River Basin Planning and Management Cycle

Module 1: Understanding the River Basin Management Cycle

6th and 7th December 2019, Lucknow

RBM Training Programme

Support to Ganga Rejuvenation Project | December 2019

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INDIA-EU WATER PARTNERSHIP

Prepared by
AHT GROUP AG Management & Engineering
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Outline

Unit	Topic	Content
1	Introduction	
2	Water Resources Management	Refreshments on Water Resources Management and discussion on its application in India.
3	River Basin Management	Refreshments on River Basin Management and discussion on its application in India. Links with the EU Water Framework Directive. Discussion on its application in India
4	The River Basin Planning and Management Cycle	Detailed presentation of the RBM Cycle and its steps. Discussions on its steps.
5	Example of implementation in the EU Context	Examples of application in EU. Discussion on application in India

1. Introduction

1. Introduction

According to Nikolai Kondratjev, every 50-60 years technological development and the use of natural ressources were so successful that they had a positive impact on the (global) production chain thus, generating noticeable economic progress. The so-called Kondratjev cyles in the past were:

- Development of steam engines, facilitating industrial power (1800)
- Development of steel and railway, facillitating transport and construction
- Electricity and chemistry, facillitating energy (1900)
- The automobile and petro-chemical industry facillitating individual mass transport
- Information tecnology facillitating added value to information

Introduction (cont.)

“It is impossible to forecast the future from the past. This is due to the unfortunate fact that the economic and social development is not strictly linear instead somewhat chaotic. The future seems to be embedded in a matrix of possibilities/opportunities that surrounds the present.”

Nikolai Kondratjev, Russian Economist, (1892-1938)

Introduction (cont.)

"*There is a **water crisis** today. But the crisis is not about having **too little water** to satisfy our needs. It is a crisis of **managing water so badly** that billions of people – and the environment – suffer badly*."

World Water Vision Report

- While the world's population tripled in the 20th century, the use of renewable water resources has grown six-fold
- Within the next 50 years, the world population will increase by another 40 to 50%
- This population growth coupled with industrialisation and urbanisation will result in an increasing demand for water → Will thus have serious consequences on the environment

2. Water Resources Management

Water Resources Management Principles

Dublin Statement 1994, International Conference on Water and the Environment:

- **Principle 1:** Fresh water is a *finite and vulnerable* resource essential to sustain development and the environment
- **Principle 2:** Water development and management should be based on a *participatory approach* involving users, planners and policy makers at *all* levels
- **Principle 3:** *Women* play a central part in provision, management and safeguarding water.
- **Principle 4**: Water has *an economic value* in all its competing uses and should be organise as an economic good as well as as social good

Water Resources Management in the Context of the SDGs and WFD

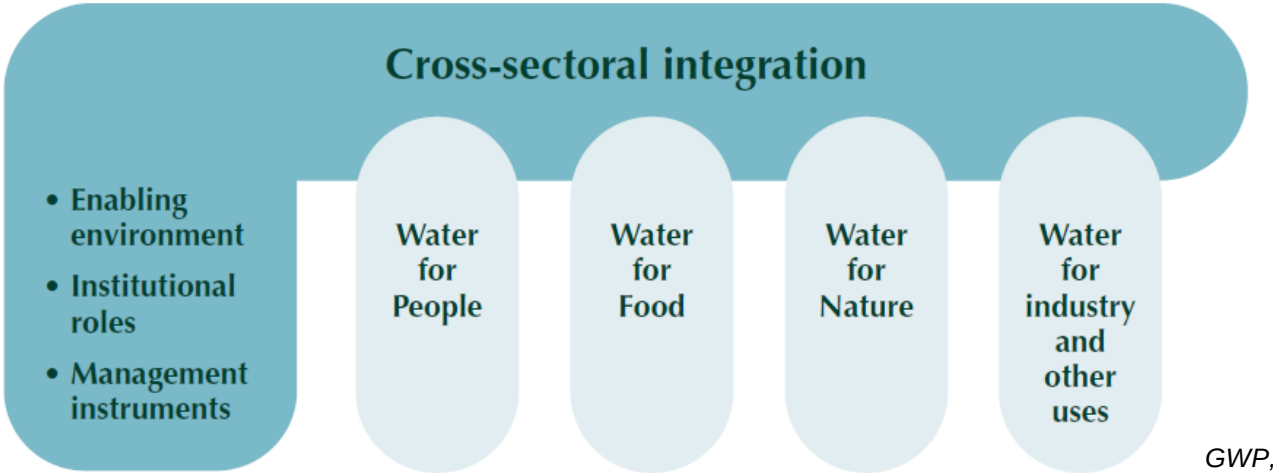
Sustainable Development Goals SDG 6.5 Target → "*By 2030, implement integrated water resources management at all levels, including through transboundary cooperation.*"

European Water Framework Directive (WFD) (Directive 2000/60EC) → "*Water is not a commercial product like any other, but rather a heritage which must be protected, defended and treated as such.*"

Cross-Sectoral Integration for Water Resource Management

Water Resource Management is “a **process** which promotes the **co-ordinated** development and **management** of water, land and related resources in order to maximise **economic and social** welfare in an **equitable manner** without compromising the sustainability of vital ecosystems and the environment.”

GWP, 2000



GWP, TAC Background Paper No. 4

Water Resources Management for Conflict Mitigation

- **Conflicts are the rule not the exception** when discussing water use
- Integration means that all sectors need to *consult* with each other over their water needs
- Consultation avoids misguided investments → Needs to be problem-based so that processes are not unnecessarily slowed down
- Consultation through RBM processes mitigates conflicts and identifies solutions

Elements of Water Management at Different Levels

National Level

- National water strategies and laws
- Harmonisation of investment planning
- Water sector reform including regulation

Basin Level

- Support of basin organisations
- **Data and information management, Decision-support Systems (DSS)**
- **Development of water management plans**
- **Multi-stakeholder agreements on Water Resources Management**

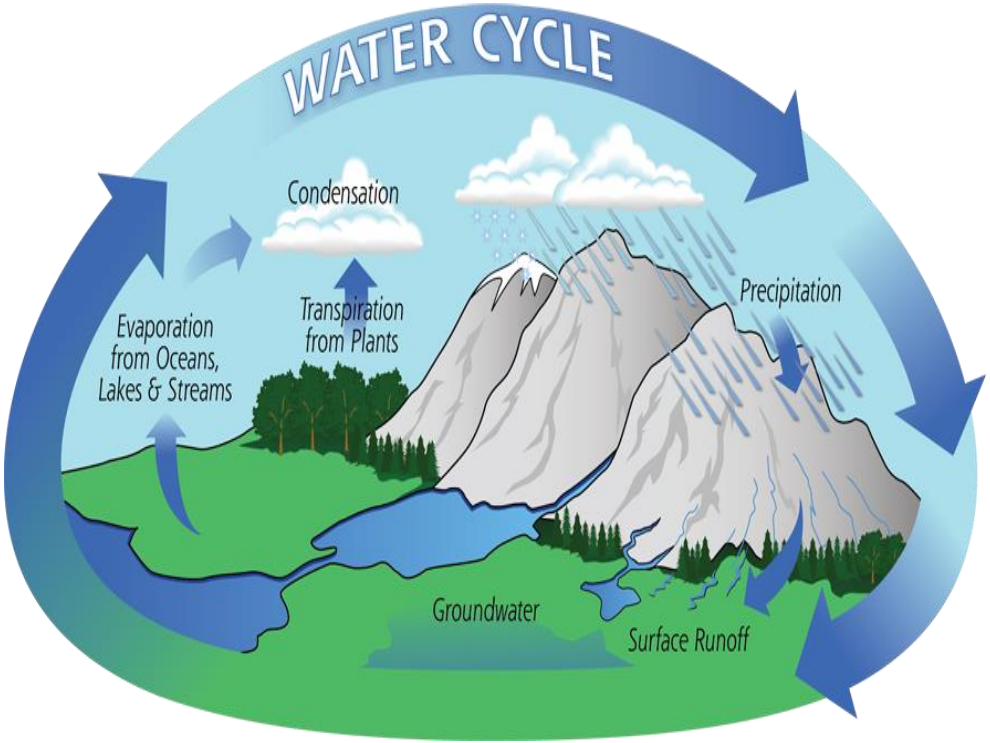
Local Level

- Participative management structures e.g. water user associations
- Wastewater treatment, water reuse
- Water storage, flood and rainwater management
- Water efficiency, energy efficiency

3. River Basin Management

Watersheds and the Water Cycle

Watersheds are part of the Water or Hydrological Cycle:



https://pmm.nasa.gov/education/water-cycle

Key Processes

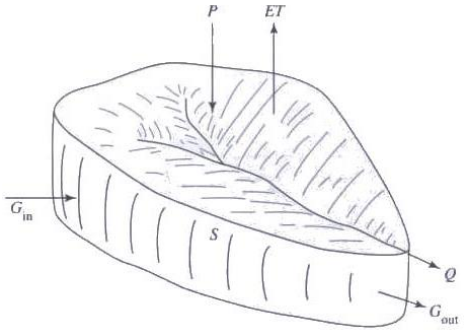
- Evapotranspiration
- Precipitation
- Runoff
- Groundwater flow

Main Water Storage

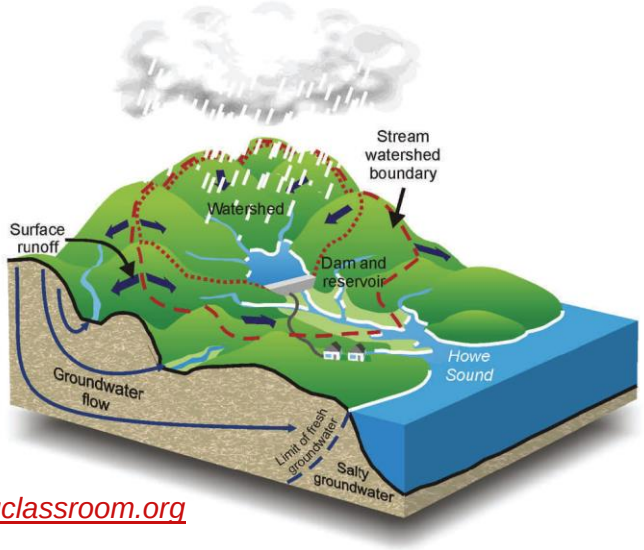
- Oceans
- Atmosphere
- Ice & Snow
- Groundwater
- Lakes

A Basin or Watershed?

- A basin or **watershed** is a geographic area that drains all precipitation into a common outlet (river, wetland, lake, ocean).
- The **watershed boundary** will more or less follow the highest ridgeline around the stream channels and meet at the outlet.
- **Watershed, catchment, river basin** are synonyms.
- Watersheds can range from a few km^2 to some million:
  - Amazonas: 7,050,000 km^2
  - Ganga: 1,086,000 km^2
  - Ramganga: 32,500 km^2



Dingman (2002) Physical hydrology

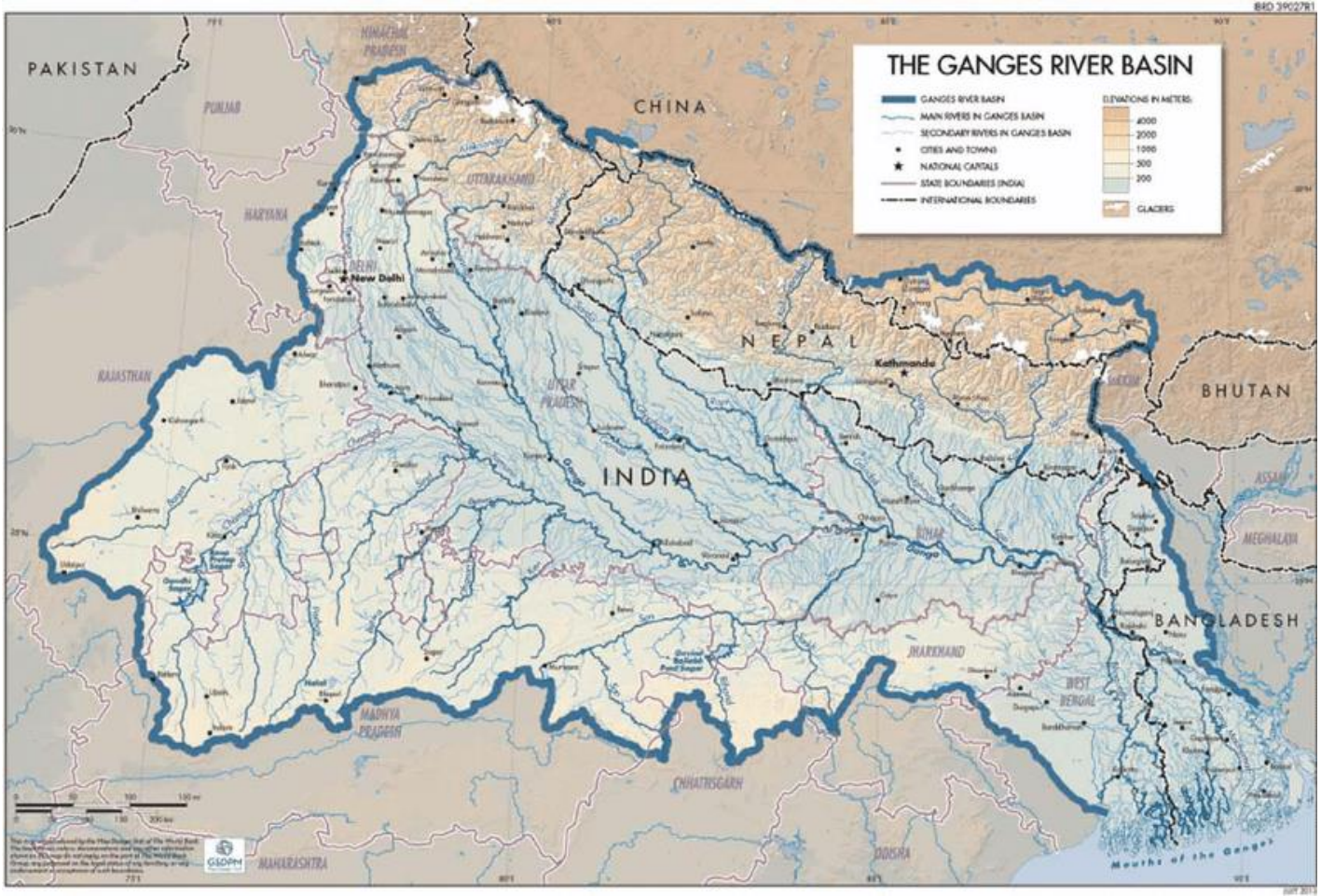


www.ksagclassroom.org

The Ganga basin

- International basin shared by India, Nepal, China and Bangladesh.

- Area of 1,086,000 km².



From paper "*Ten fundamental questions for water resources development in the Ganges: Myths and realities*", Water Policy 15(S1):147

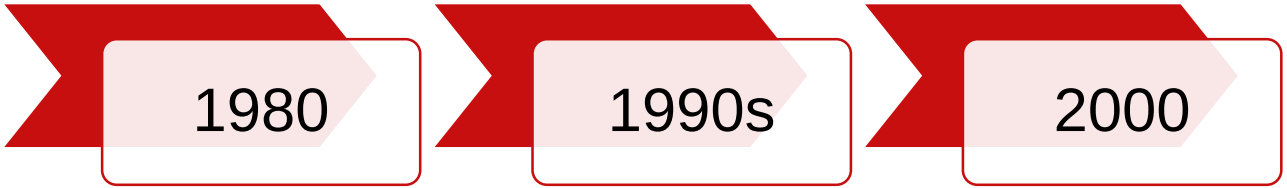
River Basin Management Principles

- River Basin Management (RBM) is a **practical** approach which includes **measures** necessary to achieve set goals and objectives
- In 2000, the European Union (EU) adopted the **Water Framework Directive (WFD)**

→ Examples for best practice benchmarks from Europe could be found at the corresponding River Basin Commissions e.g. Danube, Rhine, Elbe, Odra

- From the requirements of the WFD, and the principles and needs of water resources management, a **River Basin Planning and Management Cycle** was developed
- The structure, the processes and steps of this scheme are subject of this seminar we present today

RBM in Europe: A Long Journey with the EU Water Framework Directive



Standards for drinking water, wastewater discharge and cont. surface and bathing water quality

Acknowlegded the need for broader water policies and an integrated approach

Development and adoption of the EU WFD

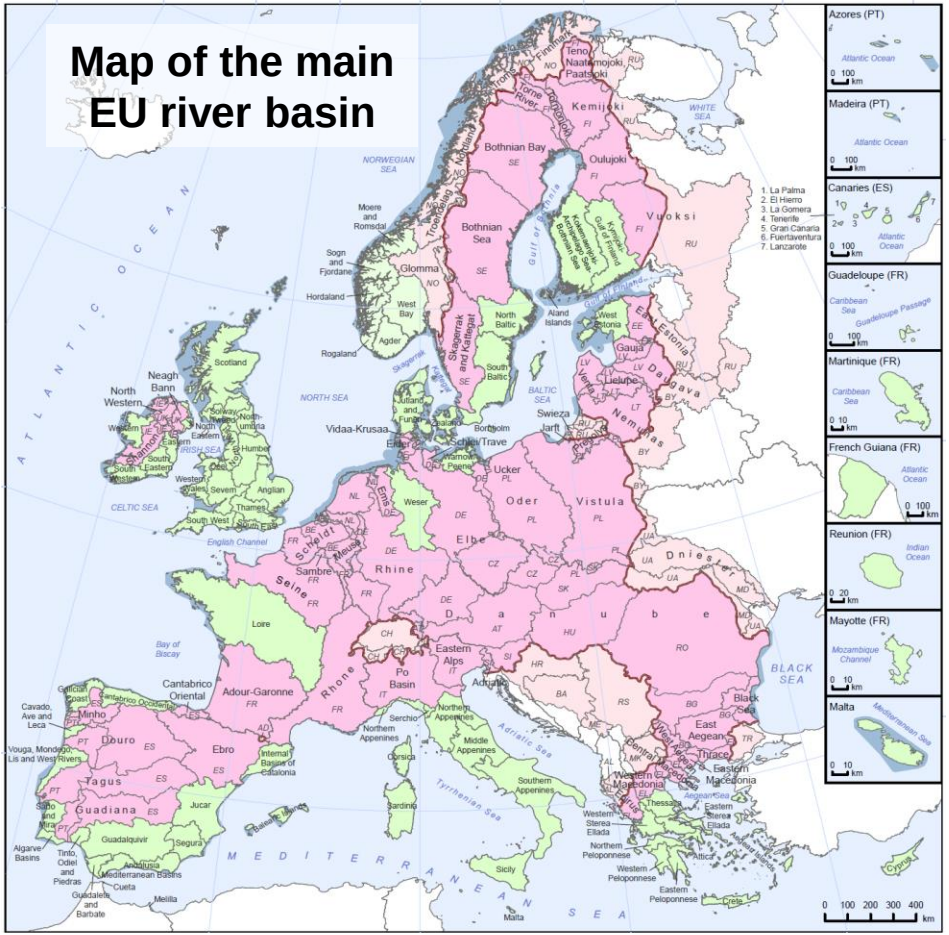
River Basin Management

RBM in Europe: A Long Journey with the EU Water Framework Directive

- River Basin Management was acknowledged to be the best model **i.e.** water **management by natural geographical and hydrological units** instead of according to administrative or political boundaries
- The overall goal is to achieve **cleaner rivers and lakes** and groundwater, i.e. a "**good status" of all water bodies** in the EU
- Positive examples were the rivers **Maas, Schelde or Rhine** river basins, with their cooperation and joint objective-setting across Member State borders, or in the case of the Rhine even beyond the EU territory

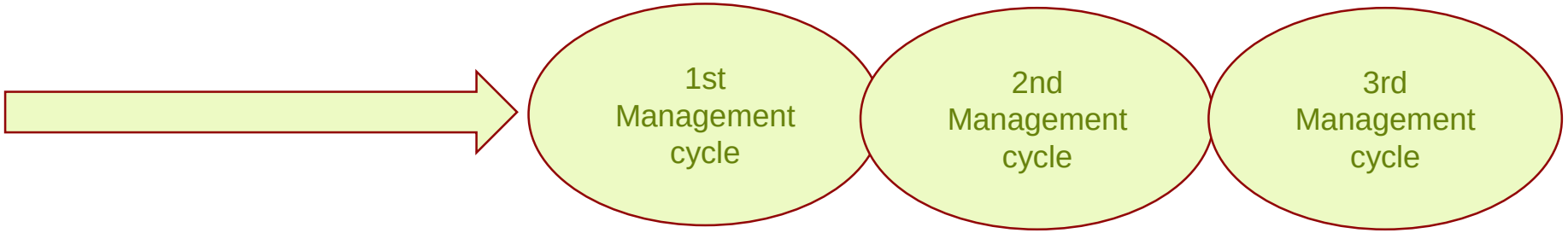
EU Water Framework Directive

- Commitment: achieve a **“good status”** for **all waters** by 2015
- EU member states are obliged to:
  - **Regularly assess the state** of the water bodies and **develop monitoring programmes**
  - **Develop plans of measures** to achieve the required good status
  - Develop **RBM plans** (40 river basins) including basin-wide management plans for transboundary rivers
- By 2015, approx. **53%** had achieved good ecological status



http://ec.europa.eu/environment/water/water-framework/facts_figures/pdf/River%20Basin%20Districts-2012.pdf

EU WFD Time-Table



2000 Entry into force

2003 River basins: Identification, characterisation

2006 Monitoring networks; Public consultation

2009 1st River Basin Management Plans

2010 - 2015 Implementation of measures

2nd River Basin Management Plans

2016 - 2021 Implementation of measures

3rd River Basin Management Plans

2022-2027 Implementation of measures

Final deadline for meeting objectives (?)

Adapted from: http://ec.europa.eu/environment/water/water-framework/info/timetable_en.htm

RBM Plans in Europe

A number of **International River Basin** Districts have published River Basin Management Plans:

- Danube
- Rhine
- Elbe
- Ems
- Finnish-Norwegian International River Basin District
- Meuse
- Scheldt / l'Escaut
- Odra
- Sava Commission (ISRBC)

Information Required by the RBM Plans

- Characterisation of the basin
- Summary of significant pressures and impacts of human activity
- Protected areas
- Monitoring programmes and status of water
- Environmental objectives
- Economic analysis of water use
- **Programme of measures** (to improve the environmental and socio-economic situations and achieve the objectives set)
- Summary of the public information and consultation measures taken, their results and the changes to the plan made as a consequence

→ The list above is incomplete but reflects the main issues addressed by WFD

Application of RBM Plans in India

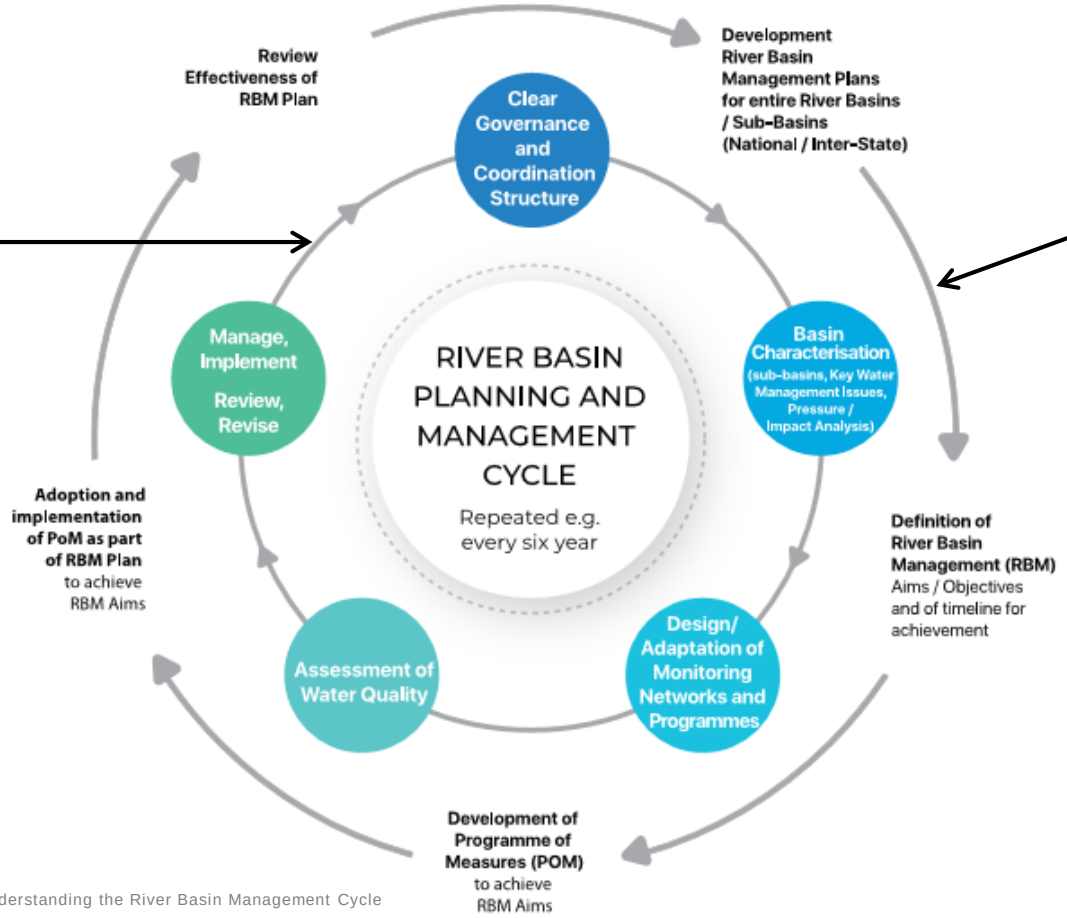
EXCHANGE

- *Please share your experience*:
  - Have RBM Plans been drafted?
  - How do you set and implement your measures?
  - Where/when?
  - What were the achievements and difficulties?

4. The River Basin Planning and Management Cycle

The River Basin Planning and Management Cycle

„Inner cycle“
Technical/
operational level“



„Outer cycle“
Planning and
decision making
level

Element 1 (Step 1)

Clear Governance and Coordination Structure:

The United Nations recommends:

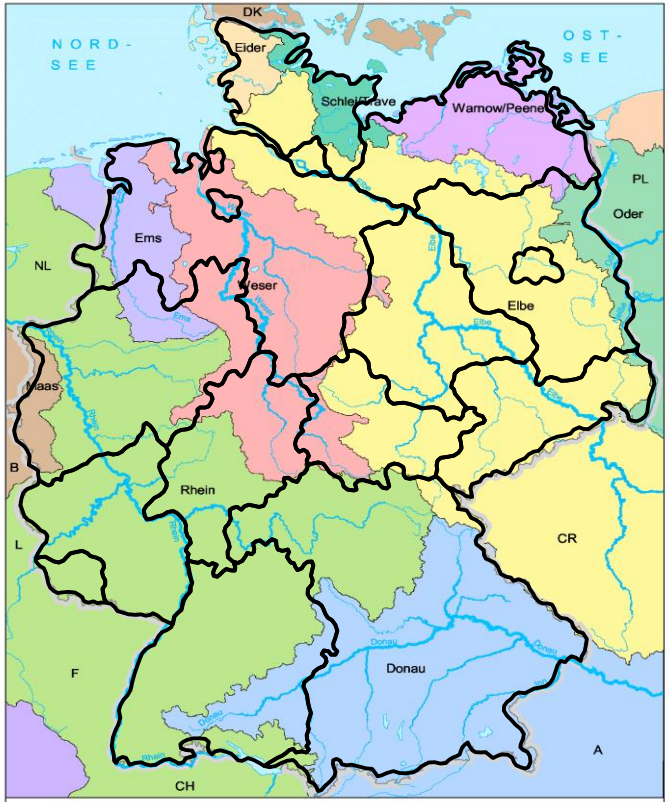
- Enabling the envrironment
- Clear admistrative structures and competence distribution
- Management instruments
- Infrastructure development
- Capacity Building

Infrastructure Europe, provisions of Directive 2000/60EC in force:

- River basin as management unit determined and water body as the smallest subunit in the basin
- Concept of a „competent authority“ was introduced
- Quality status goals for coastal waters, rivers, lakes and Groundwater are set

Governance and RBM in Germany

- Different entities for managing the environment and water resources
- River basins (at the national and the international level) - based on hydrological consideration
- Federal states (16) with own water legislation and institutions – based on legal and political considerations
- Requires complex governance mechanisms that balance different geographical, political and other dimensions

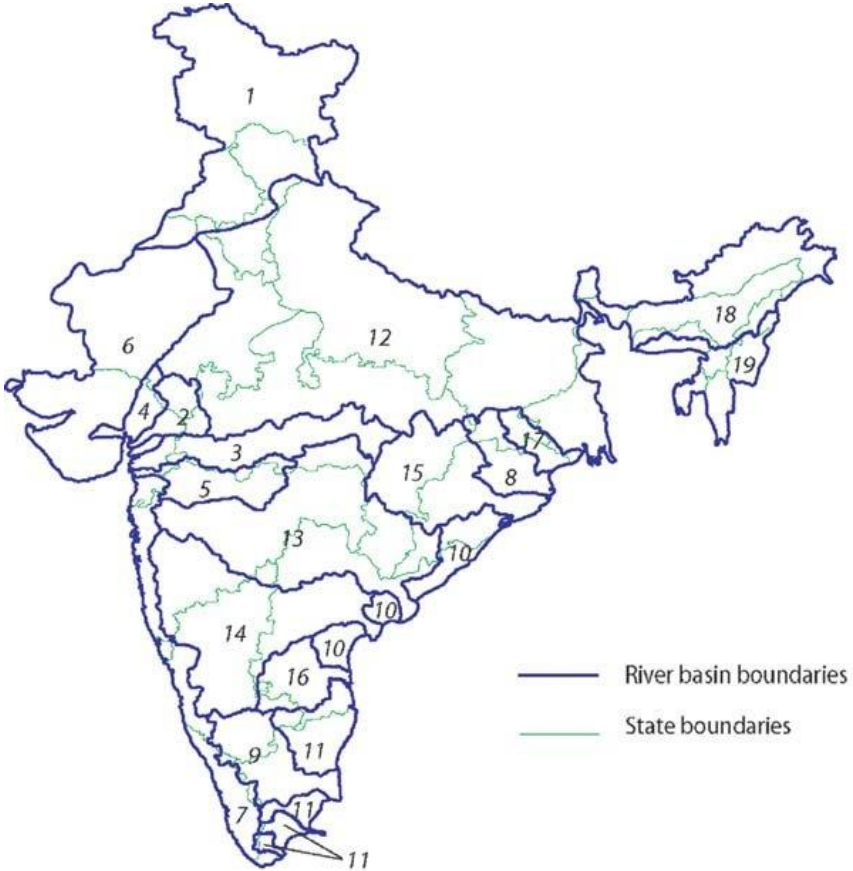


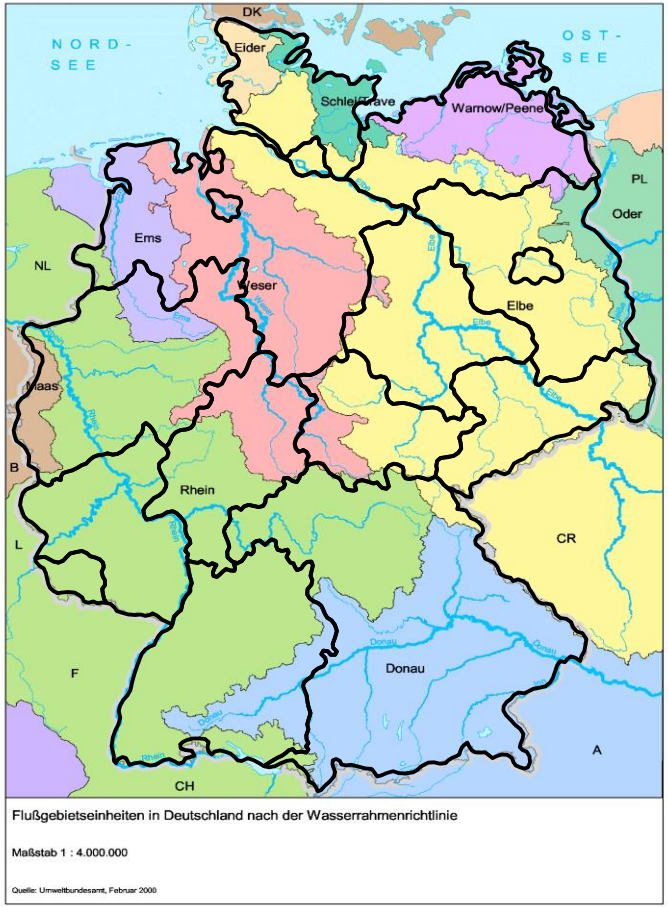
Flußgebietseinheiten in Deutschland nach der Wasserrahmenrichtlinie

Maßstab 1 : 4.000.000

Quelle: Umweltbundesamt, Februar 2000

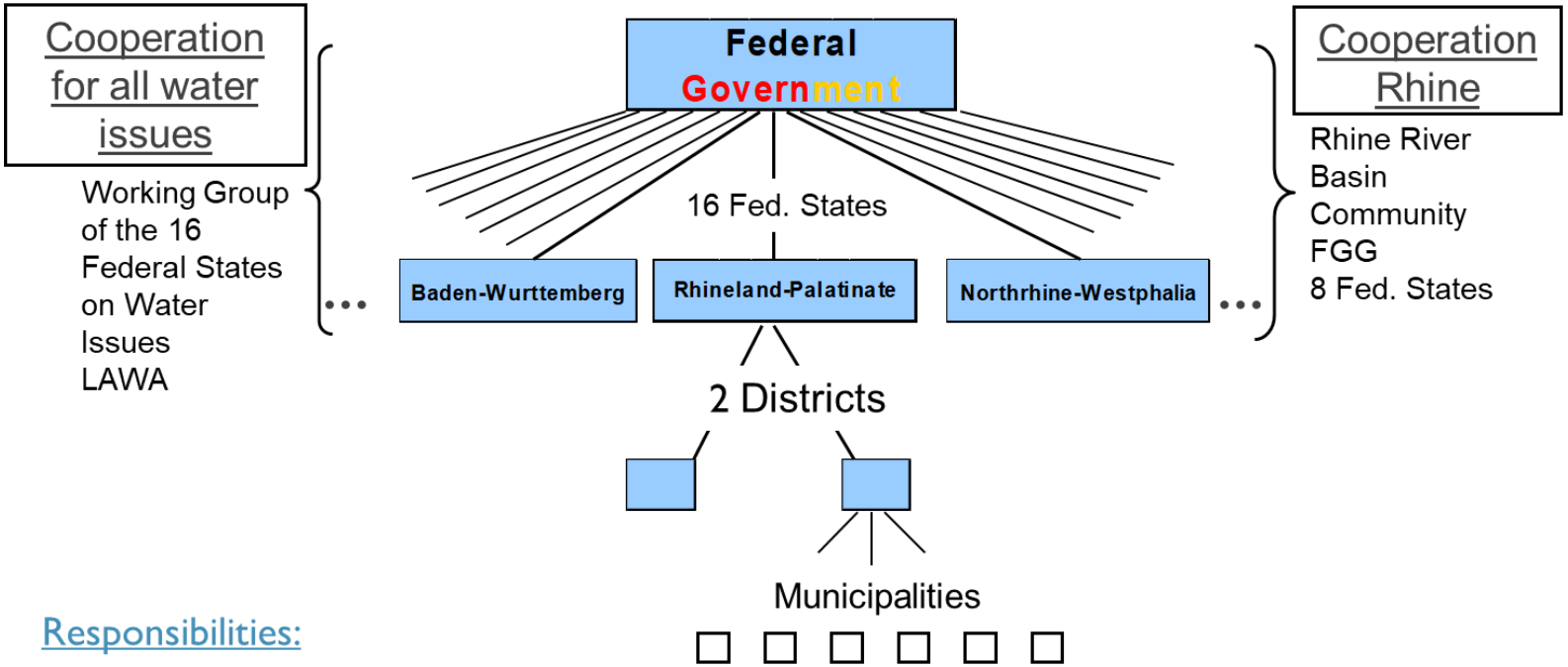
Sub-basins of the Ganga





The structure of river basin management in Germany

- The overall governance structure for basin management reflects the complex set-up of water management issues in Germany (federal state, different competences across states, subsidiarity principle, etc.)



Responsibilities:

Federal States: Management of Surface Water Bodies

States/Municipalities: Management of Wastewater

Institutions for Water Management in Germany

Due to the political nature (federalism) of the German governance system, water management (and thus basin management) is undertaken by a number of different institutions:

- **National level**
  - Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
  - Federal Agency for the Environment
- **State level (16 States)**
  - State Ministry for the Environment (or similar ministry)
  - Regional councils
- **Local level**
  - Communities
  - Districts
  - Cities

Exchange on Governance and basin management in the Ganga basin

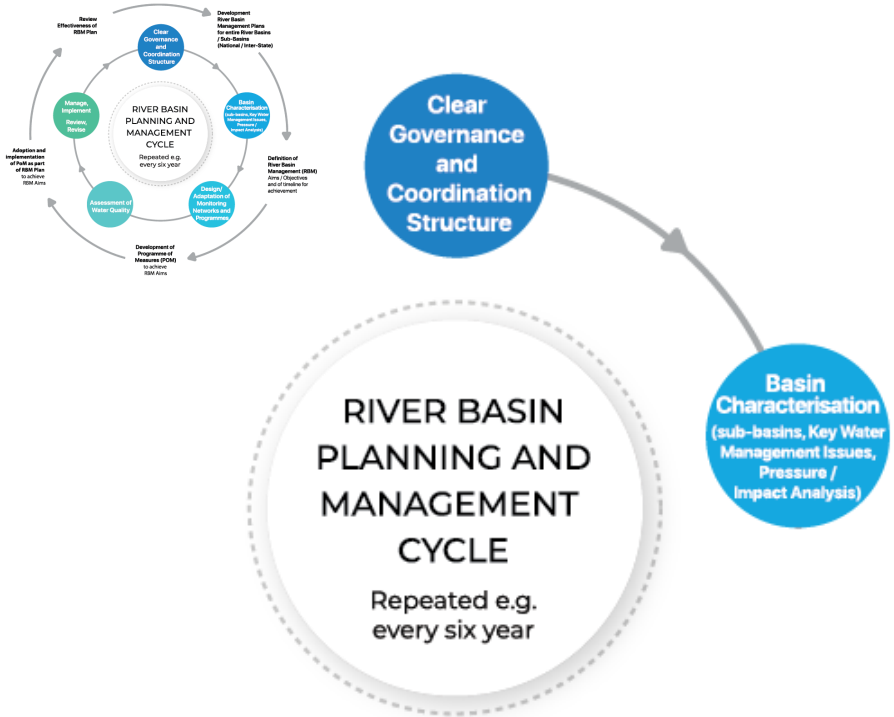
EXCHANGE

Let have a look at the stakeholders operating in the Ganga basin by doing the following:

1. List the different organisations working in the Ganga basin and list their mission(s).
2. Try to identify the role(s) they could have in Ganga RBM.

1. List of organisations working in the Ganga basin:
   - Please identify the different organisations (Governmental, Non-governmental and Private Organisations).
   - Please mention their level of operation (Central, State or District levels).
2. Using the Metaplan, let attempt to identify their role(s) in RBM.

Element 2 (Step 2)



Basin Characterisation:

Detailed description/characterisation of the basin

- Identification of significant water management issues
- Pressures and impact analysis of the human activities on the surface and groundwater bodies

Characterisation of the River Basin (i.e. surface water bodies)

- **Step 1: Categorisation of the water body within the river basin district**
  - Ex.: river/lake/transitional water/coastal water, artificial water body, heavily modified water body)

- **Step 2: Typisation/Descriptation of the water body according to its caracteristics**
  - Ex.: ecoregion, altitude, size of the catchment, geology, flow, etc
  - For artificial and heavily modified surface water bodies the differentiation shall be undertaken in accordance with the descriptors for whichever of the surface water categories most closely resembles the heavily modified or artificial water body concerned.

- **Step 3: Produce a map with the water bodies of the river basin district**
  - For each surface water body type characterised, type-specific hydromorphological and physicochemical conditions shall be established representing the values of the hydromorphological and physicochemical quality elements.

- Type-specific conditions and type-specific biological references must be derived.

Assessment of Pressures and Impacts

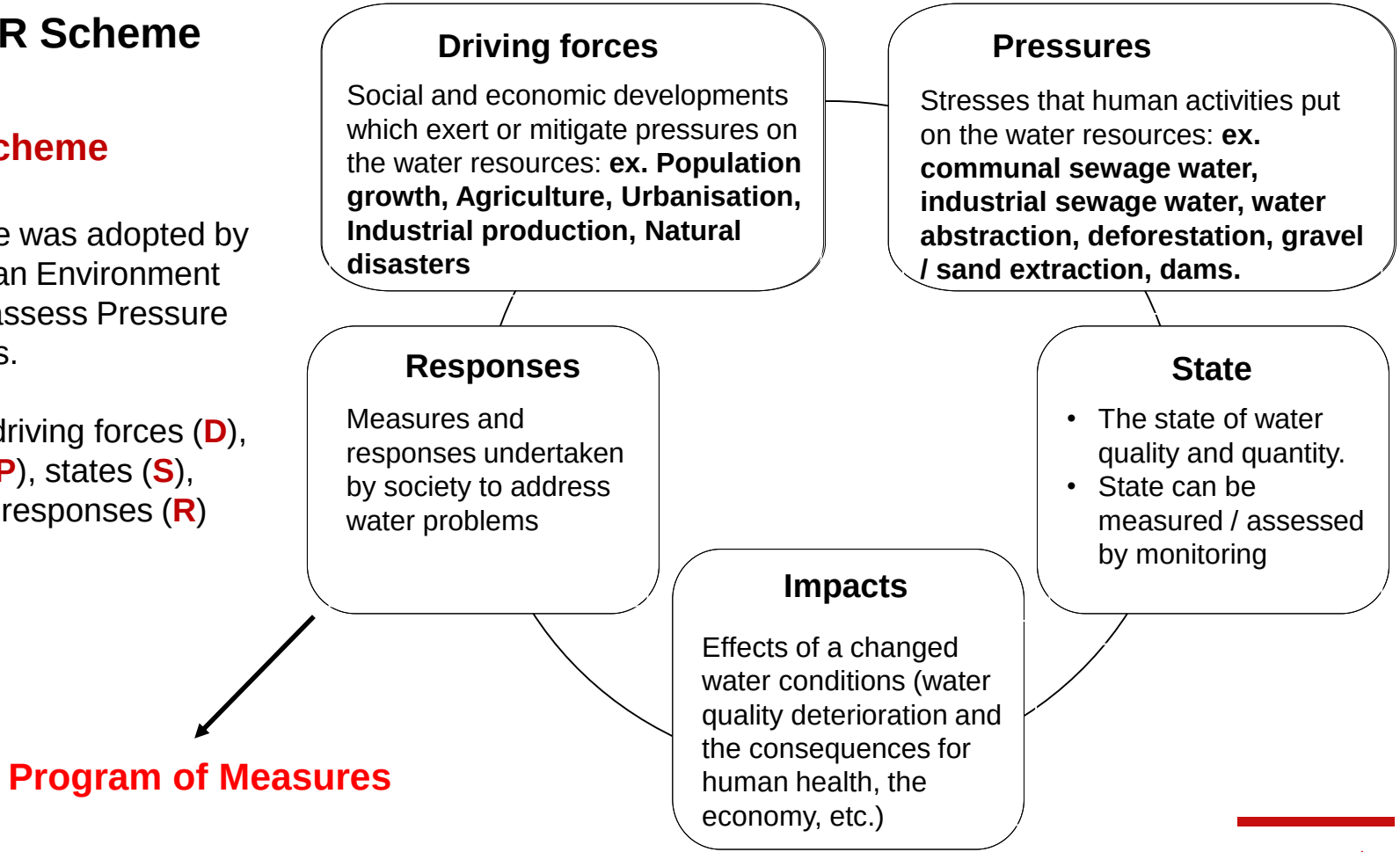
- Before assessing parameters of hydrology, morphology, chemistry and biology, the stakeholders involved should **identify** the **significant pressures** in a basin. Their **impacts** should be quantified.
- Data from **water resources assessment** can help to **understand** the nature of the pressures and the **dimension of the impacts**.
- For example, important pressures in **Central Asia** result from hydropower and irrigated agriculture. Impacts include changes in hydrological regimes, deviation of water to fields, salinization, lack of environmental flows and so on.
- In **Europe,** important pressures result from industry, agriculture and municipalities. They result in pollution of surface waters. Navigation and hydropower infrastructure has resulted in biodiversity losses and increased flood risks.

"The EU Water Framework Directive requires the identification of significant pressures from point sources of pollution, diffuse sources of pollution, modifications of flow regimes through abstractions or regulation and morphological alterations, as well as any other pressures."

The DPSIR Scheme

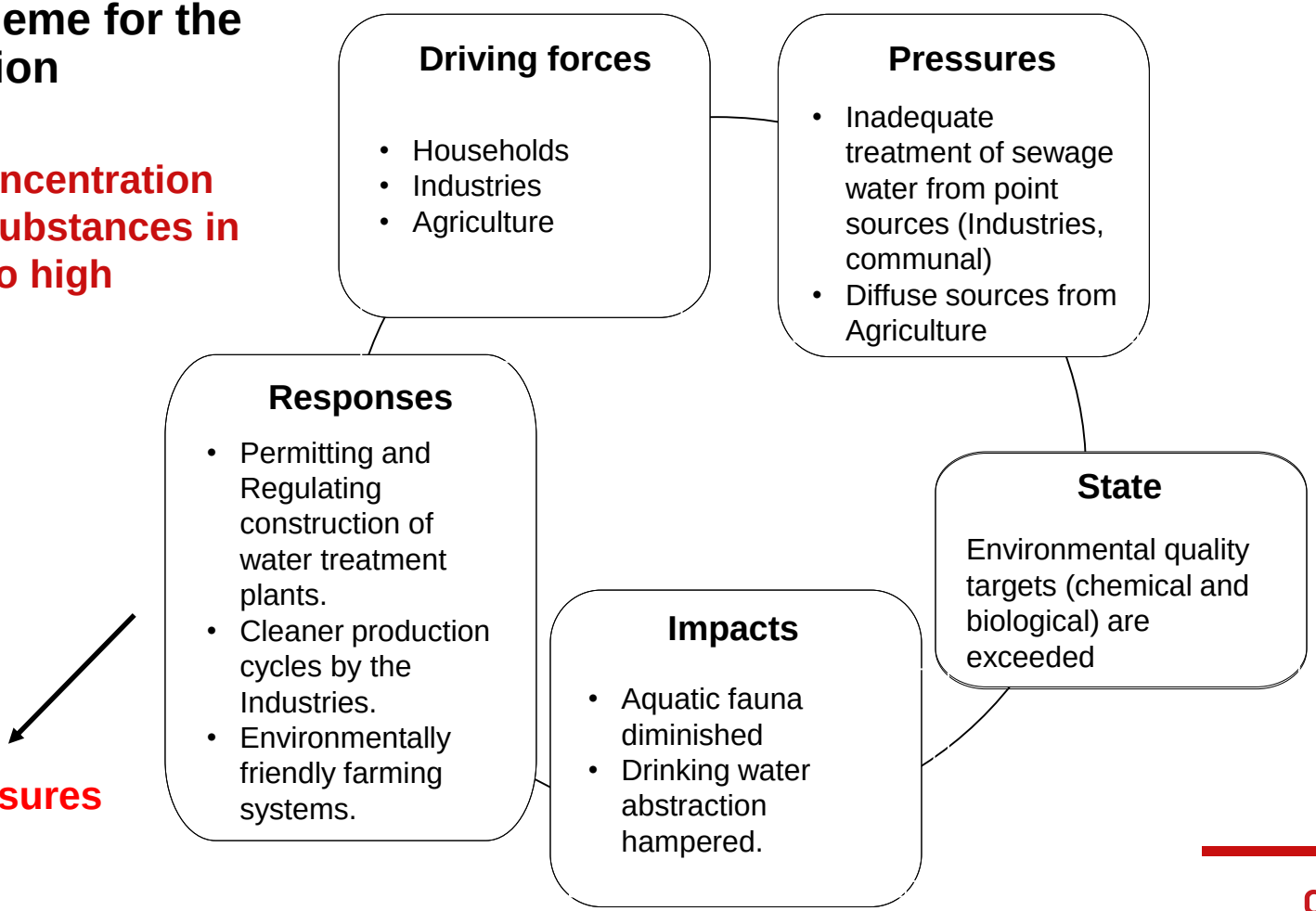
The DPSIR scheme

- The scheme was adopted by the European Environment Agency to assess Pressure and Impacts.
- Identifying driving forces (**D**), pressures (**P**), states (**S**), impacts (**I**), responses (**R**)



Ex. DPSIR scheme for the riverine pollution

Main issue: Concentration of hazardous substances in the river are too high



Program of Measures

Problem analysis for the Ganga (or a portion of it)

IT´S YOUR TURN

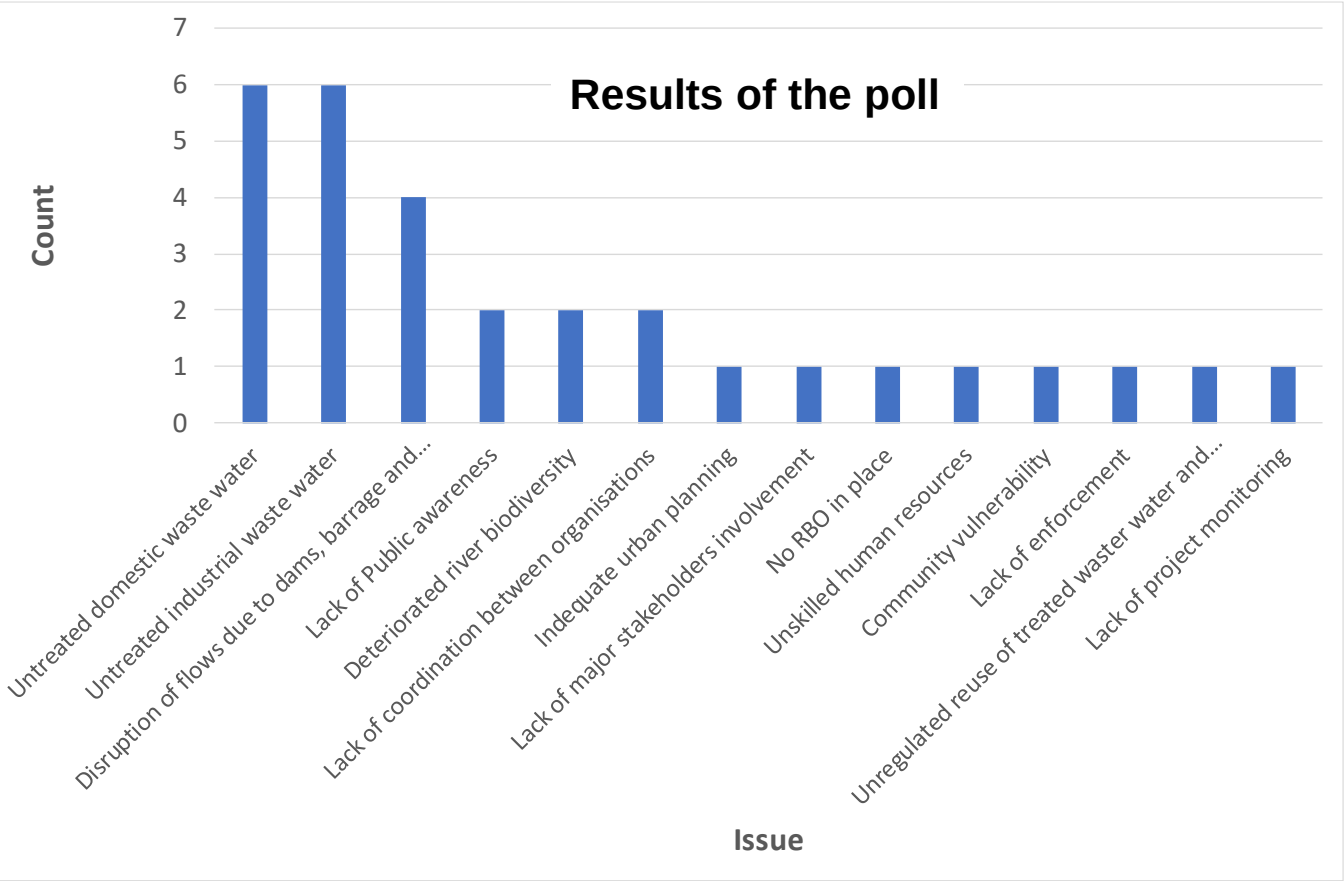
- Results of the poll:

Is it possibly this: Tragedy of the Commons?

“ The **tragedy of the commons** is a situation in a shared-resource system where individual users, acting independently according to their own self-interest, behave contrary to the common good of all users by depleting or spoiling the shared resource through their collective action.”

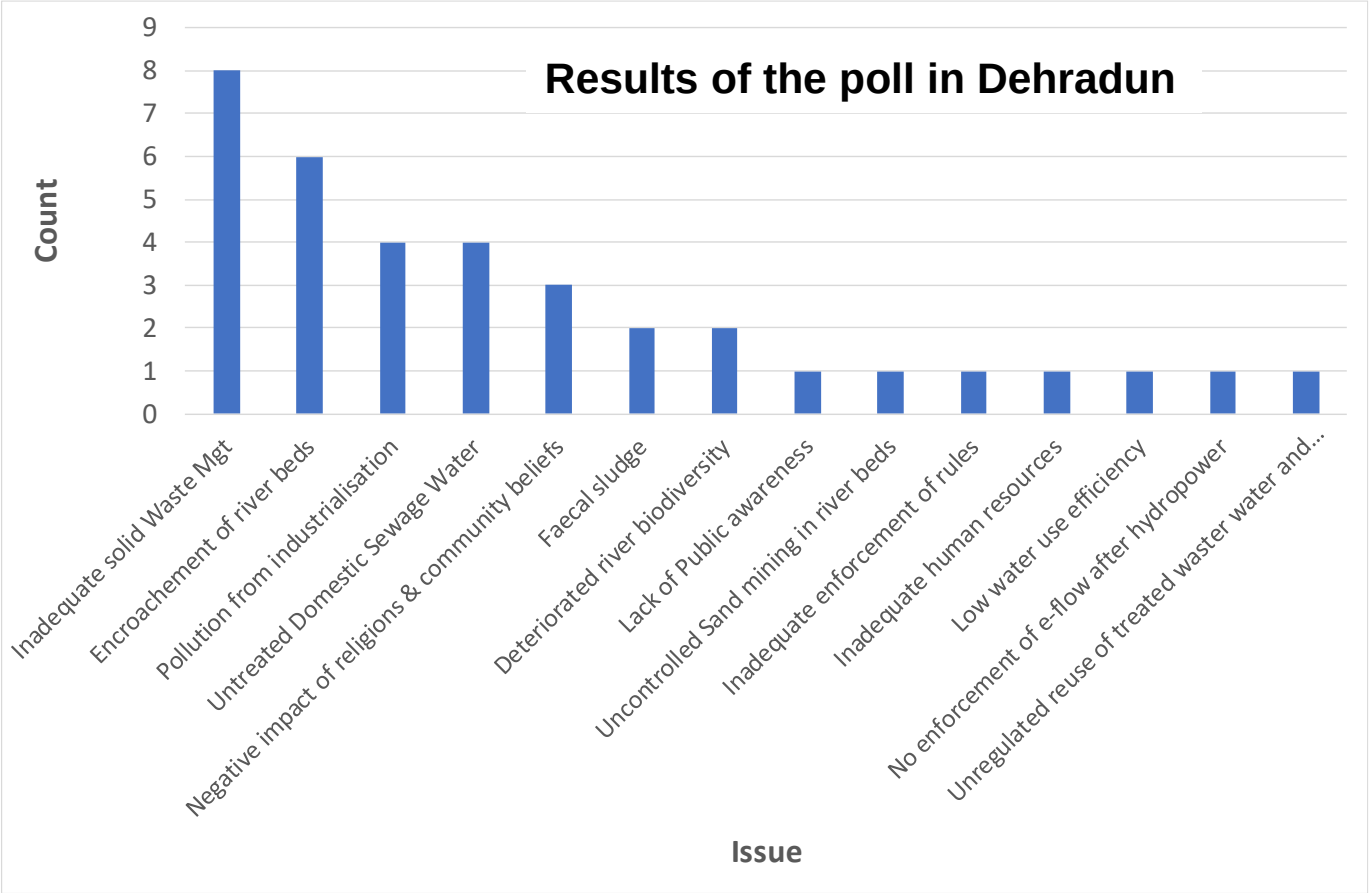
Problem analysis for the Ganga (or a portion of it)

IT´S YOUR TURN



Problem analysis for the Upper Ganga (or a portion of it)

IT´S YOUR TURN



Problem analysis for the Ganga (or a portion of it)

IT´S YOUR TURN

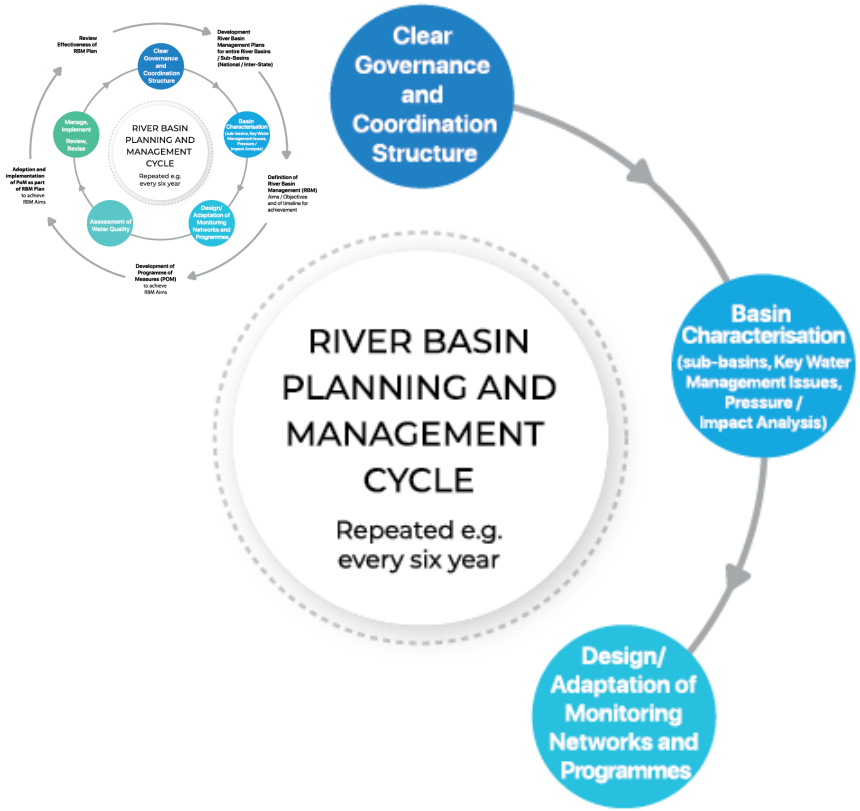
- Please try to set up a problem analysis for the Upper Ganga:
  - Group work, with cards.
  - Each group works on a specific problem.
  - Fill-up the DPSIR scheme using the cards.
  - Specific card for the **D**, the **P**, the **S**, the **I** and the **R**. The group should agree on the content of the cards.
  - Try to be **specific**, not too general.
  - Each group will display its DPSIR circle on the metaplan.

Problem analysis for a sub-basin of the Ganga

IT´S YOUR TURN

- The problems to work on:
  - Untreated Domestic Wastewater.
  - Untreated Industrial Wastewater.
  - Disruption of flows due to dams, barrages and other structures (over-abstraction).
  - Lack of Public Awareness.

Element 3 (Step 3)



Design and adaptation of monitoring programmes:

- Development of a monitoring programme and observation grid within the river basin
- Assessment of the current water quality
- Assessing options of environmental remediation
- Identify shortcomings of regulations and protection provisions
- Data to calibrate and run models

Environmental Monitoring - Programmes

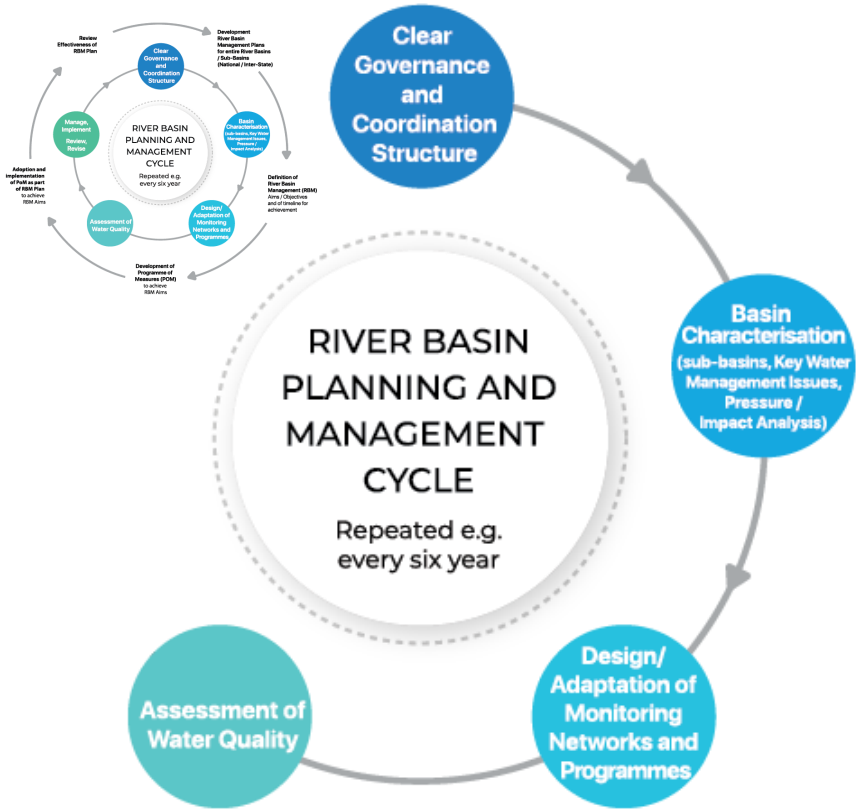
Biological Elements

Chemical Elements

Hydromorphological Elements

Physico-chem Elements

Element 4 (Step 4)



Assessment of Water Quantity and Quality:

- Assess current water quantity and quality
- Delineate interventions by authorities
- Feed models
- Develop remediation programmes
- Verify the effectivity of the programme of measures directed to assure the adequacy of water quantity and quality
- Identification of unknown environmental pressures
- Have cost-effective monitoring programme

Assessment of Water Quality

- Physical and chemical parameters
  - temperature, pH, conductivity
  - Salt content (K, Na, Ca, Mg, Cl, SO_4, HCO_3, fluoride, silica)
  - Persistent organic pollutants (pesticides, PAH, …)
  - Heavy metals such as mercury, lead, chromium, tin, zinc,..
  - Pharmaceuticals, hormones, antibiotics

- EU Water Framework Directive has list of **45 priority substances / pollutants** that have to be monitored in surface waters.
- 11 priority hazardous substances are subject to cessation or phasing out.
- If one substance exceeds threshold value, then the water quality is classified as “bad”, otherwise it is “good”.

Link to EU WFD Priority Substances Website: http://ec.europa.eu/environment/water/water-dangersub/pri_substances.htm#dir_prior

See also Arle et al (2016): Monitoring of Surface Waters in Germany under EU WFD - pdf-File.

Water Quality measurements

- Who is responsible for Water Quality measurement?
  - Public authorities for surface water, groundwater
    - Example: Rhineland Palatinate has 110 chemical monitoring stations, and 1000 biological monitoring points.
  - Private sector for hydropower plants.
  - Public authority for “navigational” weirs.
  - Utilities for wastewater treatment & water treatment plants

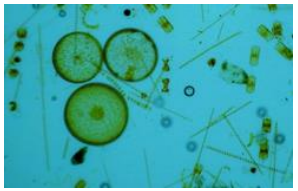
- Which measurement technology is used?
  - Laboratory tests (standard test methods)
  - Photometric test kits
  - Online measurement or sampling (mixed sample, 24 h sample, ..)

Hach Surface water test kit

Biological Assessment

- Hydromorphology and water quality influence the ecosystem of surface waters (rivers and lakes).
- Striving for a good ecological status, rivers and lakes have also to be assessed for biological indicators.
- The “biological quality elements” included in the EU WFD are:
  - Phytoplankton
  - Large algae/ Angiosperms
  - Macrophytes/ Phytobenthos
  - Macroinvertebrates
  - Fish

(Arle et al., 2015: Monitoring surface waters in Germany under the EU WFD.)



The ecological status: a combination of 3 quality elements

Quality element	River	Lake	Transitional water	Coastal water
Biological quality elements				
Phytoplankton				
Large algae/ angiosperms				
Macrophytes/ phytobenthos				
Macroinvertebrates				
Fish				
Hydromorphological quality elements				
Continuity				
Hydrology				
Morphology				
Tidal regime				
Chemico-physical quality elements				
General chemico-physical parameters				
Specific pollutants				

(UBA 2017: Waters in Germany, page 26, table 5)

Assessment method available?

Quality elements (QE) of ecological status as defined by the Water Framework Directive

Quality element	River	Lake	Transitional water	Coastal water
Biological quality elements				
Phytoplankton	X	X	X *	X
Large algae/angiosperms			X	X
Macrophytes/phytobenthos	X	X		
Macro-invertebrates	X	X	X	X
Fish	X	X	X	
Hydromorphological quality elements				
Continuity	X **			
Hydrology	X	X		
Morphology	X	X	X	X
Tidal regime			X	X
Chemico-physical quality elements				
General chemico-physical parameters	X	X	X	X
Specific pollutants	X	X	X	X

* Not available; this parameter cannot be assessed in German transitional waters of the North Sea due to the high level of turbidity.
** An assessment method for fish ladders, downstream fish passes and sediment continuity is currently under development.

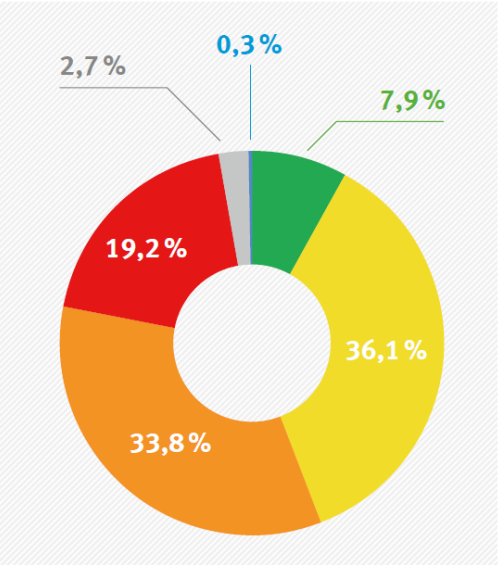
Source: German Environment Agency in accordance with the Ordinance on Surface Waters (OGewV)

Key: Assessment not required; X Assessment method available; X Assessment method currently being trialled; X Assessment method not yet available

(UBA 2017: Waters in Germany, page 26, table 5)

EU Water Assessment - Colour codes

	High status or reference conditions (RC)
	Good status (slight deviation from RC)
	Moderate status (moderate deviation)
	Poor status
	Bad status



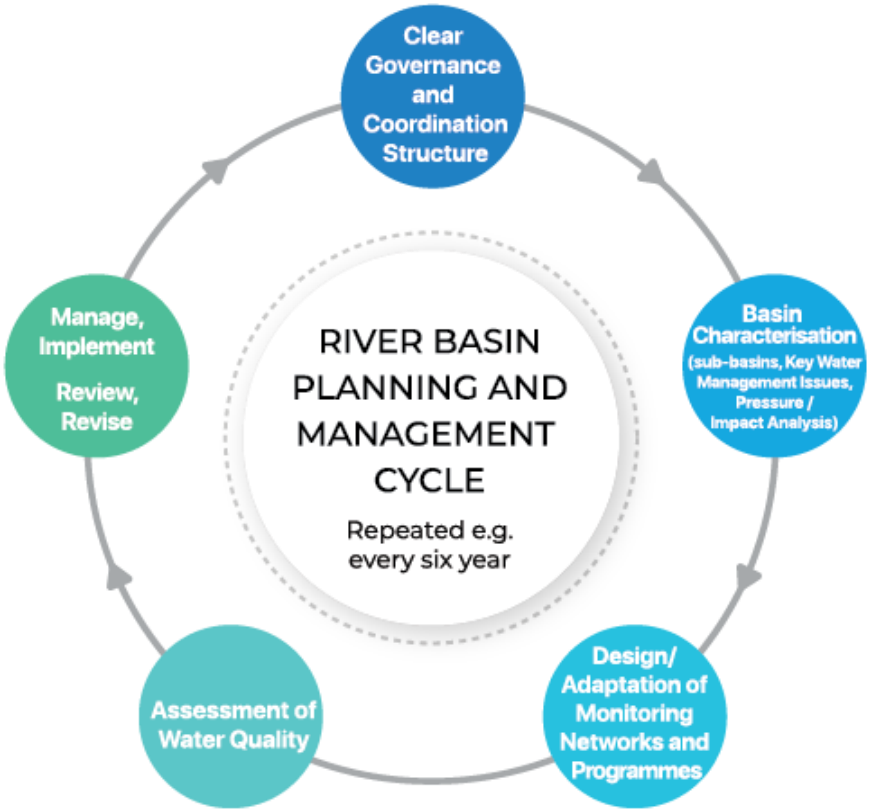
- Ecological status
  - Biology
  - Hydromorphology
  - Physico-chemical status
    red (not good) and blue (good)

Example Germany, 2015

89% of Germany´s water bodies are in a moderate, poor or bad ecological status.

(UBA 2017: Waters in Germany)

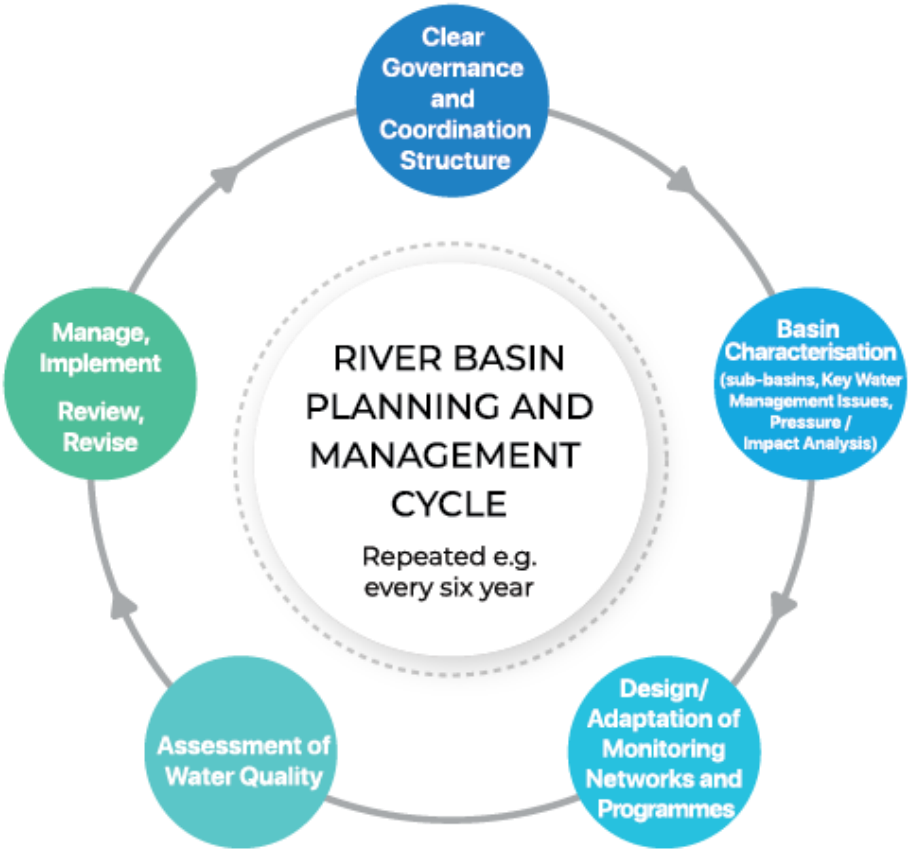
Element 5 (Step 5)



Manage, Implement, Revise, Review:

- Implementation of the first RBM Management Plan namely its Programme of Measure (POM)
- Revision and verification of the success of the program of measures within the River Basin Management plan timeline
- In Europe: Years 2015, 2021,2027 → Cycle length 6 years

River Basin Planning and Management Cycle



Inner Cycle → Technical process of planning and setting objectives (*operative level*)

River Basin Planning and Management Cycle

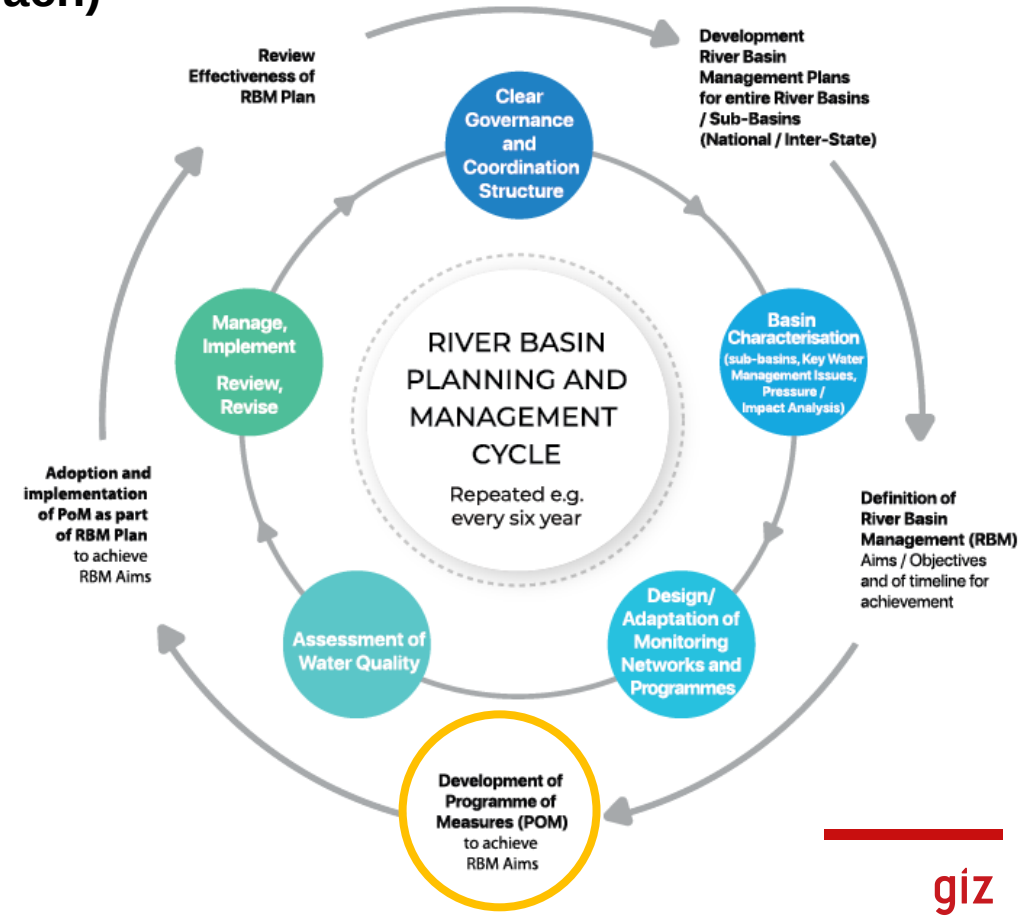
Outer cycle → Planning and decision taking level.

Finalisation of the RBM Action Plan 2009 (WFD Provision):

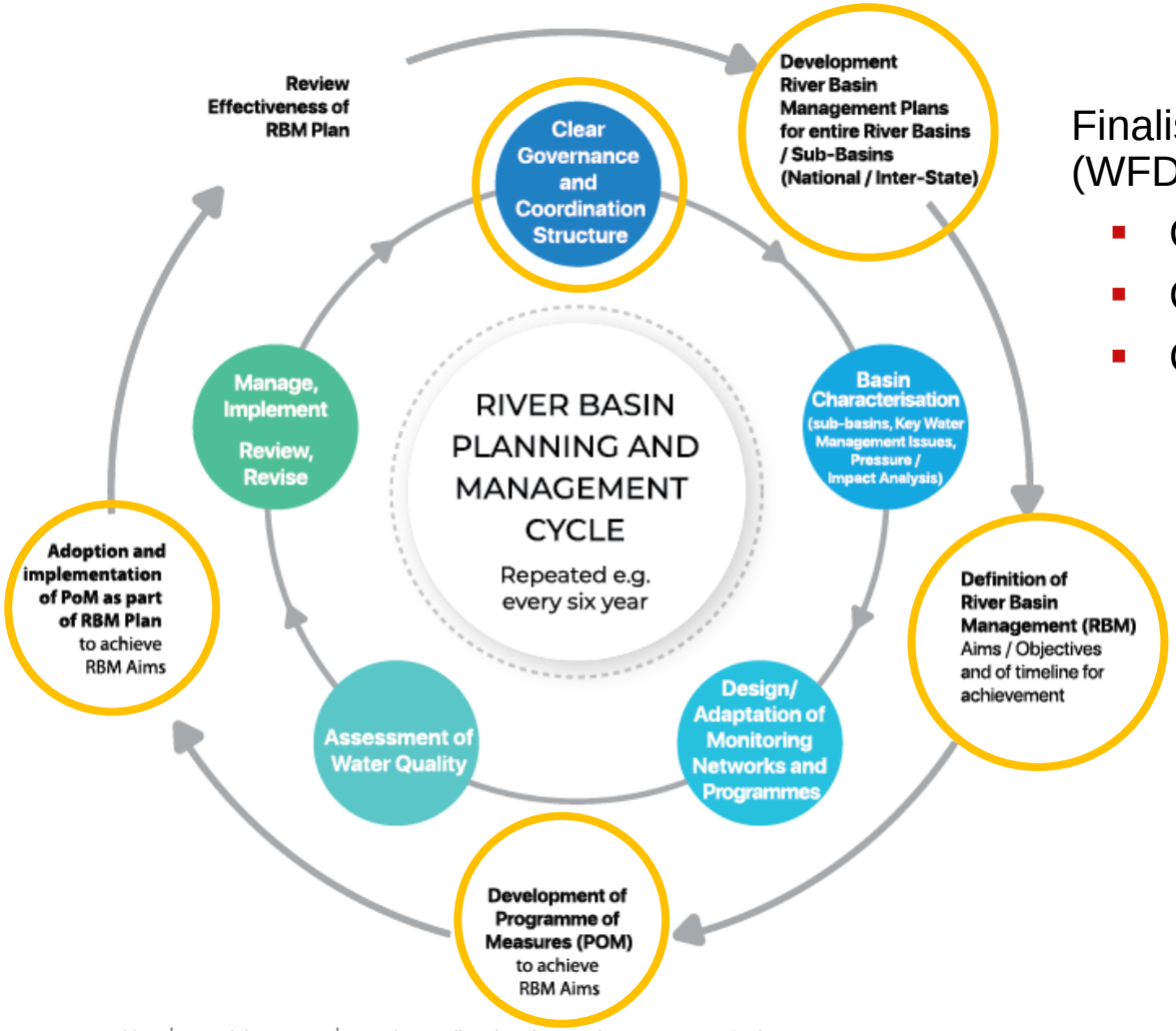
- Cycle 2015
- Cycle 2021
- Cycle 2027

Elements of the River Basin Management Plan and its Programme of Measures (WFD, Conceptual Approach)

- Environmental quality standards
- Best available technology
- No further deterioration but restoration
- Combined approach
- Best practicable environmental option
- Enforcement of permits



5. Example of Implementation in the EU Context

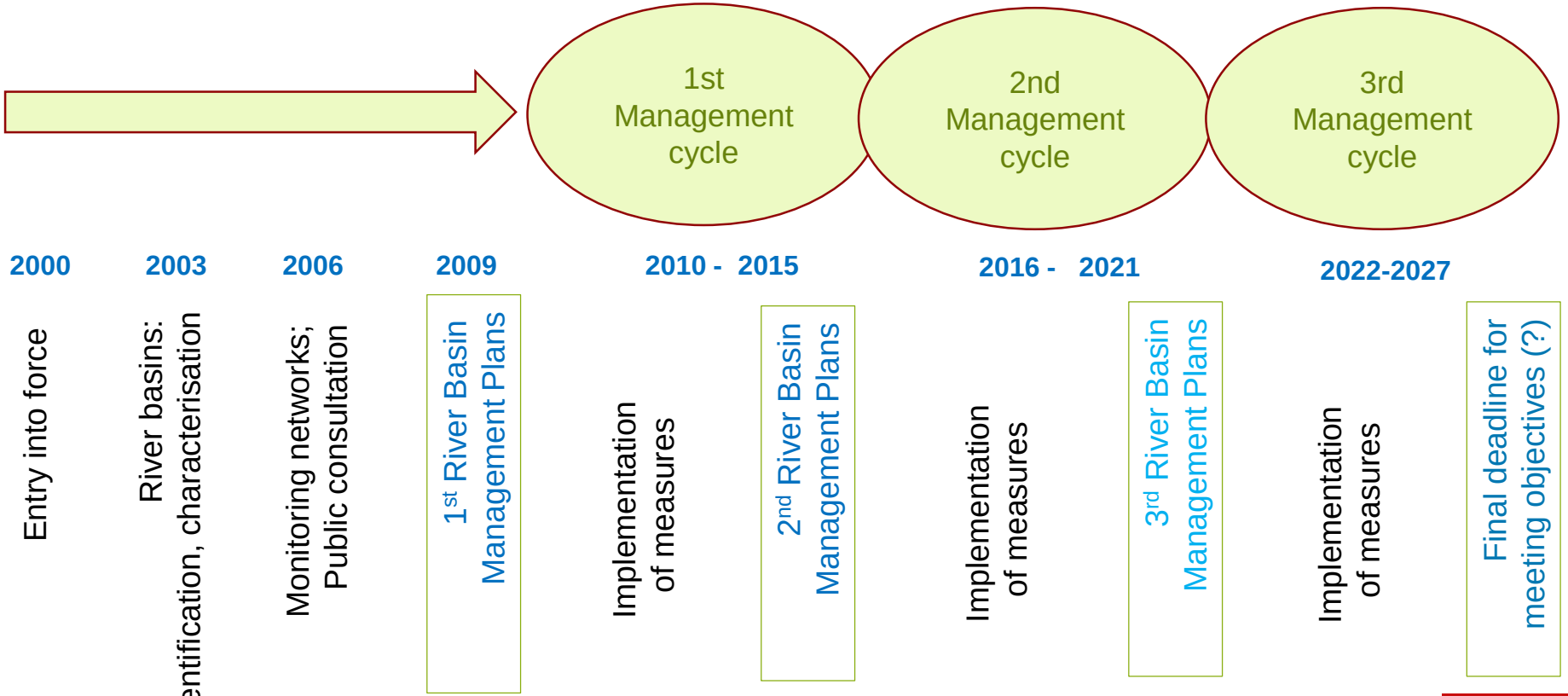


Finalisation of the RBM Action Plan 2009 (WFD Provision):

- Cycle 2015
- Cycle 2021
- Cycle 2027

Tasks important for the decision makers

EU WFD Time-Table to develop RBM Plans



Adapted from: http://ec.europa.eu/environment/water/water-framework/info/timetable_en.htm

Examples of Results from the Elbe River Basin Management Plan

River Basin Management Plan 2009 Maps

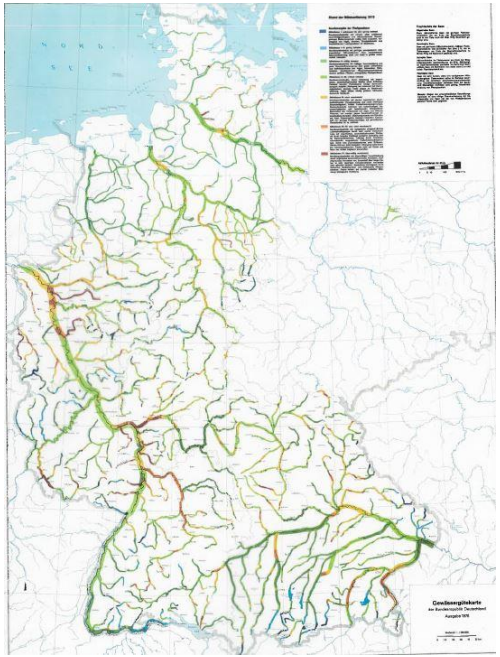
https://www.fgg-elbe.de/interaktiver-bericht.133/berichte-nach-art-13/karten-des-bewirtschaftungsplanes.html

River Basin Management Plan 2015 Maps

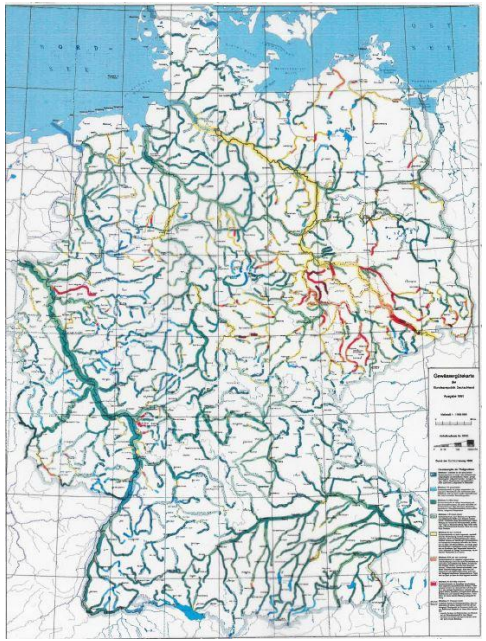
https://geoportal.bafg.de/mapsfggelbe/

Improvement of Surface Water Quality in Germany (1975-2000)

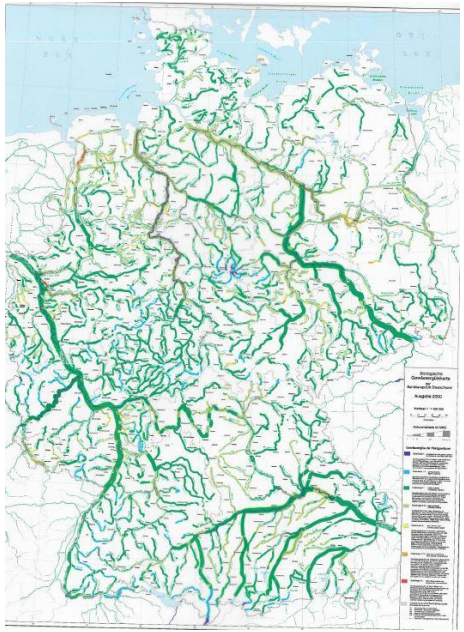
1975



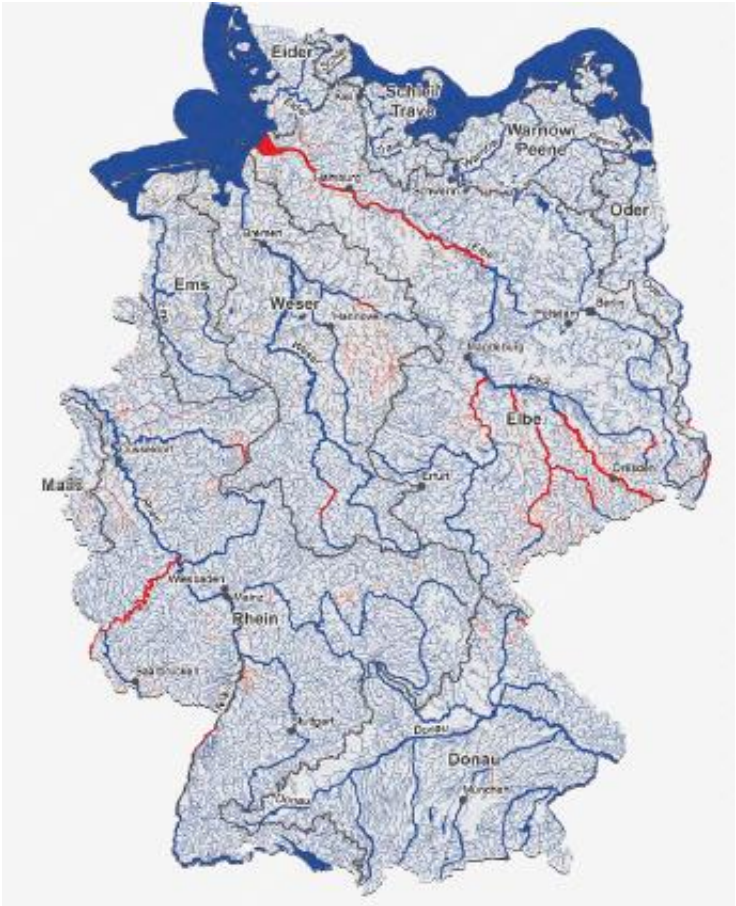
1990



2000



… but not everything is solved, improvement is still required!



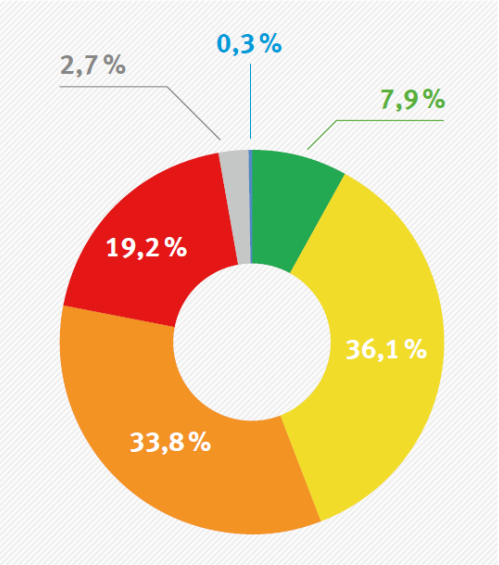
- Assessment of **Environmental Quality Standards (EQS) of priority substances**
- Good (blue) or not good (red)
- Assessment of 2016, without mercury (Hg), polyaromatic hydrocarbons (PAH), polybrominated biphenyls (PBB), and tributyltin (TBT))
- **Mercury** (Hg) results from coal fired power plants, and from industry
- **PAH** result for example from industry and any burning processes
- **PBB** are flame-retardants
- **TBT** is used on ships against biofouling (pesticide)

For more information, see UBA (2017) Waters in Germany: Status and Assessment. Pdf File, Literature LU4.

… but not everything is solved, improvement is still required!

	High status or reference conditions (RC)
	Good status (slight deviation from RC)
	Moderate status (moderate deviation)
	Poor status
	Bad status

EU Water Assessment - Colour codes

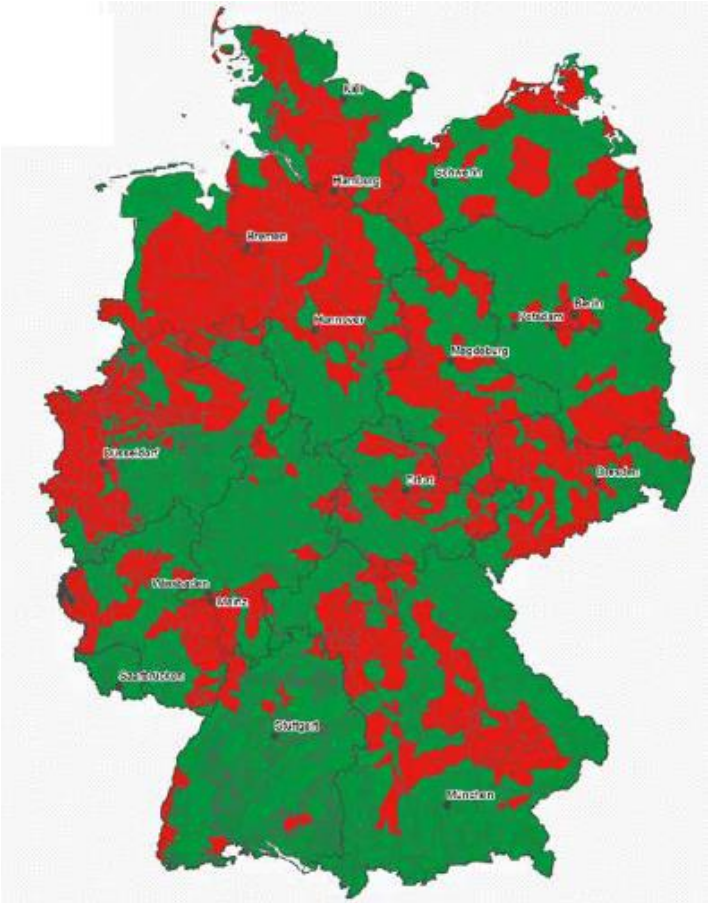


Example Germany, 2015

89% of Germany´s water bodies are in a moderate, poor or bad ecological status.

(UBA 2017: Waters in Germany)

… but not everything is solved, improvement is still required!



- Regarding groundwater quantity, the large pumping areas of lignite mining are a challenge for Germany.
- Regarding **groundwater quality**, there are areas with pollution from **agricultural activities, mainly nitrate, but also pesticides**.
- Groundwater resources have a long memory, so these problems will accompany Germany for the next decades.

Chemical status of groundwater bodies in Germany.
UBA (2017): Waters in Germany. Status and Assessment.

Factors and Ingredients of Success with Surface Water Protection
(*personal view of the presenter*)

1. Perception/awareness of the problem from the general public
2. Social and political commitment and consensus to tackle the challenge
3. Solid laws and legal security
4. Stable public administrative structures and professional capacity
5. Clear aims and targets to reach
6. Permitting system and thorough controls
7. Fees for the use of water, polluter pays principle
8. Adequate monitoring systems
9. Financial resources according to the necessary measures
10. Time, persistence and institutional stability

Discussions on the Factors and Ingredients of Success for RBM Planning

EXCHANGE

In your opinion, which of the 10 factors for success are mostly missing in India?

Based on my professional experience, I conclude:

Large scale water quality issues cannot be solved within few years … It is a long-term process

The positive turnaround is a function of time and persistence

Do not fall into frustration or despair

Thank you for giving us the opportunity to share our experiences with you!

References

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Registered offices
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Address

GIZ Office New Delhi

110057 New Delhi

India

T +91

F +91

E info@giz.de

I www.giz.de/india

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