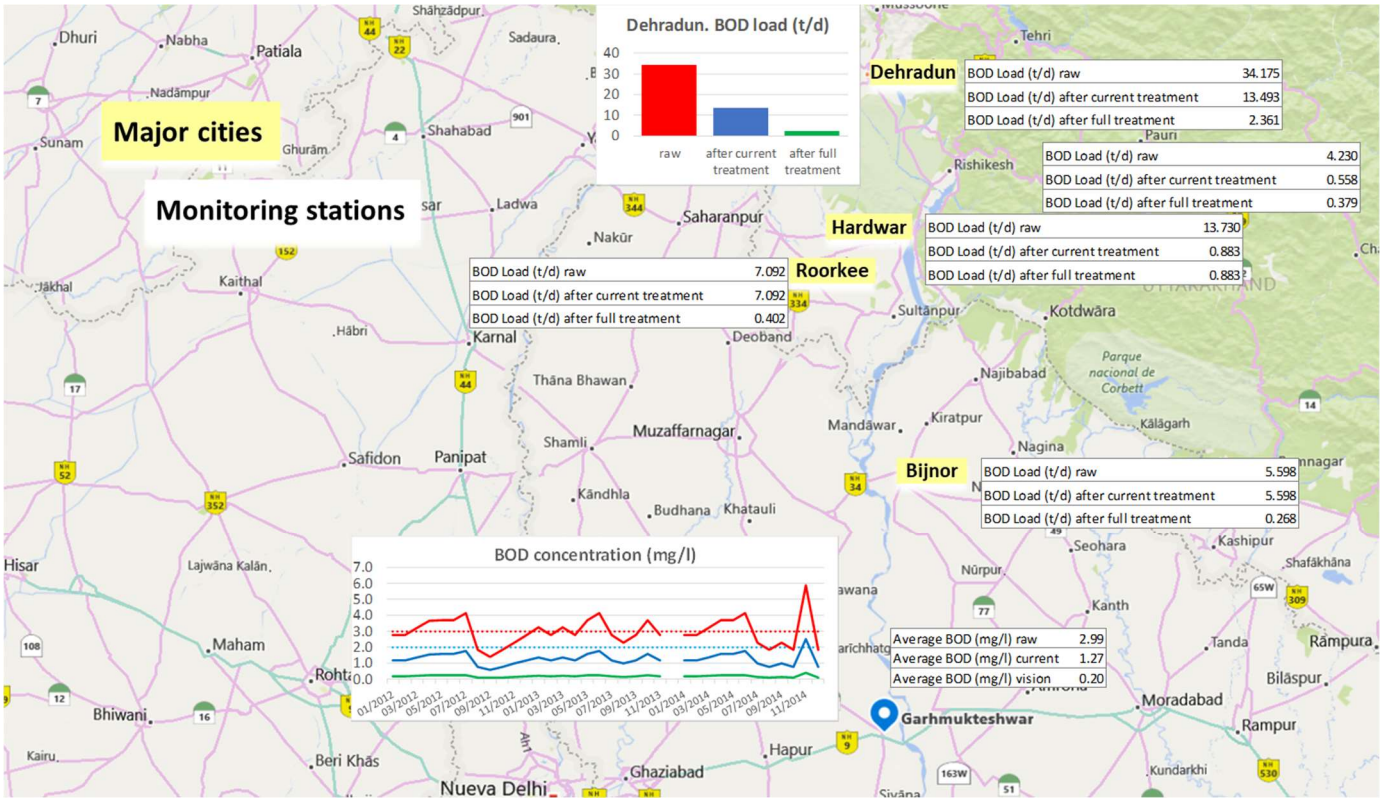


Figure 1. Illustration of resulting BOD concentrations at river monitoring stations downstream major cities.

- Red curves are calculated based on a theoretical scenario that no wastewater treatment has been installed.
- Blue curves are based on the current situation in the river with the current effluent loads from STPs.
- Green curves are calculated based on theoretical scenario with effluent loads from STPs all installed with sufficient capacity and treatment levels according to current standards.

Notes on the 3 key areas:

A. Map-viewer on river water quality

A draft map-viewer for display of results from regular monitoring programmes had been prepared by NMCG with support of ESRI. This should include results from all relevant institutions, e.g., State Pollution Control Boards (SPCBs), Central Pollution Control Board (CPCB), Central Water Commission (CWG). Detailed discussions on modifications for improvements to this draft took place - also with ESRI representative (Dr. H.V. Shashibhushan Kumar, Head Professional Services and Sr. Consultant) - and as a result, a detailed design was sketched on a flip-over chart, handed over to NMCG.

To do and needed improvements:

- Easy selection of data sources (individual or multiple) and monitoring stations (drop-down menus)
- Easy selection of analytical parameters (drop-down menu)
- Clarity that all displayed graphs and figures will refer to the selected analytical parameter
- Less focus on max. / min. values having occurred on previous time series – but use of, e.g., 90% / 10 % values to illustrate high / low values (range) in time series.

- Improvement of colour coded display of water quality of a stretch of the river-based on two observation points (upstream and downstream) with abrupt change of colour at midway.

the main design/format of the draft map-viewer was maintained. A specific request from NMCG to ESRI is required to initiate the modification.

B. Performance of STPs/ demonstration of implementation success

Only some aggregated information on STPs was available from CPCB's evaluation reports. Requests were made by Mr. Bhardwaj to CPCB for copies of raw data tables from monitoring at STPs but this was not received during the mission.

NMCG had developed a data-viewer based on technical-administrative data on new projects for STP construction or upgrade. In it's present form it has been designed for creating overview on planned, ongoing and recently completed projects and is functioning as a planning tool for follow-up on project progress.

To do: The underlying data have the potential for additional use in projection scenarios on future pollution load inventories from cities / towns/villages and STPs. Such projections can be made based on emission factors for the relevant wastewater treatment technologies to be installed in comparison with emission inventories for the current situation.

A. Display of industries

Some thematic GIS layers are already available, e.g., on towns, STPs, industries for direct displays as overlays to base maps from India WRIS. The corresponding pop-up windows are currently just reflecting all parameters in the underlying dataset and are not user friendly. A selection of the key parameters and addition of short, meaningful parameter names would improve the potential for any future public displays. This was explained and agreed to be part of the work to be done by NMCG on definition and documentation of all basic data tables.

Development of new map-viewers progressed and mock-up of possible displays of data for planning purposes were prepared and presented. The results are integrated in the attached power point presentation for the debriefing meeting (Annex-1).

Debriefing meeting

A debriefing meeting was held in the afternoon of 5 April at NMCG premises to summarise and discuss the main findings from the week in the presence of NMCG Director General Mr Rajiv Ranjan Mishra, Mr. Mathuria, Mr Ashok Kumar, Mr. Bhardwaj, and other NMCG colleagues working with their IT systems + GIZ PMU.

The proposed modifications to a draft map-viewer on river water quality developed by ESRI were well received and should be considered for implementation in continuation of the joint working session. In addition, a lively discussion took place on water pollution, in general, as well as more specific issues regarding access to and coordination with data available from CPCB and CWC, respectively. Also, the need for good metadata description of all datasets was outlined. This would facilitate the exchange of data and a more

consistent use of agreed data formats. Currently, there are several challenges concerning inconsistent data formats – this was well recognised and agreed with the NMCG IT specialists.

It was mutually agreed, that for a next mission, formulation of the specific objectives and exchange of relevant documents in advance would be an advantage in order for NMCG to allocate the staff resources required.

As a step in this direction, a draft Road Map for developing a Water Information System Ganga has been prepared in direct continuation of the joint working session.

Road Map for developing Water Information System Ganga (WISG)

The earlier commonly used term “dashboard” is being replaced by “water information system”. This shift was agreed during a parallel meeting on 5 April, where also a new Task Force for the Ganga Rejuvenation Project was established.

A ***Water Information System for Ganga (WISG)*** may have many similarities with the Water Information System for Europe (WISE) and several cross references are provided to serve as examples for inspiration – not intended for a 1:1 copying. A water information system contains several components, such as:

- Data sets / data tables with monitoring data and other relevant information
- Map viewers as display products for visualization of data sets as a communication tool
- Data viewers as display products, such as interactive, summarizing tables based on one or more datasets.

Below time-activity sheet provides a proposed way forward with consecutive steps for development of WISG. The table is also included as a separate annex for easier reading (Annex-2). The Road Map should be considered as a “living document” to be discussed among the stakeholders and adjusted when needed.

		Activity	April				May					June				July					August					September				Oct.	Nov.	Dec.
	Action by	week no.	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39				
1.1	NMCG	prepare data table definitions + documentation to serve as example		x	x	x																										
1.2	NMCG	assess current CWC data tables & map-viewers			x	x	x	x																								
1.3	CPCB, CWC	prepare data table definitions + documentation				x	x	x																								
1.4	NMCG, Dataset owner	cleanup of datasets / sharing cleaned datasets				x	x	x	x	x	x																					
1.5	ESRI (?)	develop NMCG WQ map-viewer modification			x	x	x																									
1.6	NMCG	integrating NMCG WQ map-viewer modification						x	x			x	x																			
2.1	NMCG	design and define new Water Information System Ganga (WISG) products								x	x	x	x	x	x	o																
3.1	NMCG	select candidate STP for success demonstration					x	x																								
3.2	NMCG	assess from several data sources time series data on impact						x	x	x	x																					
4.1	NMCG, CPCB	design and define STP data tables for CPCB (templates & metadata)					x	x	x																							
4.2	CPCB, NMCG	implement STP data tables with CPCB							x	x	x	x																				
4.3	CPCB	populate new STP data tables									x	x																				
4.4	NMCG	data validation										x	x																			
4.5	NMCG	implement new STP-related products within WISG											x	x	x	o																
5.1	NMCG, CPCB	design and define industry data tables for CPCB (templates & metadata)																	x	x												
5.2	CPCB, NMCG	implement industry data tables with CPCB																			x	x	x	x								
5.3	CPCB	populate new industry data tables																				x	x	x	x							
5.4	NMCG	data validation																								x	x					
5.5	NMCG	implement new industry-related WISG products																									x	o				
6.1	NMCG, GIZ PMU, EU Advisors,..	documents exchange, guidelines, advisory function					x	x	x	x	x	x	x	x					x	x	x	x	x	x	x	x	x					
6.2	NMCG, GIZ PMU, EU Advisors,..	planing for next Joint Work Session, setting objective, ensuring allocation of time and space resources												x	x	o										x	x	o				
		Potential future activities:																														
(7.1)	CPCB, NMCG	establish NMCG access to CPCB near real-time data																											x	x		
(7.2)	NMCG	assess river monitoring near real-time data for RBM planning purposes																												x	x	
(7.3)	NMCG, STPs	review potential for "crowd sourcing" with influent/effluent data from STPs												x	x	o	x	x														
(7.4)	NMCG, STPs	design and define new data sets based on STP "crowd sourcing"																			x	x	x	x								
(7.5)	STPs , NMCG	populate new STP "crowd sourcing" data tables																							x	x	x	x				
(7.6)	CPCB, NMCG	compile existing data on emissions from STPs industries and major drains																											x			
(7.7)	NMCG, CPCB	analyse and assess the emission data for derivation of emission factors																												x		
(7.8)	NMCG	compile load inventories for current situation																												x	x	
(7.9)	NMCG	compile load inventories for projected future scenarios																												x	x	

Table 1. Proposed Road Map with time-activity sheet for development of WISG (full size in Annex-2)

Description of the activities

The content of the activities is further outlined in below sections:

1.1 Prepare data table definitions + documentation to serve as example/ template

During the joint work session it was informed that there were technical problems with some of the data sets, including copies of some received from CPCB. Also some of NMCG's own data sets could be improved in terms of metadata descriptions (data about the data) and choice of parameter names to facilitate some direct uses in visualization products for communication to public end-users. It is therefore proposed to start the forward-looking work with a closer review on the current data sets owned and maintained by NMCG. For each data table in data sets for both river water quality and for environmental pressures (emission loads from pollutant sources) it is important to have strict definitions of parameter names/codes, the data formats, and the meaning of the parameters where needed. Also, additional explanatory remarks may be included in the data table definitions, similar to the current practice. Examples on the documentation of such data definition tables are available from WISE (i.e., from all the datasets which are available from "Waterbase" (link) holding regular reporting information by EU Member States to the European Commission or the European Environment Agency (EEA)). The data table definitions in Waterbase all use the following layout:

- FieldName: the exact code name used for the parameter in the data set
- Definition: the meaning of the parameter explained in descriptive text
- Note: any comment added to clarify circumstances or assumptions
- DataType a strict indication of the data format to enable machine reading

An example may illustrate the usefulness of descriptive metadata to improve the understanding of the content of a data set.

- Biochemical Oxygen Demand (BOD) is worldwide a very commonly used parameter to quantify oxygen depletion, which potentially may occur in receiving waters.
- It a common practice in India to use $BOD_3(27)$, referring to 3 days incubation at 27 ^oC (ref. Mr. Bhardwaj, personal communication)
- It is common practice in, e.g., European countries to use $BOD_5(20)$, referring to 5 days incubation at 20 ^oC.
- This difference may not represent a problem for direct comparisons, probably giving similar results for the same samples, however, it should be clear from the metadata descriptions which references apply.
- For STP effluent samples, there may, however, be another analytical issue since total BOD is typically used in India, whereas, e.g., the EU Urban Waste Water Treatment Directive (UWWTD) refers to $BOD_5(20)$ without nitrification (obtained by adding ATU (allyl thiourea) for inhibition of nitrification). In consequence, the interpretation of BOD from STP effluents is stricter in India than similar in the UWWTD.
- Related to data table definitions, this could be solved by including
    - FieldName: BOD
    - Definition: Biochemical Oxygen Demand (ref. to analytical method)
    - Note: Total $BOD_3(27)$ – 3 days incubation at 27 ^oC without inhibition of nitrification
    - DataType: Numerical (e.g., specifying decimal notation)

The data definition tables should also specify which parameter fields are mandatory and which are optional for filling in. As an example, the station ID and sampling date will be mandatory fields, whereas measured parameter values (BOD, temperature, flow..) may be optional in case of missing values or not being included in the monitoring programme.

The data definition tables should be prepared and documented by the data owner institution. It is proposed that NMCG will initiate this activity on own datasets and this may hereafter serve as examples for other institutions to prepare similar documentation.

1.2 Assess current data tables and map-viewers

Several data sets exist already and it is not the issue to change the content and parameter naming of these but rather to prepare a consistent documentation to facilitate the sharing of data, give transparency and to harmonise the data formats in a way that enables computer-based reading and analyses of the data.

NMCG will in dialogue with CWC and CPCB assess the current CWC and CPCB data tables and map-viewers and decide if modifications are needed. In this process, short parameter names which are suitable for appearance in pop-up windows for public display will be considered.

1.3 Prepare data documentation for the database

Based on the template developed by NMCG, similar table definitions will be prepared by CPCB and CWC, respectively for their own data sets with corresponding documentation. In particular for data sets to be shared among more institutions, it is important to have good metadata descriptions to enhance the understanding of the content and to facilitate routines for checking if the dataset complies with the data specifications.

If different formats are used, e.g. for date (dd.mm.yyyy ; mm.dd.yyyy ; dd/mm/yyyy; dd Feb YYYY, ..) and time formats (19:15; 7:15 pm, ..), a merged data set will collapse for machine reading of the time stamp. It is important to note that uniformly formatted database is a foundation for design of a sound and competent information system.

1.4 Cleanup of datasets / sharing cleaned datasets

NMCG and the relevant data set owners will make a cleanup of own data sets in order to be consistent with the data table definitions.

In this process, the use of "logical rules" – criteria to be met by the monitoring data – may be useful to identify any outlier values. Example of a logical rule could be absolute min. or max. values for the parameters, e.g. for dissolved oxygen that $0 \leq DO < 20$ mg/l O_2 , or could be relative, e.g. for chemical versus biochemical oxygen demand that BOD < COD. The criteria used should be documented and transparent – they should not be used to exclude high, but realistic values from the data set but used to exclude data errors (e.g., caused by wrong units) or to flag high/low data values, which could be subject to checking of the data validity.

The IT methodology for how to share the cleaned datasets should be arranged between NMCG and the data set owners. This could range from simple exchange of copies of updated data sets to the use of "linked data", where any update conducted by the data owner, automatically will be transferred to NMCG via links.

1.5 Develop NMCG WQ map-viewer modification

The agreed modification of the current map-viewer on river water quality developed by NMCG with technical support from ESRI should be encoded into the product. It would be logical that ESRI will do this in continuation of the work already completed, however, it is for NMCG to decide which IT consultants should be used and to make the request.

1.6 Integrating NMCG WQ map-viewer modification

Once the new coding has been developed, this should be installed at NMCG into the current data sets. This may be needed in 2 steps: first to enable the correct reading of parameters and displays and, secondly, to observe if a cleanup of data sets will result in different performance of the product.

2.1 Design and define new Water Information System Ganga (WISG) products

In consequence of establishing the Task Force under the Ganga Rejuvenation Project with several stakeholder organizations represented under the leading role of NMCG, it is proposed to consider, design and define specifications what end-user products should be developed as part of a new Water Information System Ganga (WISG).

This may include map-viewers, data-viewers, indicators to monitor progress, other visualization products. It is also under this activity that data policy may be discussed, e.g., to define the availability of the underlying data to which stakeholders and at which aggregation level.

Some proposals for content of map-viewer for river water quality and for performance and characteristics of STPs, respectively, were shared in advance of the joint working session.

3.1 Select candidate STP for success demonstration

It was agreed during the joint working session that it would be motivating for the communication to the public as for investments in environmental technology to display some cases where installation of a new STP or upgrading of an existing has led to significant improvements of river quality. It would be most likely to find such motivating case with the combination of relatively large wastewater emission to a river with relatively small flow. For the same reason, it may be difficult to observe on a short-term basis for the main stem of River Ganga – it is more likely to find such situation in contributory rivers/tributaries with towns on their banks.

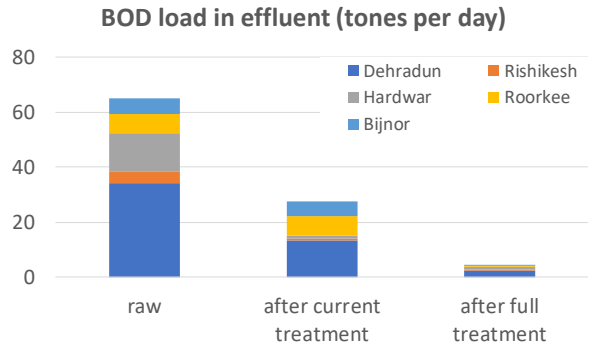
3.2 Assess from several data sources time series data on impact

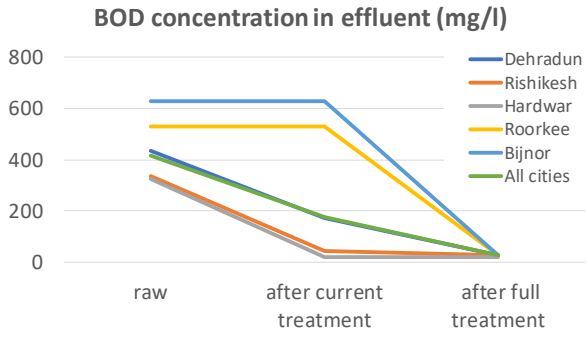
It is proposed to use the NMCG data sets on sanitation infrastructure projects as a starting point and combine with time series of water quality from downstream monitoring stations. It is likely that stronger impacts in reduction of faecal coliforms rather than reduction of BOD may be observed.

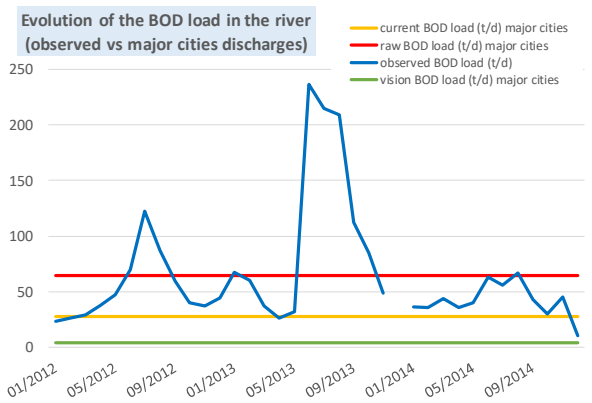
For the selected candidates, mass balance calculations may support the observations – this will require access to data on flows both from the STPs and from the river around the discharge point.

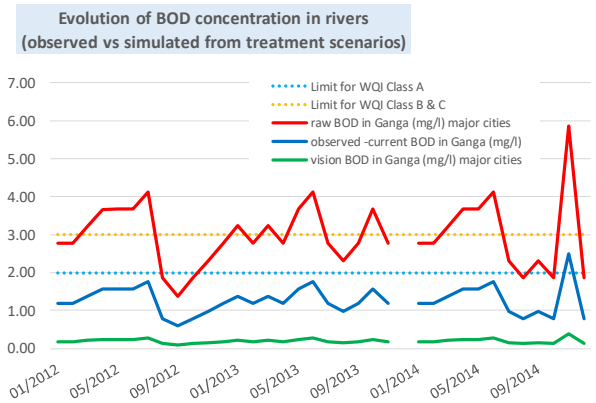
A simple exercise is included in the debriefing presentation under the following premises:

- Scope includes major population centres (class I and II cities) discharging into Ganga upstream the CWC monitoring station at Garhamukteshwar. Water quality data available and flow data provided by NMCG under strict confidentiality.
- Generation of BOD has been estimated assuming 60 gr/inhabitant/day for population (Census 2011).
- Status of STPs and volume of sewage discharge from previous IEWP work based on CPCB reports. To be updated.
- Load reduction estimated from typical rates derived from Performance evaluation of STPs funded under NRCD (CPCB 2013). Of course, more robust analysis would be possible if influent and effluent datasets are available for relevant pollution components.









More robust analysis could be made by using water quality modelling tools

4.1 Design and define STP data tables for CPCB (templates & metadata)

This activity relates also to activity 1.3 but here it refers to any new data tables required to create the WISG products defined. With lead from NMCG this should take place in dialogue with CPCB.

It is recommended to build upon existing content in data sets owned and maintained by CPCB but that all extensions or modifications needed will be documented to the same level as defined in activity 1.1. New tables may also include data to characterize the load from agglomeration, population, connection rate, area served by sewers, etc. This will facilitate the derivation of emission factors to be used for planning purposes.

During the mission, a database (ST_Dashboard.xlsx) including Ganga STPs and major cities was provided to NMCG Team. This database was designed and populated in -months?? of 2017 in the framework of IEWP and can be used as starting point for the design of the future (NMCG owned) inventory of STPs in the Ganga Basin. The document *Description of the main worksheets of the database file* is provided as Appendix 4 (ST_Dashboard.docx).

Some recommendations can be made when designing the final data tables:

- The compilation of all the information available under a common structure (database), avoiding dispersion among users, multiplication of versions with inconsistent information, as well as facilitating the generation of illustrations and reports always updated.
- The establishment of a single code per plant to avoid confusion - use of different names or spellings, discrepancies in the treatment technology (new STP or change of system?), discrepancies in size (different STP or extension? - and will ensure the traceability of data.
- The differentiation of "static" data from dynamic data such as quality monitoring.

4.2 Implement STP data tables with CPCB

CPCB will implement the new data tables in their existing IT structure according to the specifications from the templates and metadata. Any new logical rules for self-check of the data may be applied to facilitate the creation of clean data sets.

The role of NMCG will be to arrange for the sharing mechanism for easy transfer by copying of updated data sets or by direct reading in the data sets via linked data.

It must be mentioned that different datasets were provided to the GIZ Team during the mission, both in excel and dbf/shp formats. The information included in these files should be used to complete / review / update the former database on status, size and technology of STPs through NMCG, also incorporating the new facilities.

More data have been provided by NMCG that should be integrated. In fact, an interactive dashboard has been already launched to present the progress of the Namami Gange Programme regarding implementation status of the measures and the investment. Graphs to show the impact of STPs in terms of pollution reduction are also prepared but apparently not populated so far with actual data.

4.3 Populate new STP data tables

CPCB will populate new data tables with monitoring data from SPCBs and own measurements, respectively, and labelled accordingly.

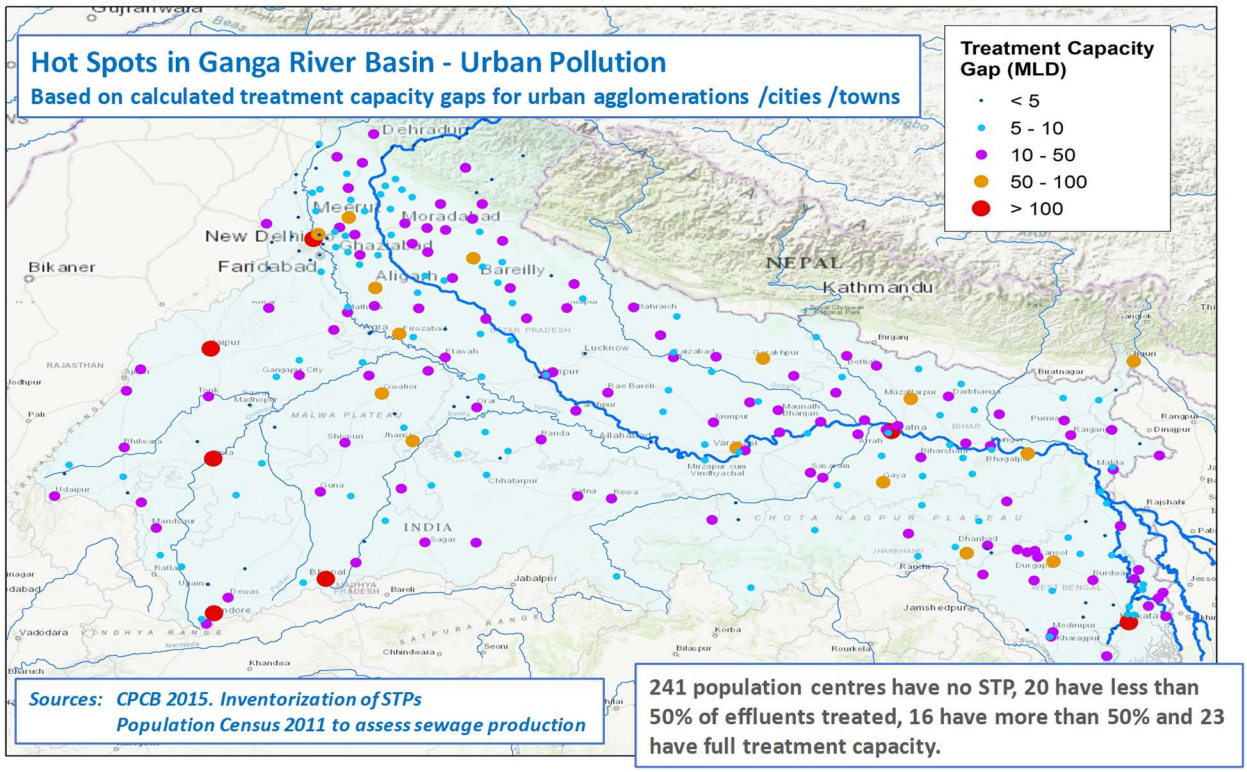
4.4 Data validation

NMCG will conduct a validation of the data to be used in WISG products including compliance with defined logical rules, completeness of mandatory parameter fields

4.5 Implement new STP-related products within WISG

NMCG will implement new STP-related products within WISG based on current new validated data tables.

One example of the products that might be included is the urban pollution hotspots map that was developed from the information of the IEWP database by identifying the population centres with higher sewage treatment gap.



5.1 – 5.5 Data tables and WISG products for industries

This block of activities related to emissions from industries are very similar to the described activities 4.1-4.5. It should be recognized that the characterization of industries by branches, type of production, codes from trade statistics, sizes, etc. is more complex than for STPs. However, results from monitoring programmes, IT related work of table definitions and metadata are the same.

6.1 Documents exchange, guidelines, advisory function

Throughout the work process for development of the WISG, the GIZ Planning and Management Unit (PMU) supported by EU advisors are prepared to cooperate with NMSG and other relevant stakeholder organizations.

This includes exchange of relevant documents and guidelines as well as supporting in an advisory function during progress of the work. Also meetings, tele-meetings, and e-mail communication should be practiced on a regular basis. The GIZ PMU and EU advisors may also give feedback to draft documents, data sets, WISG products, etc. as support between missions.

6.2 Planning for next Joint Work Session

The joint working session 1-5 April is considered a very useful format of cooperation during missions of the EU advisors; however, the outcome may be further enhanced by more specific objectives setting for the sessions in advance along with advance exchange of available, relevant documents, e.g., about 2 weeks in advance of a session. This may also facilitate the allocation of time and spaces resources well in advance.

7. Potential future activities

Some potential future activities going beyond the direct scope of developing WISG have been listed in the following sections

7.1 Establish NMCG access to CPCB near real-time data

CPCB owns and operates in total about 50 river monitoring stations operating in the Ganga main stem and in the Yamuna River, Each station delivers near-real time data – some up to 17 parameters, simultaneously. A server harvesting the near-real time data is feeding results into a kind of map-viewer (rotating slide show with most recent data) with public display from the CPCB platform (link) .

At present, the data are used for this purpose, however, there is a potential for conducting further statistical analyses such as time series, frequency analyses and cross-relations between parameters.

A first step would be to enable ready access for NMCG to the server holding the near real-time data. Since the amount of data stored is considerable (almost one value/logging per minute for all parameters for all stations) it is probably more feasible to keep data on only 1 server but with password protected access to more than one user organization.

It should be discussed between CPCB and NMCG if there is a preparedness to share access to the data and which data policy should apply. If positive, the most feasible technical solution should be identified and established; at earliest.

7.2 Assess river monitoring near real-time data for RBM planning purposes

The proposed additional use of the data goes beyond a compliance assessment of which stations meet which standards for water quality and how often. Instead it may provide insight in long term trends for the individual parameters as well as typical, diurnal, weekly, seasonal and annual variations. Also frequency of any irregular occurrence of extreme events, e.g., in pH due to industrial releases may be detected and assessed if these represent general, significant problems or not.

Such basic data analyses and assessments may form a technical sound basis for policy interventions at river basin scale.

7.3 Review potential for “crowd sourcing” of STP data

During the meeting on February 22, 2019 between NMCG and GIZ PMU and EU environmental Advisor, Mr. Mathuria proposed to make use of data from STP operators – in addition to data from CPCB/SPCB on compliance assessment and investigative monitoring,.

It is proposed to investigate this further since several (especially big) STPs have own laboratories and conduct routine analyses of influent and effluent as an integrated part of STP operation. Such monitoring data may be a very useful source of information – even if analysed by simpler quick test methods – since they normally are much more frequent than the sampling for compliance assessment purposes.

If positive, this would represent a data source based on voluntary sharing from the STP side with the objective of improving the estimates of incoming pollutant loads as well as loads to the river from treated effluents.

It is proposed to include a visit to one of the big STPs in Delhi in connection with next joint working session to review the potential for such "crowd sourcing".

7.4 Design and define new data sets based on STP "crowd sourcing"

In principle, the monitoring data based on "crowd sourcing" are similar to other data from compliance monitoring, however, it is recommended to keep them separated due to different data ownership and possibly different analytical methods being applied. The same practice for table definitions and metadata as well as check of data quality via logical rules as for other monitoring data should apply.

7.5 Populate new STP "crowd sourcing" data tables

The STPs that are ready to share their data on influent and effluent water quality and quantity will be responsible for populating the data tables. It is proposed that the SPCBs are being kept informed of such parallel data flow – and should be aware that the data are not intended for compliance assessment.

7.6 Compile existing data on emissions from STPs industries and major drains

In river basin management planning, it is essential to obtain overview of pollutant loads to receiving waters (environmental pressures) and thereby obtain overview on source proportion for relevant pollutants. Since policy interventions are often targeted per sector, it is important to know the relative contributions from various sectors – and their expected environmental impacts - before considering regulations on emission load reduction.

As monitoring for compliance assessment often focuses on water quality, it is essential for addressing pollutant loads that the corresponding flows at time of sampling are recorded. This is in particular important for monitoring of drains before, during and after monsoon season as the flows will vary significantly.

It is proposed that the compilation of existing emission data is conducted by the data owners and that CPCB provides compilations of the existing data for sharing with NMCG –dialogue with NMCG underway.

7.7 Analyse and assess the emission data for derivation of emission factors

Once the emission data have been compiled into data tables, they should be analysed and assessed for turning into load inventories. It is not straightforward to calculate, e.g., monthly or annual (average/representative) loads based on single measurements of water flow and pollutant concentrations, so a coordination / harmonisation of estimation methodology is required. It is proposed that NMCG takes a coordinating role on this with reference to the Task Force under the Ganga Rejuvenation Project.

In order to be able to extrapolate the load estimations from the point sources monitored, normalization of the emission data is required to obtain emission factors. For STPs this could e.g. be by population connected to the STP, for manufacturing industries, e.g., be by production volume for the main product(s), and for main drains, e.g. by local catchment area for the drain.

7.8 Compile load inventories for current situation

Pollutant load inventories can be established by emission data from monitoring of the major sources supplied by load estimations based on emission factors for the remaining sources, including untreated wastewater. It is important to aim at inventories including all emissions – even that some are less accurate than others.

As an example, if untreated wastewater is not included in the inventory due to lack of direct monitoring, one would get a false impression when establishing a STP. In this case the loads from treated effluents would increase – whereas the much larger decrease in loads from untreated wastewater and thereby reduction in total emission loads would not be acknowledged.

It is proposed that the compilation of total load estimations from all significant sources is conducted by NMCG as a central element in the overall river basin management planning for the Ganga River Basin.

7.9 Compile load inventories for projected future scenarios

Similar exercise should be conducted, also by NMCG – as part of the policy making process – for projected future scenarios. These may include measures for pollution abatement (new STPs, upgrading of existing capacity and/or improved treatment technology) as well as increased pressures (population growth, increased industrial production, ..).

This activity – combined with calculation of imposed economic costs and expected environmental impacts is crucial as input to the completion of a river basin management plan.

Annexes:

1. Power-point presentation of debriefing meeting
2. Road map for development of Water Information System Ganga (WISG)
3. Map viewer proposals

   A. Surface water quality map-viewer proposal

   B. STP map-viewer proposal

4. ST_Dashboard - Description of the main worksheets of the database file (Ganga STPs, population in cities and towns,..)

Support to NMCG and cooperating institutions in building water quality dashboards

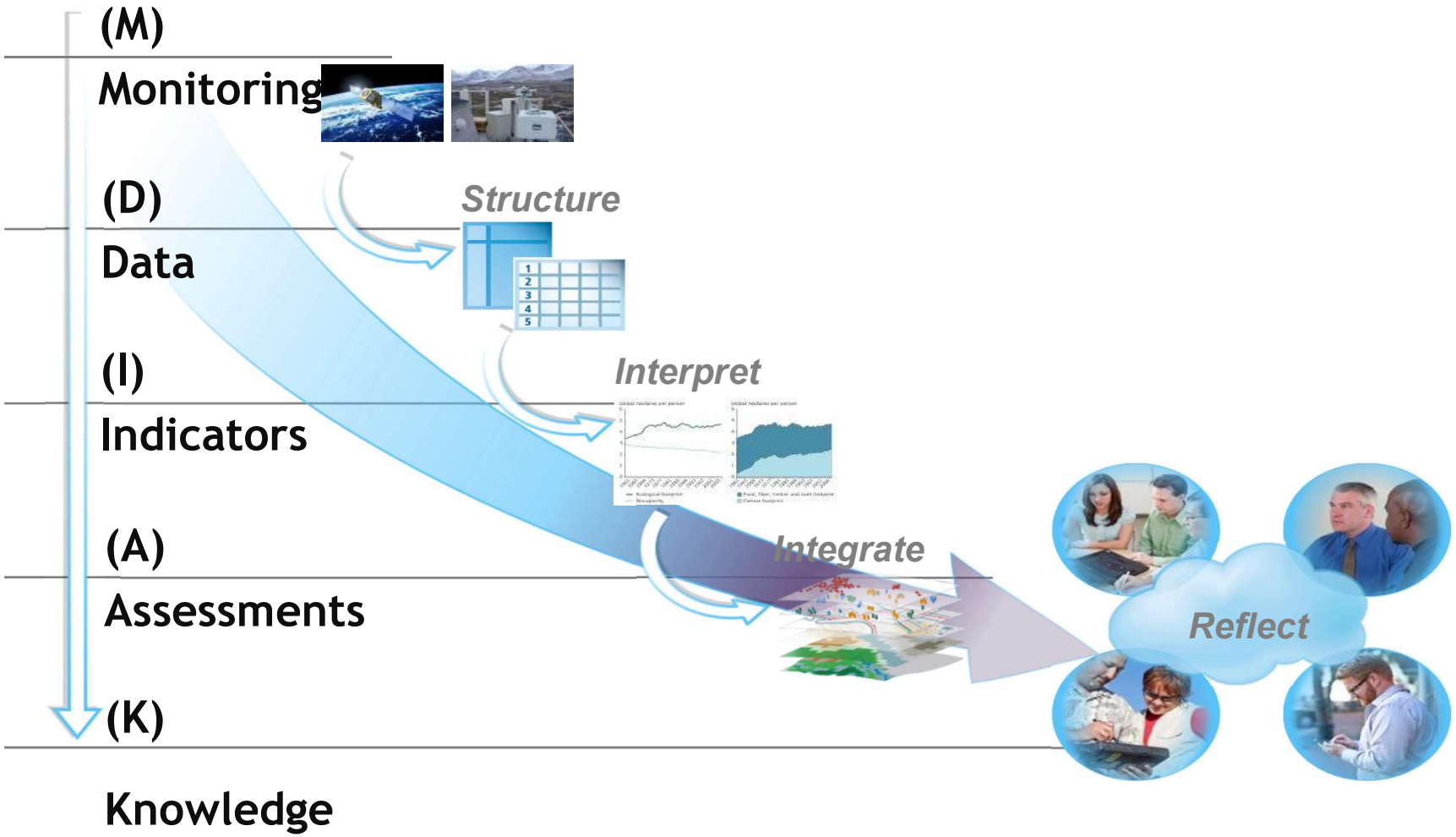
Immediate outcome of working together at NMCG 1-5 April 2019

Bo Jacobsen, former European Environment Agency (EEA) (boneergaardjacobsen@gmail.com)

Carlos Benitez Sanz, INTECSA-INARSA,S.A (carlos.benitez@intecsa-inarsa.es)

The MDIAK Information Chain

- monitoring data need to be processed and interpreted to provide useful input to decision making



Based on slides from Thomas Henrichs, EEA – prepared for Integrated Environmental Assessments - EEA West Balkan Summer School 2013

Introduction - remarks

- A very good opportunity to work together in-house
  - Facilitates discussions and understanding of the current status on data availability and dashboard products already existing / in progress
  - Accelerates access to relevant documents and datasets
  - Allows testing of ideas/concepts directly with NMCG IT infrastructure
- Feeling very welcome, well taken care of but staff time allocation not so easy
  - a matter of priority among several tasks and requests
- Have obtained a much better understanding of the current situation(s) concerning underlying :
  - data generation, reporting into datasets, sharing across institutions, building NMCG database in support of dashboards

Overall achievements

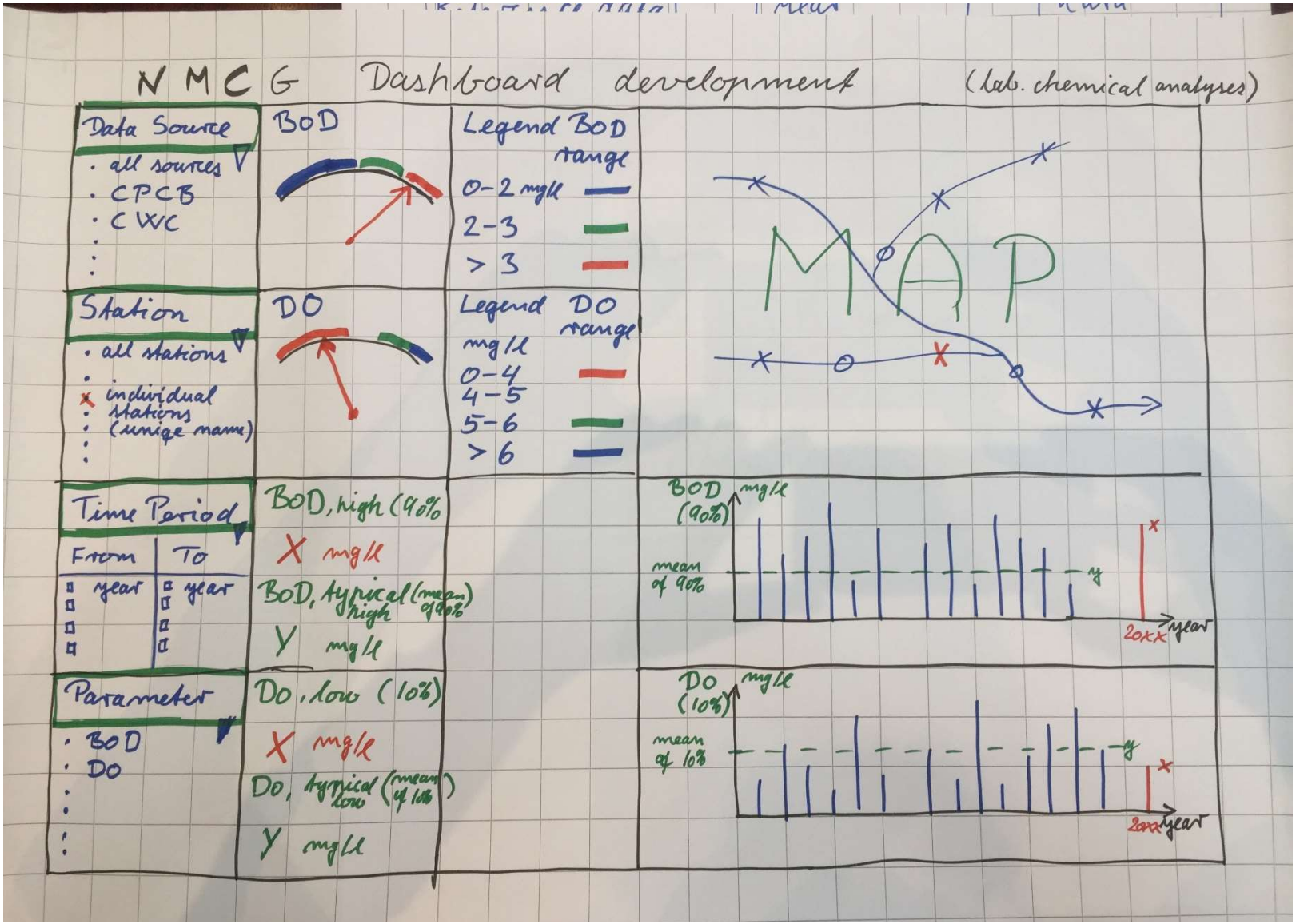
- Draft NMCG dashboard on river water quality has been reviewed and proposals for modifications have been specified
  - ready to be implemented via IT support contract (ESRI)

- Current GIS reference (static) and thematic (dynamic) layers available at NMCG have been discussed and useful combinations (overlays) selected for presentation by NMCG
  - Current pop-up information reflects underlying dataset parameters in a raw form
  - Potential to customise these for more user friendly display of parameters

- Examples of integrated use of the crosscutting data available for river water quality & flow and STP effluent quality & flow illustrate the added value of collected data beyond use for compliance assessment

- Based on disussion of several IT management strategic considerations it is recommended that:
  - immediate efforts are made for preparation of documentation for current and future datasets (clear definition of tables, parameters and formats)
  - In design of dataset parameter names, their use in pop-up windows is foreseen to be understandable
  - clean-up exercise to be conducted for some datasets to be used by NMCG

Snapshot of NMCG dashboard modification



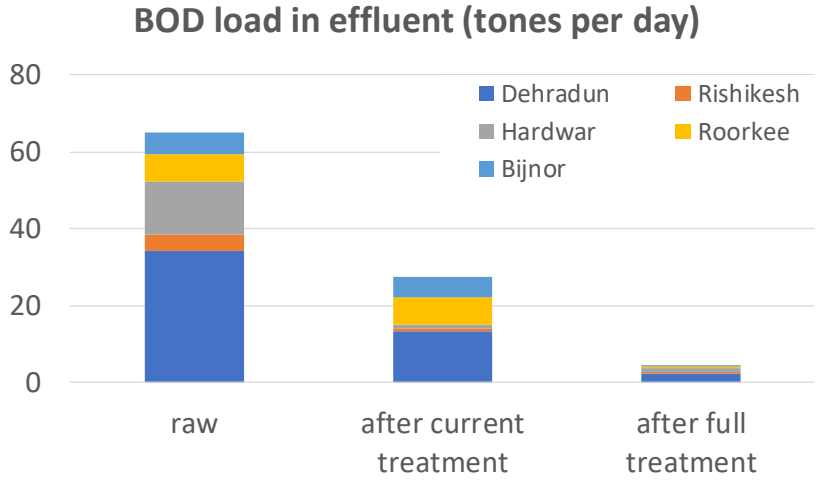
Presenting the impacts of STPs in water quality quality

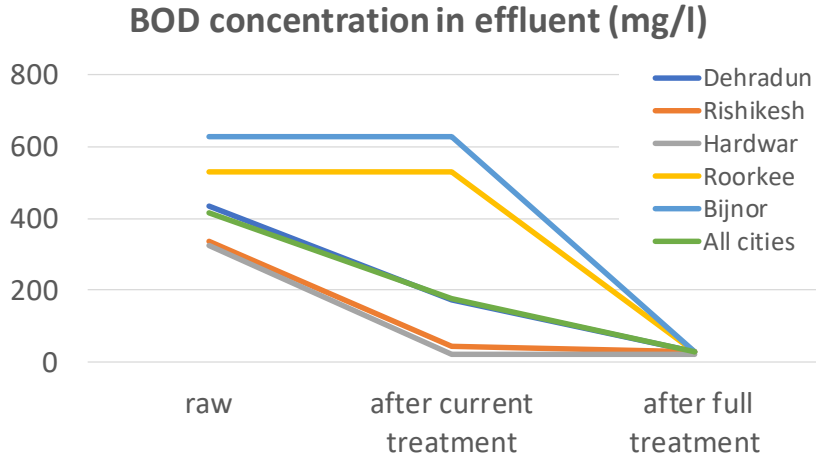
Objective

Possible illustrations of positive impact of STPs through the expected reduction of pressures and the associated improvement of the quality in receiving waters. Data on quality of influent and effluent of STPs not available so methodological approach based on available data has been used.

- Scope includes major population centres (class I and II cities) discharging into Ganga upstream the CWC monitoring station at Garhamukteshwar. Water quality data available and flow data provided by NMCG under strict confidentiality.
- Generation of BOD has been estimated assuming 60 gr/inhabitant/day for population (Census 2011).
- Status of STPs and volume of sewage discharge from previous EIWP work based on CPCB reports. To be updated.
- Load reduction estimated from typical rates derived from Performance evaluation of STPs funded under NRCD (CPCB 2013).

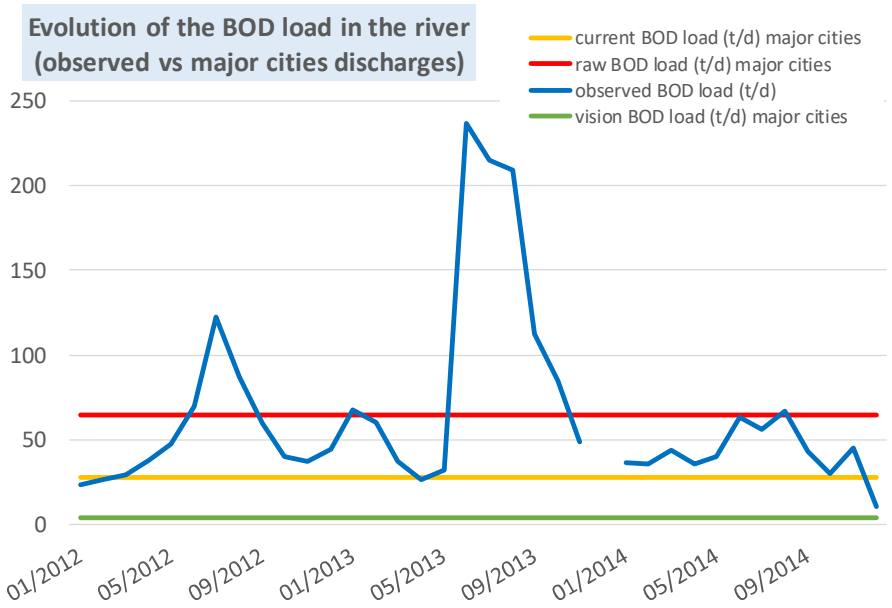
Assessing the reduction of pressures

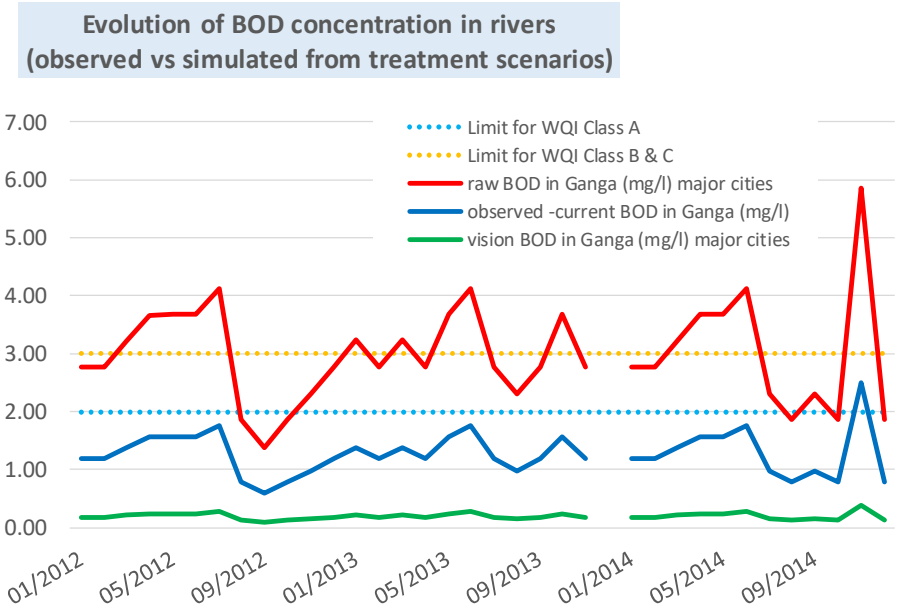




Robust analysis and demonstration of positive effect is possible if influent and effluent data sets are available for relevant pollution components.

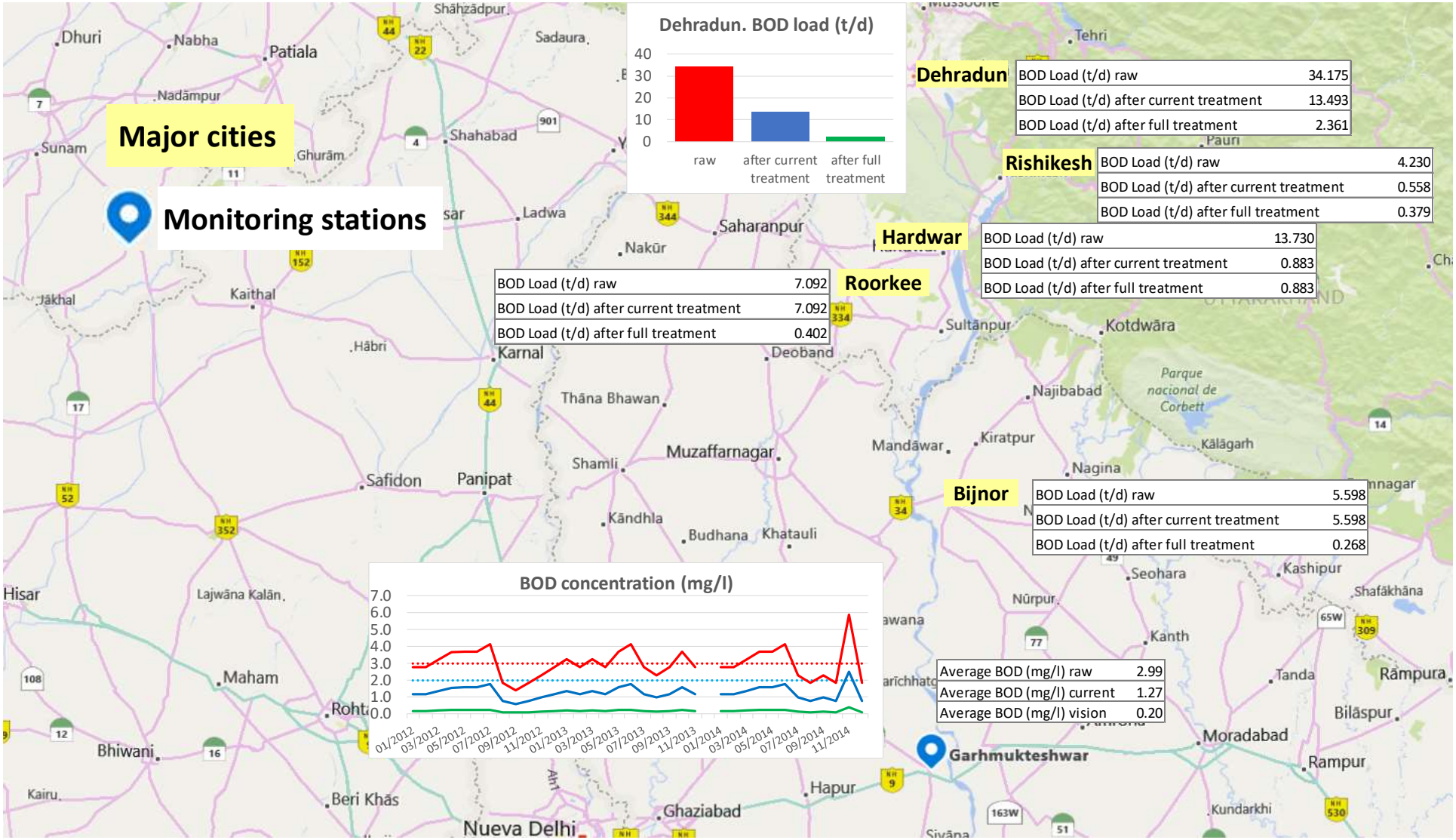
Impact on river water quality





First approach for presentation the impact of different scenarios regarding STPs implementation. Analysis of real impact would need more information on other pollution sources and modelling self-depuration in the river.

Spatial scope and visualization



Identified limitations

- 2018 STP Performance Evaluation report from CPCB
  - Internal summary extracts are available where actions are needed
  - Full report with performance data for all STPs is not available from CPCB
- Data on effluent quality is only available in text reports and not in, e.g., excel datasets
  - Would facilitate data management significantly
  - Influent data would characterise connection rates and typical pollutant loads
- Several data format errors in CPCB datasets for river water quality disable reading of numerical data
  - e.g. date formats
- Data on river flows on dates for water quality sampling are rarely available
  - Would otherwise enable the calculation of pollutant fluxes as important part of mass balances and quantification of pressures

Next steps (1)

- The agreed modifications of NMCG WQ dashboard, should be implemented as an integrated product in NMCG reading in NMCG datasets.
- All existing and future datasets should have a data table definition document:
  - Specifying the parameter codes, explanatory names, data format and any clarifying comments
  - Enabling automatic QA/QC routines for data validation
  - Facilitating data sharing among stakeholders
- The most important datasets should be cleaned according to the specifications
  - Enabling the use in dashboard products
- Candidate STP(s) with recently established/upgraded treatment technology and downstream river station with good monitoring data time series should be shortlisted
  - To illustrate success cases where STP investments have resulted in documented reduction of effluent pollution loads (pressure) and/or environmental improvements

Next steps (2)

- Work towards a Ganga Water Information System (GWIS) for decission support
  - Basin wide approach and overview for planning and management
- Recommend the establishment of a Task Force
  - NMCG (lead, planning/management, GIS/IT),
  - CWC, CPCB,NHP,…
  - EU advisors, IEWP/GIZ PMU

Roadmap

Development of Water Information System Ganga (WISG) **Draft fill-in** v2.1

	Action by	Activity / week no.	April				May					June				July					August					September				Oct.	Nov.	Dec.
			14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39			
1.1	NMCG	prepare data table definitions + documentation to serve as example		x	x	x																									
1.2	NMCG	assess current CWC data tables & map-viewers			x	x	x	x																							
1.3	CPCB, CWC	Prepare data documentation for the database				x	x	x																							
1.4	NMCG, Dataset owner	cleanup of datasets / sharing cleaned datasets				x	x	x	x	x	x																				
1.5	ESRI (?)	develop NMCG WQ map-viewer modification			x	x	x																								
1.6	NMCG	integrating NMCG WQ map-viewer modification						x	x			x	x																		
2.1	NMCG	design and define new Water Information System Ganga (WISG) products								x	x	x	x	x	x	o															
3.1	NMCG	select candidate STP for success demonstration					x	x																							
3.2	NMCG	assess from several data sources time series data on impact						x	x	x	x																				
4.1	NMCG, CPCB	design and define STP data tables for CPCB (templates & metadata)					x	x	x																						
4.2	CPCB, NMCG	implement STP data tables with CPCB							x	x	x	x																			
4.3	CPCB	populate new STP data tables									x	x																			
4.4	NMCG	data validation										x	x																		
4.5	NMCG	implement new STP-related products within WISG											x	x	x	o															
5.1	NMCG, CPCB	design and define industry data tables for CPCB (templates & metadata)																	x	x											
5.2	CPCB, NMCG	implement industry data tables with CPCB																		x	x	x	x								
5.3	CPCB	populate new industry data tables																				x	x	x	x						
5.4	NMCG	data validation																								x	x				
5.5	NMCG	implement new industry-related WISG products																									x	o			
6.1	NMCG, GIZ PMU, EU Advisors,..	documents exchange, guidelines, advisory function					x	x	x	x	x	x	x	x					x	x	x	x	x	x	x	x	x				
6.2	NMCG, GIZ PMU, EU Advisors,..	planing for next Joint Work Session, setting objective, ensuring allocation of time and space resources												x	x	o										x	x	o			
		Potential future activities:																													
(7.1)	CPCB, NMCG	establish NMCG access to CPCB near real-time data																											x	x	
(7.2)	NMCG	assess river monitoring near real-time data for RBM planning purposes																												x	x
(7.3)	NMCG, STPs	review potential for "crowd sourcing" with influent/effluent data from STPs												x	x	o	x	x													
(7.4)	NMCG, STPs	design and define new data sets based on STP "crowd sourcing"																			x	x	x	x							
(7.5)	STPs , NMCG	populate new STP "crowd sourcing" data tables																							x	x	x	x			
(7.6)	CPCB, NMCG	compile existing data on emissions from STPs industries and major drains																											x		
(7.7)	NMCG, CPCB	analyse and assess the emission data for derivation of emission factors																												x	
(7.8)	NMCG	compile load inventories for current situation																												x	x
(7.9)	NMCG	compile load inventories for projected future scenarios																												x	x

Intro remark:
The format of this draft document has been prepared similar to the WRIS document: "PROPOSED DASHBOARDS – INDIA STATES' WRIS" from National Hydrology Project Office.

1.x Map-viewer Dashboard for Surface Water Quality - rivers

1.x.1 Purpose of the dashboard

The purpose of the dashboard is to inform the public user - including laypersons, water use stakeholders, water specialists and policy/decision makers - on the status of water quality as outcome of monitoring programmes.
This dashboard aims at providing the user with overviews as well as options for further details for display of results from regular monitoring programmes. The results reflect the individual parameters measured in the monitoring programmes as well as a grouping into water quality index categories for corresponding water uses.
The purpose of containing both overview information as well as further details for the more experienced user in the same map-viewer is obtained by displaying a layer with summarised information for optional geographical units when looking at low zoom level, whereas individual monitoring stations appear at higher zoom levels and further details can interactively be shown in pop-windows.
The map-viewer is designed to be applicable for all river basins in India, however, a stepwise implementation is foreseen. Both the main river stretches as well as contributory rivers should be included.

1.x.2 Data computation methodology

For each data record (set of parameter values per sampling per monitoring station), the corresponding water quality index category is calculated – similar to the current practice for the CPCB dashboard (link) for drinking water vs. bathing water, respectively. (optional selection of criteria for irrigation water could be considered)

For each monitoring station and for each parameter, a set of basic statistics are calculated for each calendar year (can be discussed if seasonality should be encountered), e.g. annual average, mean, std. dev., max. and min. values and these are stored in the underlying datasets as annual aggregated data along with corresponding number of observations.
pH is here exempted from the average, mean and std. dev. calculations.

For each geographical unit (state, district, river basin or sub-basin, respectively) pie chart statistics are calculated for the relative distribution of water quality index categories (% distribution of no. of stations in each category) for the time period selected. (for aggregation of individual water quality index categories into an annual value, a political/administrative discussion is required to reach an agreed assessment method (1 out – all out, or a more balanced approach, e.g. most frequent category occurring). The outcome will have impact on the "stringentness" in the assessment also considering whether 1 violation really has environmental impacts.)

1.x.3 GIS View

Low zoom level
The GIS view let the user visualize the monitoring results – aggregated overviews or station level results - geographically on top of other map layers. By default the view starts at India level map with all the states showing aggregated distribution of water quality index categories for drinking water; this is visualised as pie charts with number of stations meeting the category criteria per state. By default, the newest calendar year with acceptable data completeness should be displayed.
The user should be able optionally to select other calendar years or a layer with the newest individual data available from the data set. The user may also select other geographical units for the visualised aggregations, e.g. river basins or sub-basins.
When clicking on the pie chart in a geographical unit, a pop-up window will show a stacked bar diagram with no. of stations in each water quality index category for each of the calendar years in the underlying dataset.

High zoom level

Each monitoring station will be shown with a colour code corresponding the water quality index category or parameter value range and a legend shape reflecting the data provider / monitoring programme.
A thematic layer should be selected by the user from two groups:

- Water quality index category (optionally selected between drinking water purposes or bathing water purposes (irrigation water to be considered, too ??)
- Individual monitoring parameters (BOD, COD, coliforms, faecal coliforms, temperature, pH, …)

For the chosen thematic content and for the chosen time period (calendar year, latest measurement) the legend will reflect the category / range of measurement value and a pop-up window will show time trends for the same parameter.

1.x.3.1. Map Layers to be provided

Data Items ▪ Surface water quality station data

Time Frames Dynamic time stamp to see the quality data at station level for the selected time stamp; calendar years for aggregated annual values

Dynamic Layers

- Water quality station point data – both containing individual observations as well as annual aggregates for water quality index categories and for monitoring parameters (BOD, COD, nutrients, DO, temperature,..), respectively.
- Water quality geographical unit – annual aggregated data (generated per year per geographical unit and linked with geographical unit ID)

Static Layers

These are the layers already present in India WRIS system. They consist of base maps like DEM, Bhuvan, LULC and other satellite-based layers. In addition to base maps they consist of overlays like boundaries, rivers etc. These layers will be shown by organizing them into groups. The users can select or unselect based on their choice. Since there are more than 100 layers are present in India WRIS only select layers relevant can be shown here. Some of the relevant layers are boundary layers, DEM etc. Based upon the evolving user needs more layers from India WRIS can be added to the system.

Locations

Admin: State& District (vector boundaries & polygon shapefiles)
Basin: Basin & Sub-basin (vector boundaries & polygon shapefiles)
Monitoring stations (points, lat-long coordinates)

1.x.3.2. Features

Selection – low zoom level

(1) Click on a geographical unit:
i. Show the details of the geographical unit (state name & abbreviation, district name, river basin name, sub-unit name, geographical area (km^2)
ii. trend of the water quality index category

Selection – high zoom level

(1) Click on a station:
i. Show in pop-up window the summary details of the station (station ID, river name, station lat-long coordinates, data provider (CWPCB, SWPCB, CWC,..),
ii. Show in pop-up window trend of the variation of water quality of the station shown together with actual value for same parameter & time stamp for sample for actual value. Historical data to be shown as mean +/- std. deviation.

Legend
i. The legend colour should clearly show the water quality at each of the stations/ wells categorizing it as Class A/B/C/D/E/Below E
ii. The legend shape (e.g., circle, square, triangle,..) could indicate the data provider / monitoring programme (CWPCB, SWPCB, CWC,..),
Filter Specific timestamp to see water quality data at that point of time / chosen calendar year

1.x.3.3. Mockups

Examples of mock-up sketches is inserted below – hopefully, these can be better exemplified by GIZ IN office team / Carlos Benítez Sanz.

1.x.4 Reports and Analytics

1.x.4.1. State wise and District wise/Basin wise and Sub-basin wise and station wise water quality report

The user can select appropriate geography (Admin/Basin) and time stamp to generate the report that shows region wise water quality report. By default, all the states are shown. When a state is selected in the drop down all the districts in the selected state are shown.

Sample report looks as follows:
Surface water quality table
Sl.No. ; State; Station; Water quality class
Mockup xx: Station wise Surface water quality class

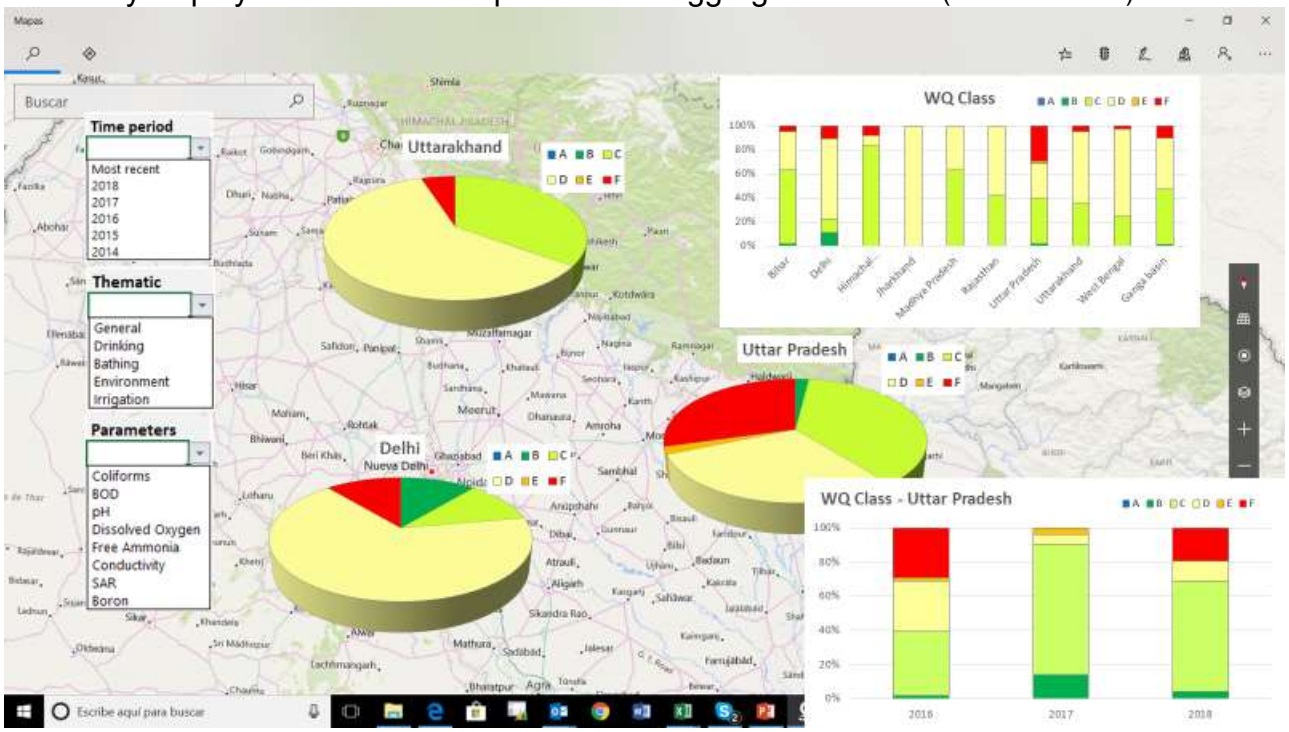
1.x.4.2. State wise and District wise/Basin wise and Sub-basin wise water quality summary report

The user can select appropriate geography (Admin/Basin) and time stamp to see number of stations falling in class A/B/C/D/E/Below E.

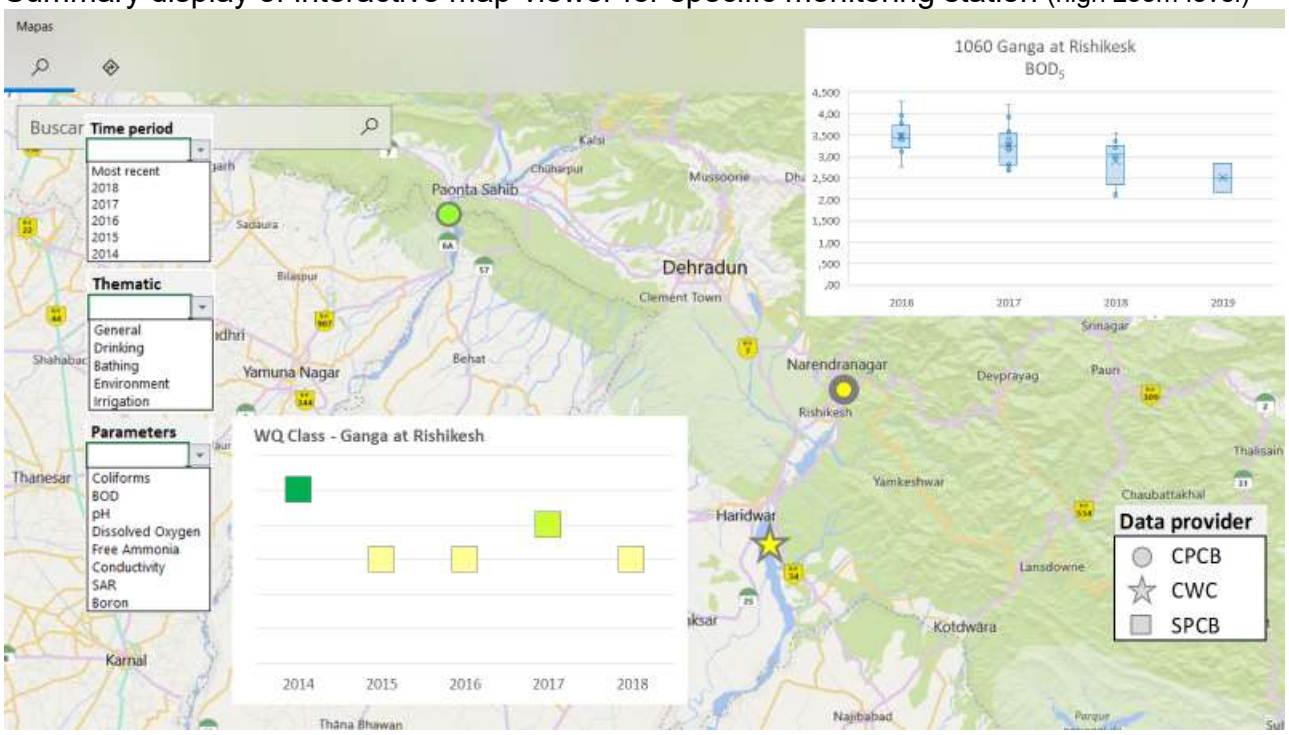
Surface water quality table – drinking water:
Sl.No. ; State; # A #B # C # D # E # Below E – no. of stations in each water quality index category
Mockup xx: Surface water quality data region wise summary – drinking water
Surface water quality table – bathing water:
Sl.No. ; State; #fit #unfit – no. of stations in each water quality index category
Mockup xx: Surface water quality data region wise summary – bathing water

Sketch for mock-ups

Summary display of interactive map-viewer for aggregated values (low zoom level)



Summary display of interactive map-viewer for specific monitoring station (high zoom level)



1.y Map-viewer Dashboard for Sewage Treatment Plants

1.y.1 Purpose of the dashboard

The purpose of the dashboard is to inform the public user - including laypersons, water use stakeholders, water specialists and policy/decision makers - on the current situation and already planned projects related to sewage treatment plants (STPs).
This dashboard aims at providing the user with overviews as well as options for further details for display of results from regular performance reports as well as selected in-plant control data maintained by the operator.
The purpose of containing both overview information as well as further details for the more experienced user in the same map-viewer is obtained by displaying a layer with summarised information for optional geographical units when looking at low zoom level, whereas individual STPs appear at higher zoom levels and further details can interactively be shown in pop-windows.
The map-viewer is designed to be applicable for all river basins in India, however, a stepwise implementation is foreseen. Both STPs along the main river stretches as well as along the contributory rivers should be included.

1.y.2 Data computation methodology

The core spatial unit for this dashboard is each individual STP represented as point (lat – long. coordinates) with both static attribute data and more dynamic performance attribute data.

- The static data are such as: unique ID no., STP official name, Plant owner, Plant operator, year of concession, treatment type, treatment technology, plant capacity,... The static data serve as a reference data set that only changed when changes are made to the plant, e.g., upgrade of technology or plant capacity.
- The dynamic data could, e.g. be organised as a dataset per calendar year and the actual data depend on the influent characteristics and on the performance of the plant. The dynamic data include: monitored influent flow , concentrations of pollutants and state variables (pH, temperature,..) as well as similar for the monitored effluent. The dynamic data may also include additional parameters of relevance for computations, such as power consumption, energy recovery, operational costs,..

The data computations include calculation of pollutant loads (multiplication of actual wastewater flow and corresponding pollutant concentrations) treatment efficiency (effluent as percentage of influent concentrations) and compliance status (comparison of effluent concentrations versus effluent standard concentrations – depending on the compliance assessment method), degree of treatment (annual flow balance for fully treated, partially treated, bypassed without treatment). A set of basic statistics are calculated for each calendar year (can be discussed if seasonality should be encountered), e.g. annual average, mean, std. dev., max. and min. values and these are stored in the underlying datasets as annual aggregated data along with corresponding number of observations; these basic statistics are only relevant if there are >1 set of monitoring data per calendar year.
Computations may also include normalisation of pollutant loads, e.g., related to no. of persons connected to the plant and thereby enabling comparisons and data analyses across different STPs.

It may be considered to include projections for specific STPs, i.e., a future situation with upgraded STP capacity, improved treatment technology, reduced emissions – based on already granted projects.

For each geographical unit (state, district, river basin or sub-basin, respectively) pie chart statistics are calculated for the relative distribution of no. of STPs in various treatment types, treatment technologies and compliance status; similar statistics will be computed based on actual loads to the (MLD) to the STPs, thereby giving a higher weight to big STPs.

1.y.3 GIS View

Low zoom level

The GIS view let the user visualize the monitoring results – aggregated overviews or station level results - geographically on top of other map layers. By default the view starts at India level map with all the states showing aggregated distribution of STP compliance status; this is visualised as pie charts with number of STPs meeting the compliance criteria per state. (It may be considered if the yes/no compliance indication should be extended with a category where non-compliance is due to missing data or if only minor violations occur) . By default, the newest calendar year with acceptable data completeness should be displayed.

The user should be able optionally to select other calendar years or a layer with the newest individual data available from the data set. The user may also select other geographical units for the visualised aggregations, e.g. river basins or sub-basins.

When clicking on the pie chart in a geographical unit, a pop-up window will show a stacked bar diagram with no. of STPs in each compliance category for each of the calendar years in the underlying dataset. The pop-up window may also include a link (URL) to the most recent published performance assessment report from State Pollution Control Board.

High zoom level

Each STP will be shown with a colour code corresponding the compliance category and a legend shape reflecting the data provider / monitoring programme.

A thematic layer should be selected by the user from two groups:

- Compliance status
- Actual performance in terms of wastewater concentrations or pollutant loads. Individual monitoring parameters (BOD, COD, TSS, coliforms, faecal coliforms, nutrients, temperature, pH, …), annual flow balance for the degree of treatment (full, partial, bypass).

For the chosen thematic content and for the chosen time period (calendar year, latest measurement) the legend will reflect the category / range of measurement value and a pop-up window will show time trends for the same parameter. (In case that more detailed description of the specific STP is available online, a link (URL) might be provided in the pop-up window)

1.y.3.1. Map Layers to be provided

Data Items ▪ STP data

Time Frames Dynamic time stamp to see the quality data at STP level for the selected time stamp; calendar years for aggregated annual values

Dynamic Layers

- Individual STP point data – both containing individual observations as well as annual aggregates for monitoring parameters (BOD, COD, nutrients, temperature,..), respectively.
- State/ district or River Basin/subunit geographical unit – annual aggregated data (generated per year per geographical unit and linked with geographical unit ID)

Static Layers

These are the layers already present in India WRIS system. They consist of base maps like DEM, Bhuvan, LULC and other satellite-based layers. In addition to base maps they consist of overlays like boundaries, rivers etc. These layers will be shown by organizing them into groups. The users can select or unselect based on their choice. Since there are more than 100 layers are present in India WRIS only select layers relevant can be shown here. Some of the relevant layers are boundary layers, DEM etc. Based upon the evolving user needs more layers from India WRIS can be added to the system.

Locations

Admin: State& District (vector boundaries & polygon shapefiles)

Basin: Basin & Sub-basin (vector boundaries & polygon shapefiles)

STPs (points, lat-long coordinates)

1.y.3.2. Features

Selection – low zoom level
(1) Click on a geographical unit:
i. Show the details of the geographical unit (state name & abbreviation, district name, river basin name, sub-unit name, geographical area (km^2)
ii. trend of the STP compliance categories

Selection – high zoom level
(1) Click on a STP:
i. Show in pop-up window the summary details of the STP (STP ID, river name, STP lat-long coordinates, data provider (CWPCB, SWPCB, CWC,..), type of treatment,
ii. Show in pop-up window trend of the variation of pollutant parameter selected for the STP shown together with actual value for same parameter & time stamp for sample for actual value. Historical data to be shown as mean +/- std. deviation.

Legend
i. The legend colour should clearly show the compliance status at each of the STPs
ii. The legend shape (e.g., circle, square, triangle,..) could indicate the type of treatment in operation
Filter Specific timestamp to see STP data at that point of time / chosen calendar year

1.y.3.3. Mockups

Examples of mock-up sketches is inserted below – hopefully, these can be better exemplified by GIZ IN office team / Carlos Benítez Sanz.

1.y.4 Reports and Analytics

1.y.4.1. State wise and District wise/Basin wise and Sub-basin wise summaries and STP performance reports

The user can select appropriate geography (Admin/Basin) and time stamp to generate the report that shows region wise water quality report. By default, all the states are shown. When a state is selected in the drop down all the districts in the selected state are shown.

Sample report may be designed similar to tables included in, e.g., in the CPCB 2015 report: Inventorization of Sewage Treatment (link) and the performance reports of STPs prepared by CPCB.

There is also a potential to conduct analyses on the performance monitoring data, such as sewage (pollutant load) generation per capita and resulting specific emission loads depending on STP technology in operation, plant size and other operational parameters.

Description of the main worksheets of the database file

Ganga_STPs

This worksheet compiles the info at individual STP level. Updates and/or inclusion of new facilities must be made in this sheet. Three kinds of fields may be distinguished:

Grey	Info included in current database and used for elaborations and maps.
Yellow:	Data taken form compliance reports that should serve for updating / refining the current info.
Light blue	Compliance analysis evaluated in the excel based on Indian Standards (worksheet **Indian_ST_Standards**)

Field	Source	Comments / Assumptions
State	CPCB 2015[1]	
City/ town (CPCB 2015)	CPCB 2015	
City/ town (Census 2011)	Own assessment	Correspondence with name as per Census 2011
Location (CPCB 2015)	CPCB 2015	Also includes list of STP projects sanctioned for rehab / upgrade or new ones (sanctioned in 2017) under Namami Ganga (worksheet **STPs_Namami**)
long city/town	Own assessment	Based on internet shapefiles complemented with google maps
lat city/town	Own assessment	
Commissioned in (Year)	CPCB 2015	
Status	CPCB 2015	
STP Installed Capacity MLD	CPCB 2015	
Technology[2]	CPCB 2015	
long STP	Own assessment	Provided for some STPs as first approximation. To be reviewed and completed
lat STP	Own assessment	
Ganga Basin	Own assessment	From spatial analysis
Treatment Capacity Operational (MLD) 2015 [op+uc]	Own assessment	This fields are included to facilitate aggregation in the worksheet **Ganga_pc**
Treatment Capacity Present (MLD) 2015 [op+uc+no]	Own assessment	
Treatment Capacity Future (MLD) [all]	Own assessment	
Compliance assessment year	Performance Evaluation Reports[3]	
Source		
Name of STP according to Compliance Report		
Design Capacity (MLD)		It should correspond to Installed Capacity in CPCB 2015

1 Inventorization of Sewage Treatment Plants (CPCB, 2015)

2 Acronyms explained in the worksheet **Technologies**. In some cases, technologies, as reported in the Inventorization do not fit with categories or include combinations, problems that have been solved either by expert judgement.

3 Different reports can be included in this group such as:
Performance Evaluation of Sewage Treatment Plants in Central Zone (CPCB Bhopal 2015)
Performance Evaluation of Sewage Treatment Plants under NRCD (CPCB 2013)
Other info provided by NMCG such as the attached report *STP monitored during February-April 2017*

Field	Source	Comments / Assumptions
Actual capacity (MLD)		In principle, this would better reflect the current sewage treatment gap if info is available
Operational status		
Compliance status (as reported)		
Technology		
Disposal		
Date of visit		
pH outlet		
BOD5 (mg/l) outlet		
COD (mg/l) outlet		
TSS (mg/l) outlet		
TDS (mg/l) outlet		
TKN (mg/l) outlet		
NH3-N (mg/l) outlet		
P (mg/l) outlet		
FC (MPN/100 ml) outlet		
pH inlet		
BOD5 (mg/l) inlet		
COD (mg/l) inlet		
TSS (mg/l) inlet		
TDS (mg/l) inlet		
TKN (mg/l) inlet		
NH3-N (mg/l) inlet		
P (mg/l) inlet		
FC (MPN/100 ml) inlet		
Performance as calculated	Own assessment	
Complying according to pH	Own assessment	
Complying according to BOD5 (mg/l)	Own assessment	
Complying according to COD (mg/l)	Own assessment	
Complying according to TSS (mg/l)	Own assessment	
Complying according to TDS (mg/l)	Own assessment	
Complying according to TKN (mg/l)	Own assessment	
Complying according to NH3-N (mg/l)	Own assessment	
Complying according to P (mg/l)	Own assessment	
Complying according to FC (MPN/100 ml)	Own assessment	

Most of the work related with the quality data and compliance is pending. The city of Jaipur can be taken as a complete example of the info that can be extracted from the performance reports.

In any case, a protocol must be established for properly handling the database, establishing when the basic information (grey data) can be substituted for updated or more trustworthy ones.

Ganga_PCs

This worksheet aggregates the info of **Ganga_STPs** and presents the results against the situation registered in CPCB 2009[4]. Three kinds of fields may be distinguished:

Grey	General info from various sources.
Orange	Data taken form CPCB 2009 (summary in worksheet CPCB_2009)
Light green	Update from own assessment based in Census 2011[5], **Ganga_STPs** and sewage generation ratios inCPCB 2009

Field	Source	Comments / Assumptions
Class	CPCB 2009	
No.	CPCB 2009	
City/Town [CPCB 2009]	CPCB 2009	
States/UT	CPCB 2009 + own assessment	
Comments		Some population centres from CPCB has not been individualized in Census 2011. List of pop. centres in **Census_2011_Kolkata**
Name Census 2011	Census 2011 + own assessment	Correspondence has been established based on Census (see worksheets **Census_2011_Cities** and **Census_2011_Towns**). It must be noted that towns / villages not in CPCB 2009 have been occasionally added.
long city/town	Own assessment	Based on internet shapefiles complemented with google maps
lat city/town	Own assessment	
Ganga Basin	Own assessment	
Kolkata UA	Own assessment	Kolkata UA is aggregated because of the difficulty of assigning STPs to its different municipalities
Population CPCB 2009	CPCB 2009	
Per capita sewage, l/d [CPCB 2009]	CPCB 2009	Deducted from CPCB 2009 data on population and sewage generation
Total Sewage (MLD) CPCB 2009	CPCB 2009	
Installed Treatment Capacity (MLD) 2009	CPCB 2009	
% Treatment Capacity 2009	CPCB 2009	*Treatment Capacity / Total Sewage*
Treatment Capacity Gap (MLD) 2009	CPCB 2009	Estimated as the difference *Total Sewage - Treatment Capacity*
Treated Sewage Disposal 2009	CPCB 2009	
Population Census 2011	Census 2011	

[4] Status of Water Supply, Wastewater Generation and Treatment in Class-I Cities & Class-II Towns of India (CPCB 2009).

[5] http://www.census2011.co.in/

Field	Source	Comments / Assumptions
Comparison 2011 2009	Own assessment	This field is included to highlight apparent inconsistencies that should be further researched.
Population Metropolitan Census 2011	Own assessment	In some occasions sewage generation is estimated based on the metropolitan population.
Total Sewage (MLD) 2015	Census 2011	Assuming 2011 population and sewage generation like CPCB 2009. If both data could be updated to 2017, significant improvement of estimates is to be expected.
% Sewage collected 2015	Absent data.	If possible, its inclusion could substantially improve diagnosis and design of Action Plan.
nº STPs Operational 2015 [op+uc]	Own assessment	Assuming that those plants under construction are operative (what might be questionable).
nº STPs 2015 [op+uc+no]	Own assessment	Including also non-operational. It is not possible to evaluate what is needed to make them operative again.
nº STPs future [all]	Own assessment	Including also planned STPs.
Installed Treatment Capacity Operational (MLD) 2015 [op+uc]	Own assessment	Same criteria than above
Installed Treatment Capacity Present (MLD) 2015 [op+uc+no]	Own assessment	
Installed Treatment Capacity Future (MLD) [all]	Own assessment	
ST Capacity reduced?	Own assessment	To highlight possible inconsistencies unless STPs have been definitively abandoned.
% Treatment Capacity 2015 (operational)	Own assessment	If above 100%, this estimate is highlighted.
Treatment Capacity Gap (MLD) 2015	Own assessment	Please note that this info is the basis for the Urban Hotspots Map.

Potential improvements

Some results are not fully consistent, particularly, Installed Treatment Capacity well above 100% suggesting that the sewage generation and / or the population covered by the STPs are underestimated. Further research is needed to improve the data quality.

Data on the fraction of the population which is covered by sanitation networks would also be helpful to improve diagnosis and prioritize action. In many occasions, the difference between actual and design capacity suggest that sewage is simply not reaching the STP.

If information on actual / utilised capacity can be obtained from Performance Reports, the treatment gap estimates might be improved. Gap could be assessed in a more realistic way as the difference between Total Sewage and Actual Treatment Capacity, instead of Installed Treatment Capacity.

If enough information on quality of the outlet is provided in the performance reports, BOD estimates could also be included in addition (or substitution) of the volumetric gap. For the untreated sewage, inlet BOD values could be assumed.

Similarly, the compliance assessment could help to identify where upgrade / rehabilitation is needed.

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