Acquisition and management of lake-related water quality information at the global level

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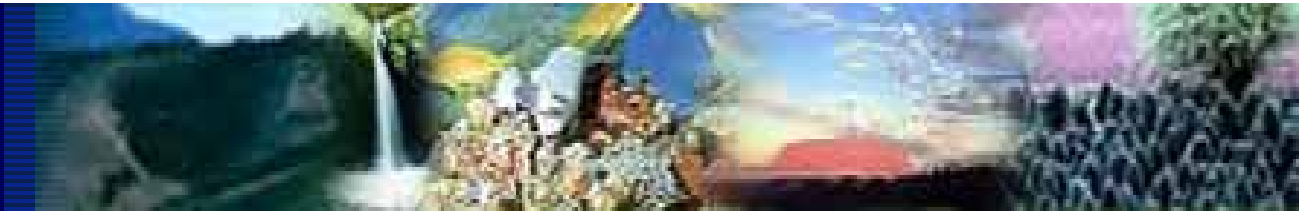
UNEP

GEMS Water



INTRODUCTION

- Global freshwater resources are shrinking in quantitative as well as qualitative terms due to pollution from: human and industrial wastes, agricultural activities and the interacting effects of climate change.
- Is the water quality of lakes and other inland waters improving or deteriorating?

Why is there a need for global water quality monitoring and assessment?

- Inland waters are a country's responsibility, however:
- There are 263 international river basins
- Many rivers flow into coastal environments
- There is general consensus that our knowledge of the state of the world's freshwaters needs to improve
- To assess current status and trends, identify emerging issues, vulnerability and hotspots
- Assess effectiveness of multilateral environmental agreements and conventions.

Why do we need long-term water quality monitoring programmes?

- Many aquatic systems may change slowly - the long-term record of key parameters provides the essential yardstick to assess status and trends.
- Especially important now as we try to assess and predict the impact of climate change and variability on inland water systems.
- Long-term programmes may also identify previously unknown “hotspots” and point to developing issues.
- Also necessary to determine whether an event or change is normal, unusual or extreme – may lead to the development of a scientific project or a more detailed monitoring activity.

Globally, Water Quality and Pollution are Priority Issues in All Regions of the World

Africa:	Variability of water resources
	Water stress and scarcity
	Access to safe water and sanitation
	Deteriorating water **quality**
	Wetlands loss
Asia & Pacific:	Water scarcity
	Pollution
Europe:	Water quantity and **quality**
	Policy and legislative framework
Latin America & Caribbean:	
	Decreasing water availability per capita
	Water **quality**
North America:	Groundwater
	Great Lakes water **quality**
West Asia:	Increasing water demand
	Overexploitation of groundwater
	Water **quality**
Polar Regions:	Alien Species
	Pollution

Source: UNEP (2002) GEO-3.

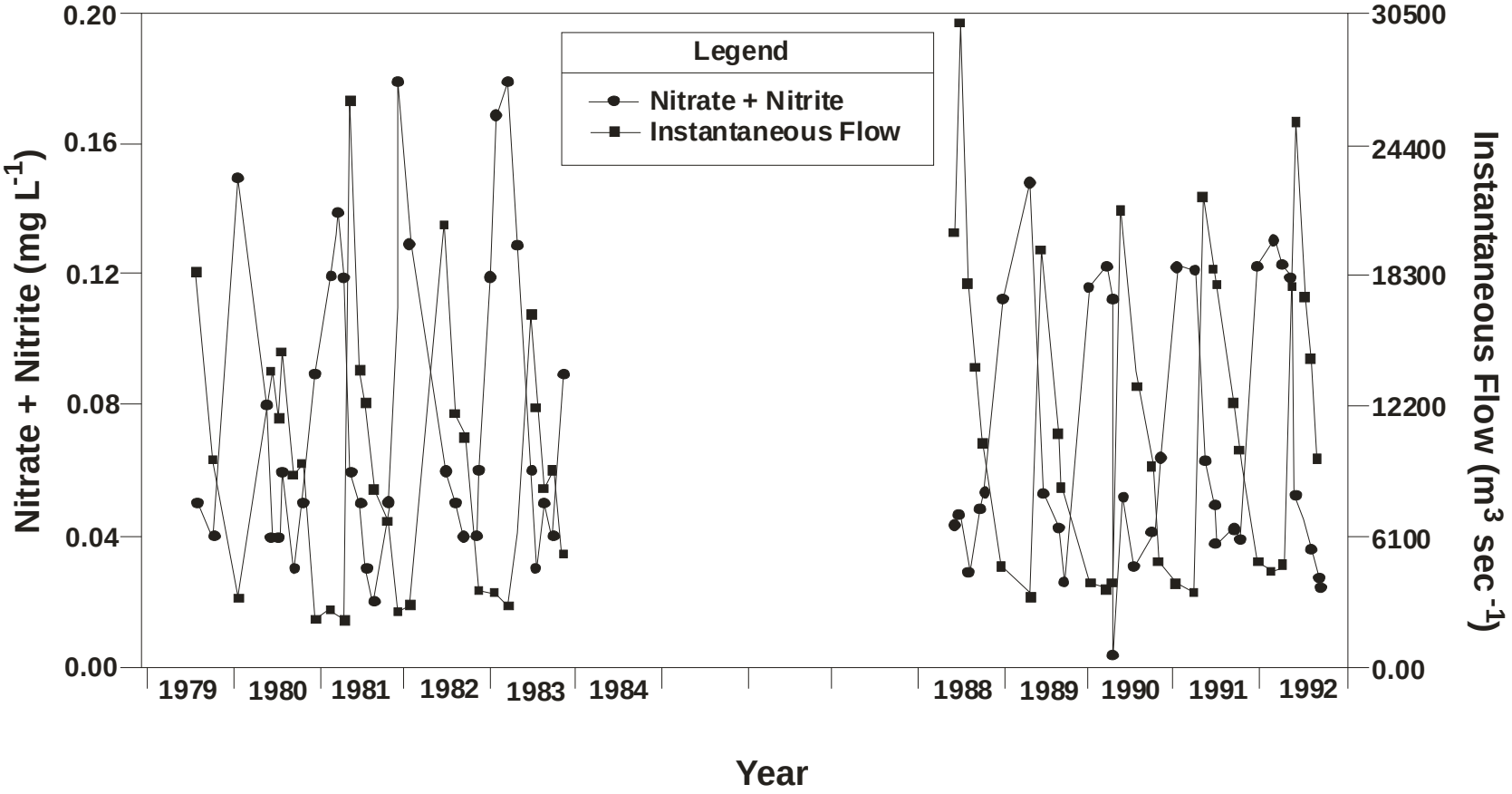
Negative Views of Water Quality Monitoring from the Past

- Monitoring was viewed by some as not being real science, but only a fishing expedition that diverts resources from “real” science.
- Programmes were large and expensive requiring sophisticated and expensive equipment.
- They were disconnected from the purpose of science or management as a result of organizational fragmentation.
- They became self-focused and their own sole purpose, i.e., monitoring for the sake of monitoring.
- Too many and unnecessary parameters were measured too frequently at too many stations.
- Large amounts of data were collected but not used.
- We cannot know today what crucial questions will need to be answered in the future.

Modern Lake Monitoring Programmes

- Water quality monitoring when properly designed and integrated into decision-making processes provides crucial information for the development of policies and management plans that protect and preserve our essential lake ecosystems.
- In countries where this was realized and financial resources could be re-instated for monitoring, programmes became operational again.
- The importance of water quality to not only ecosystem health but also to human health has in an increasingly number of developing countries led to political support to try and find ways to revitalize these monitoring networks (a good example is Kenya).

Effect of a decision to halt and restart monitoring – Mackenzie River, Canada



How to Acquire Global Inland Water Quality Data

There are two approaches to obtain this information:

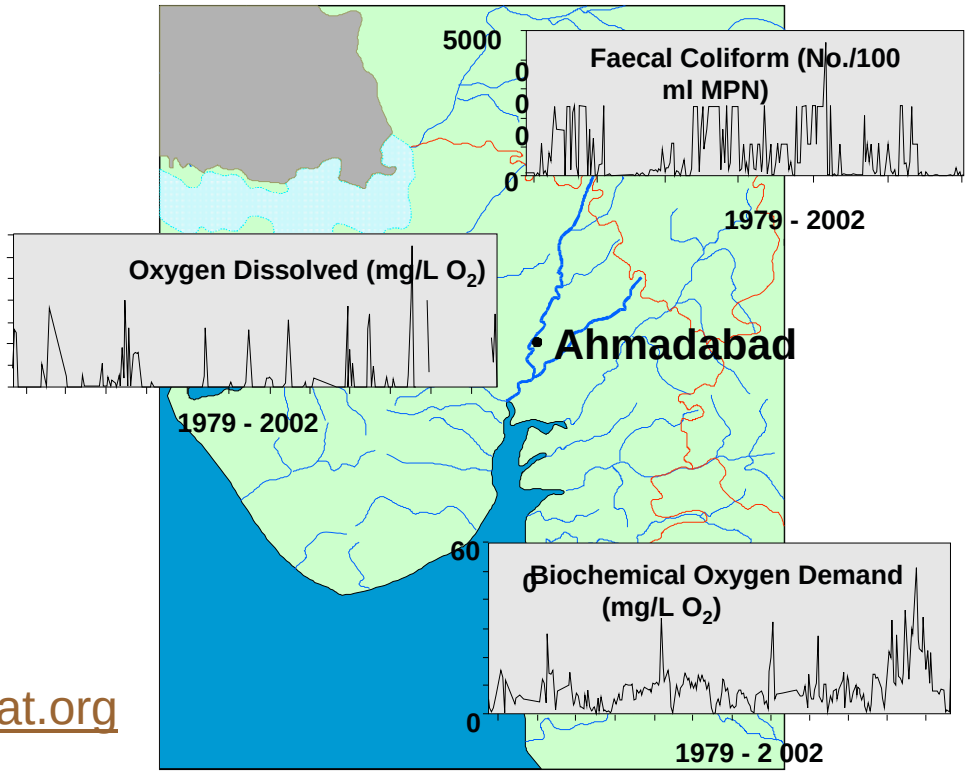
- Establish monitoring laboratories and staff worldwide to operate a global programme – this would be exorbitantly expensive and politically impossible at the present time.

- Create a network of participating countries and other organizations that provide data to a central global database.

The UNEP GEMS/Water Programme: A Network of Networks

GEMS/Water has created a network of more than 100 countries that provide data to a central global database - GEMStat.

More recently, universities and other organizations are providing water quality data sets to GEMS/Water.



www.gemswater.org and www.gemstat.org

PROBLEMS

This approach has limitations because GEMS/Water has no control over many aspects of the data:

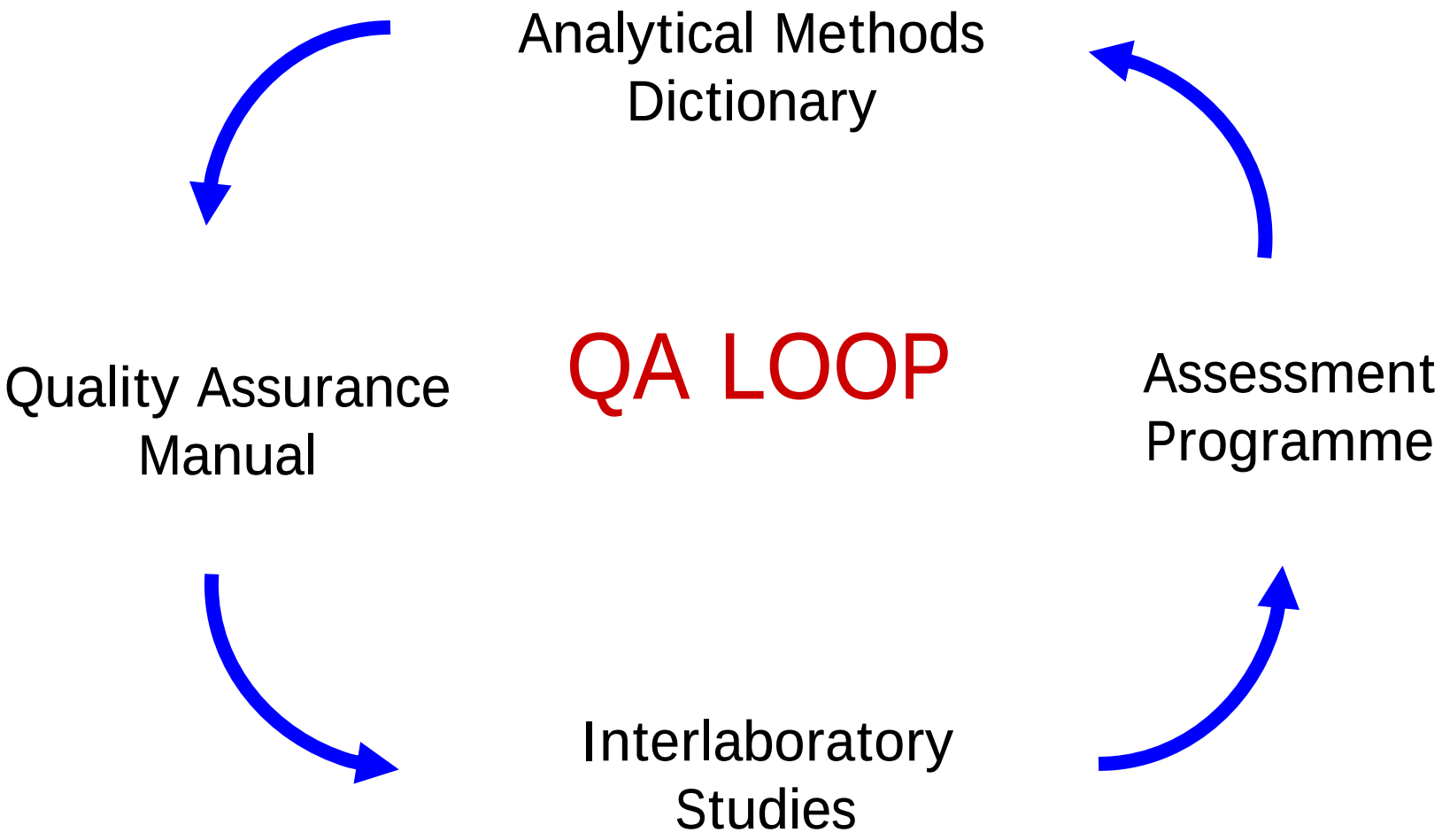
1. Geographically representative data – the location and number of sampling stations and the frequency at which they are monitored.

2. Relevant and reliable data – the parameters measured and the analytical methods used.

3. Real-time data – the delay between analysis and the transfer of data to the global database.

The GEMS/Water QA/QC Programme -

To minimize impacts of different data sources and methodologies in GEMStat

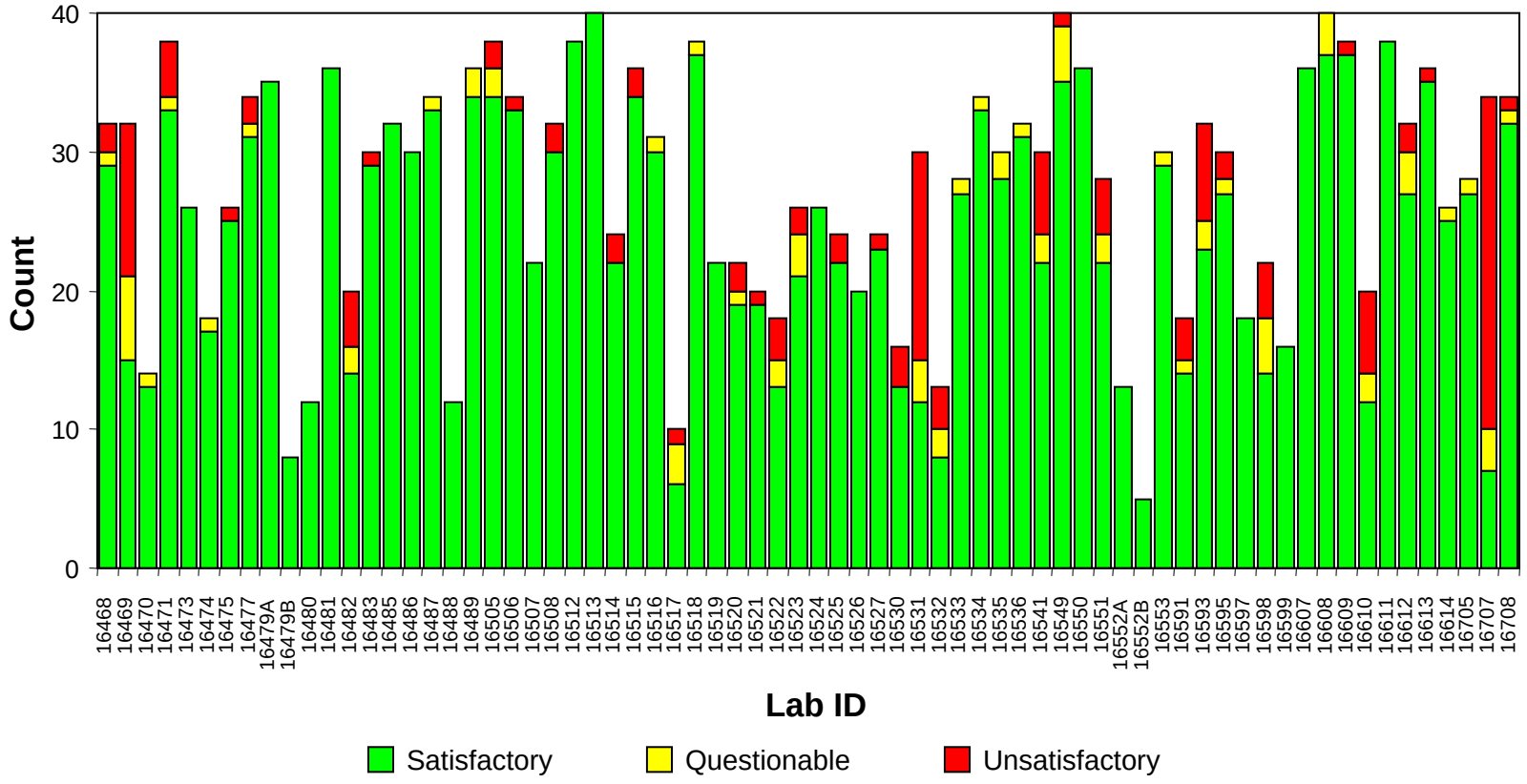


Outcomes and Benefits

The QA “loop” will improve water quality data:

- Known analytical methods are used (from AMD),
- QC procedures consistent between laboratories (as describe in the QMS),
- Interlay studies improve laboratory performance (PE Studies),
- Lab assessments will lead to improved analytical results.

Performance in Laboratory PE Study No. 5 was good



Analytical Methods Dictionary

- Documents environmental analytical methods used for water quality testing in participating countries
- Ensures the validity and comparability of water quality data
- Improves the reliability of global water quality assessments

Available at www.gemswater.org

QA Assessment Program – Building Capacity

- By request of laboratory or external agency

  (e.g. Panama Canal Authority via UNDP, Government of Uruguay)

- Review and advise on:
  - Monitoring strategies
  - Monitoring program design and implementation
  - Analytical techniques and methodologies
  - QA/QC procedures
  - Data handling, interpretation, and reporting

- Supports capacity building efforts

New Services from GEMS/Water

Review and advise on:

- Monitoring strategies
- Monitoring program design and implementation
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- Data handling, interpretation, and reporting

EVALUATION SERVICES FOR

National Water Quality Monitoring Programmes and Laboratories

Clean water is life

As a service to national water quality monitoring agencies, UNEP's GEMS/Water Programme undertakes specialized auditing activities. These include a review and evaluation of the efficiency, technical rigor and scientific credibility of all aspects of the water quality monitoring programme, from design to implementation.

GEMS/Water also provides national laboratories with the technical basis to judge their own ability to address departmental water quality monitoring responsibilities. As well, GEMS/Water can assist laboratories to prepare for international accreditation to ISO/IEC 17025.

Contact

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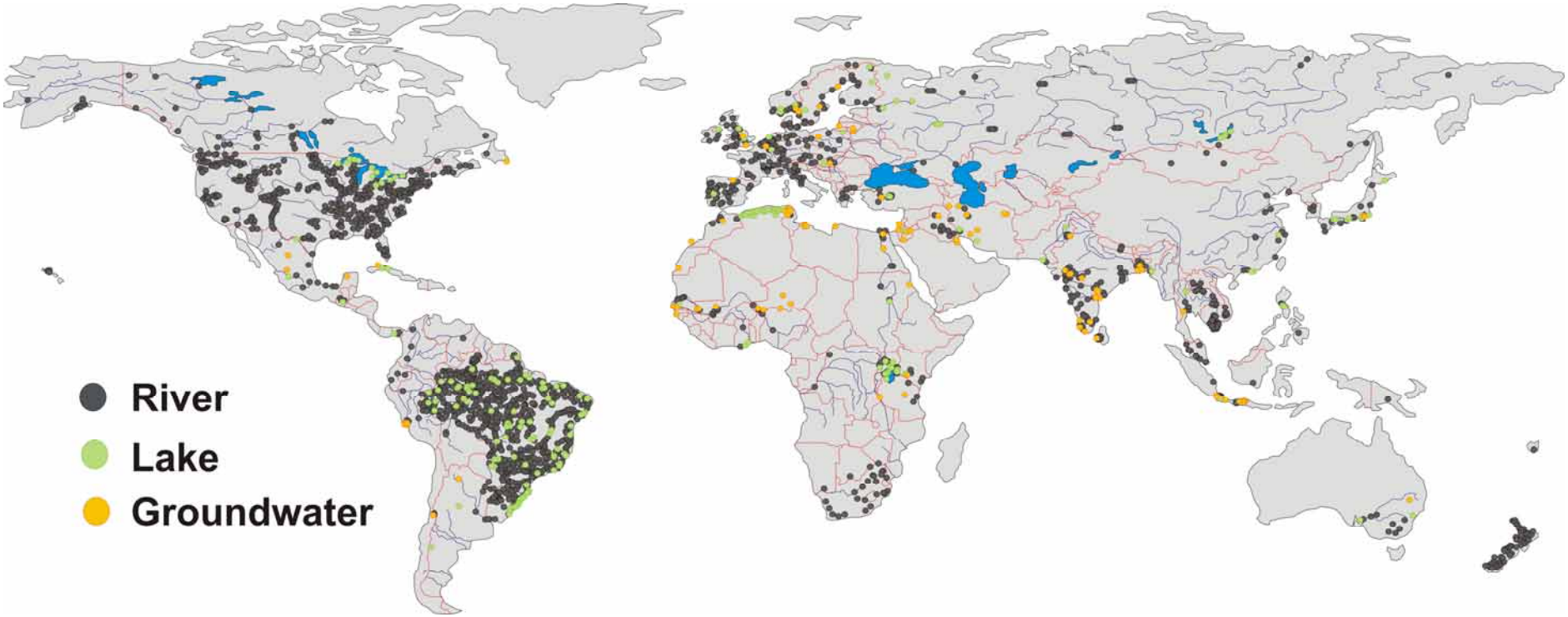
UNEP

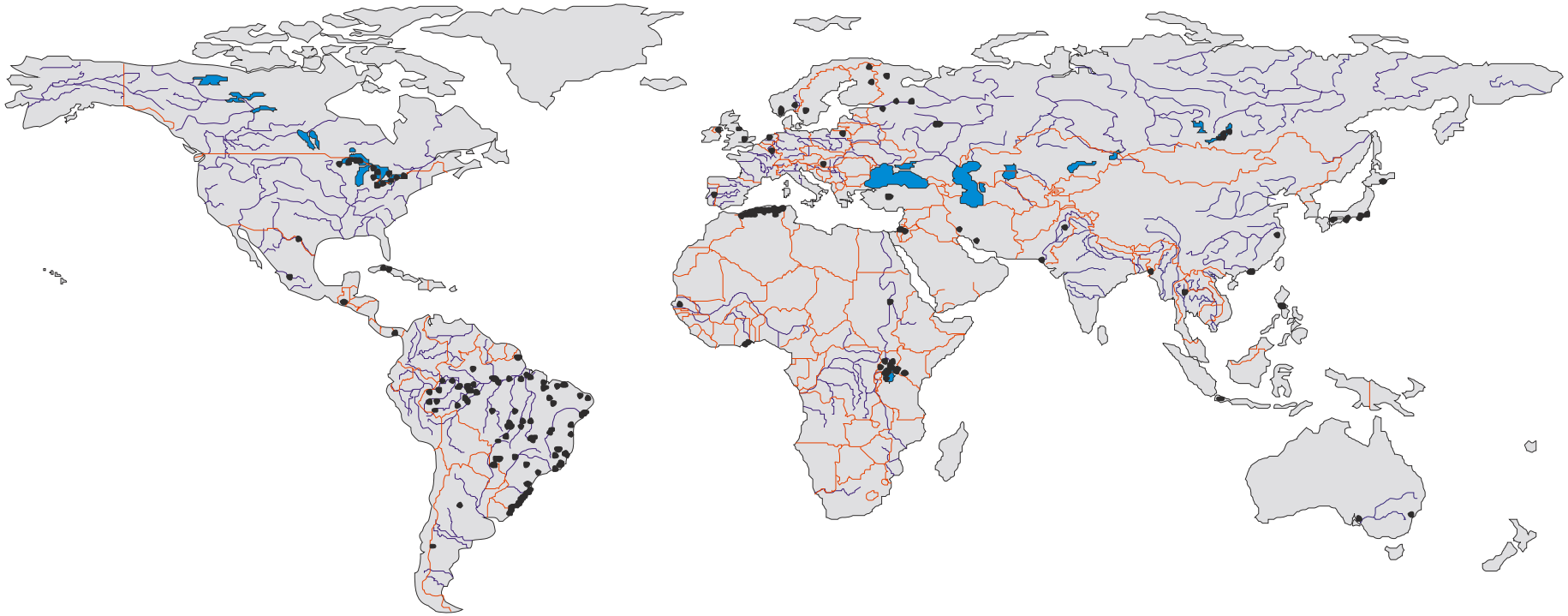
GEMS Water

UNEP's GEMS/Water Global Network



Total stations: 3021

GEMS/Water Lake and Reservoir Monitoring Stations



Total = 267 – mainly surface water samples

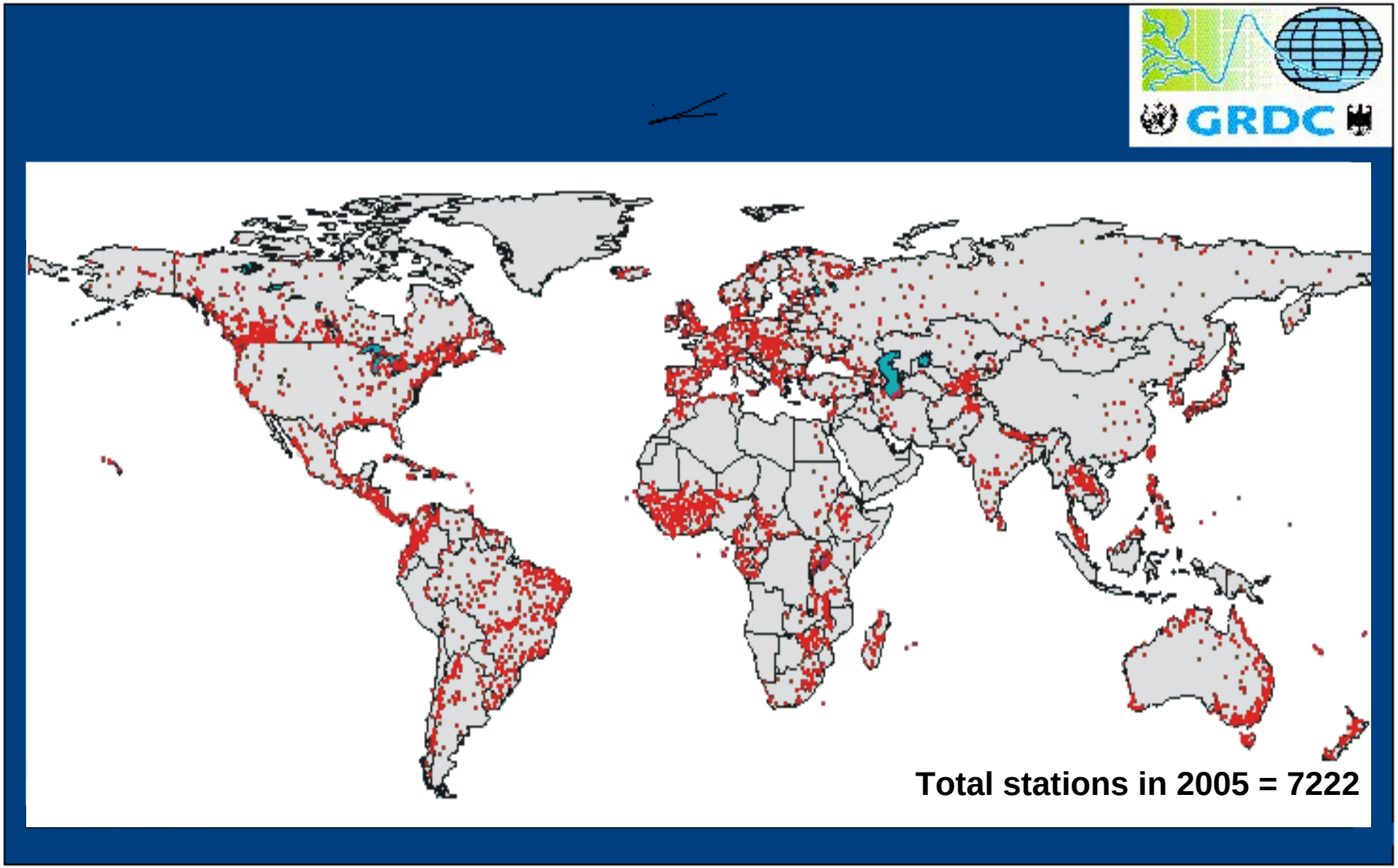
Only 44 stations have two or more sampling depths

GEMS/Water Data Categories

- More than 100 parameters
- Almost 4 million data entries

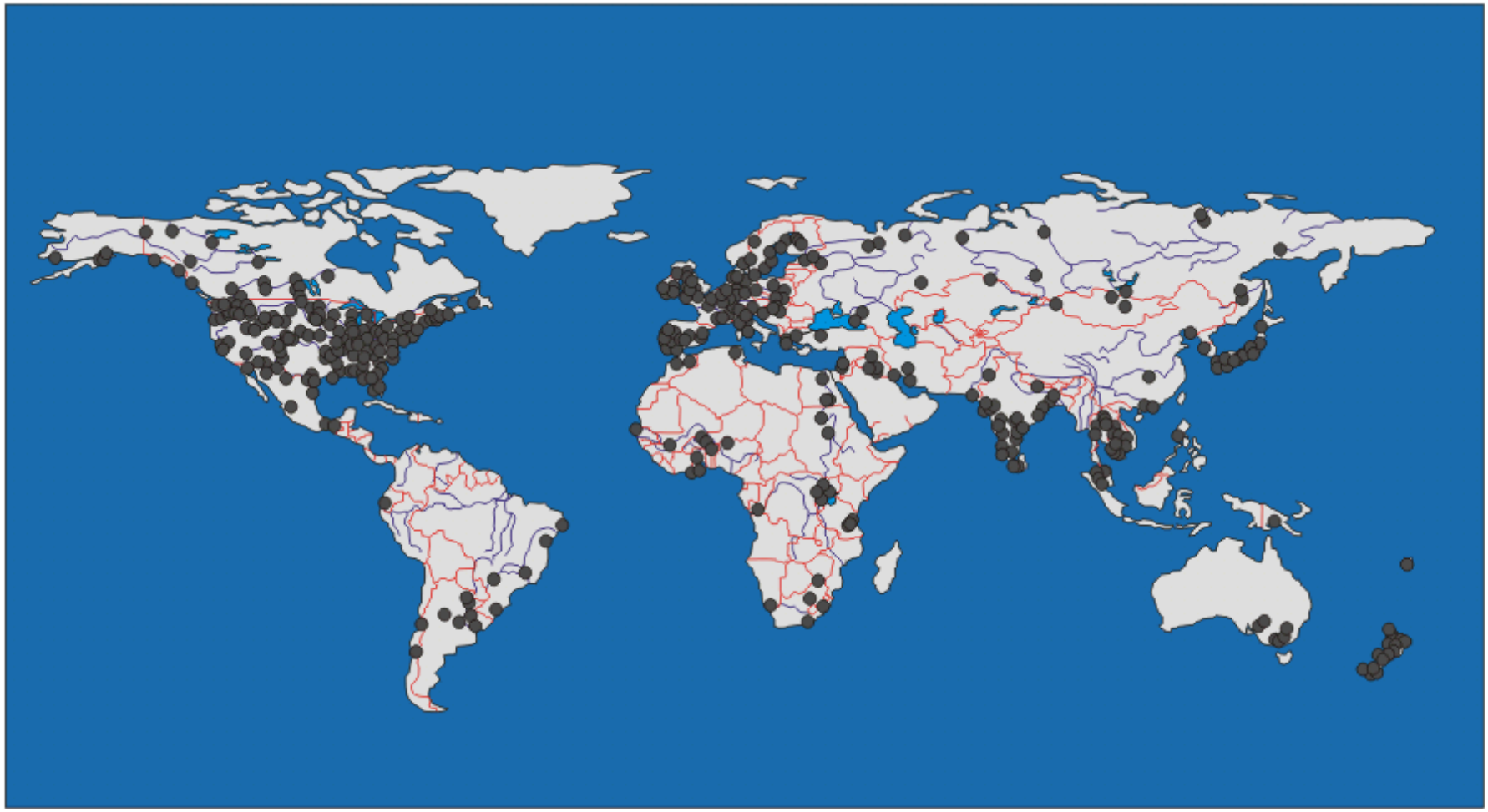
Region	Physical / Chemical	Nutrients	Major Ions	Metals	Organic Matter	Organic Contaminants	Micro-biology	Hydrological & Sampling Variables	Date Range
Africa	62619	67076	102612	9617	5005	1732	4846	313	1977-2007
Americas	188374	220634	237890	307041	38275	594344	19758	12997	1965-2006
Asia	214495	117784	151144	82380	47529	8646	36764	12256	1971-2007
Europe	249178	146846	134365	182091	72144	23985	40061	66983	1978-2005
Oceania	212018	89713	11159	3199	14248	1438	5249	18000	1979-2006
Total	926684	642053	637170	584328	177201	630145	106678	110549	1965-2007

Global Runoff Data Centre (Koblenz, Germany) - GEMS/Water Hydrological Counterpart Programme



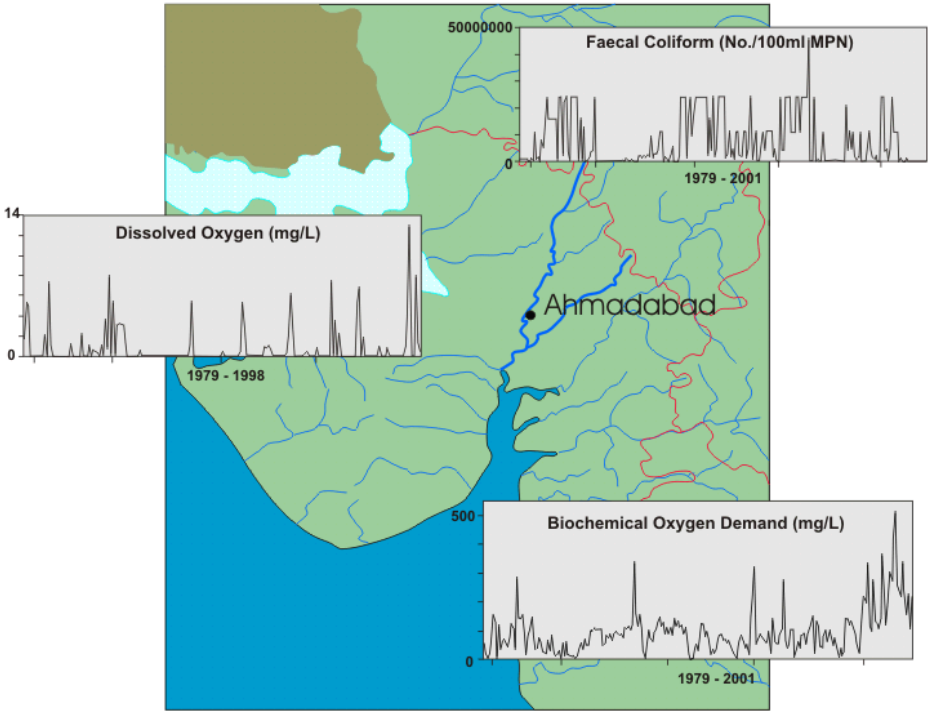
Joint GEMS/Water and GRDC Stations (446)

Integrating water quality and quantity data for flux computations



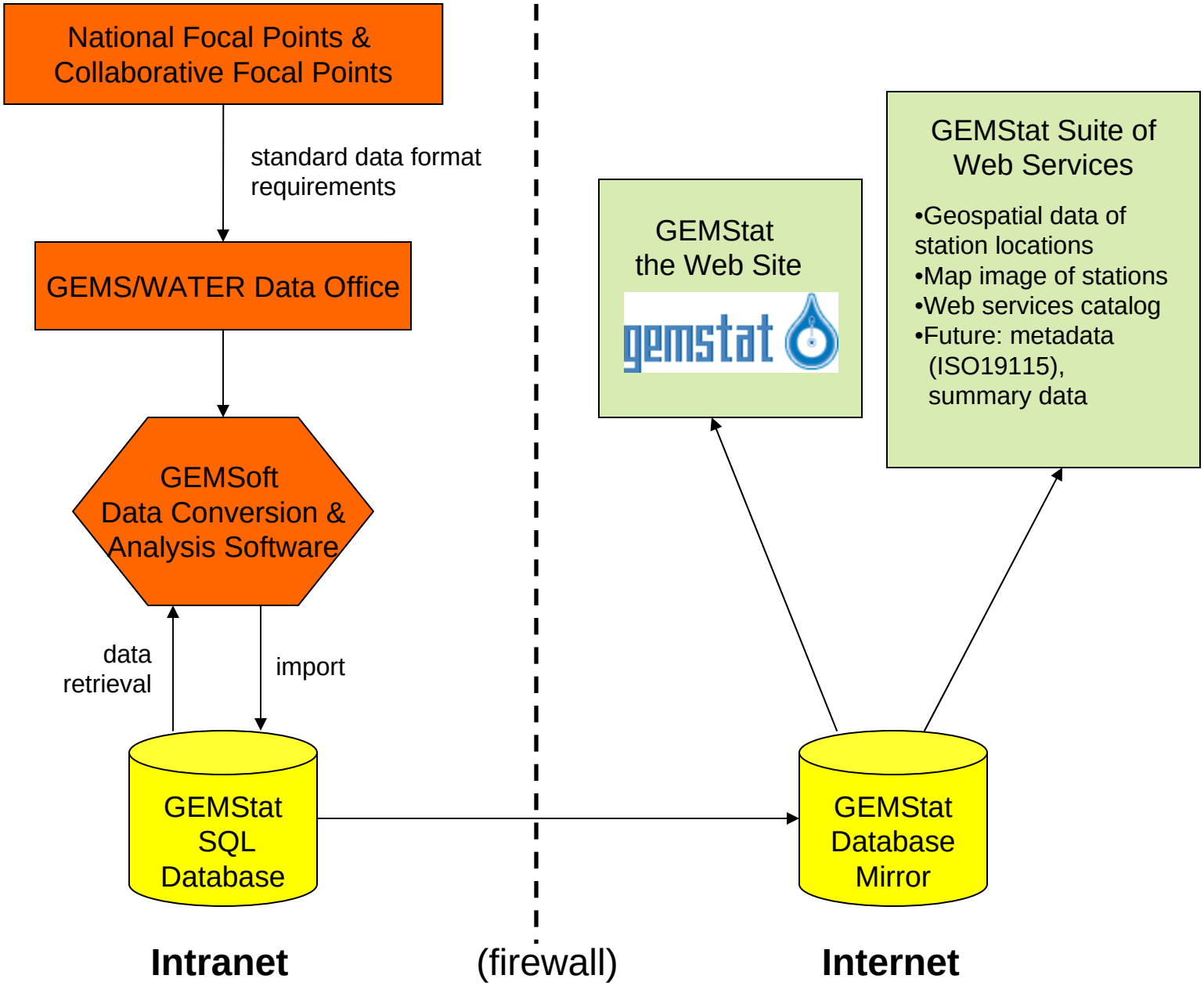
Data Warehousing and Access: GEMStat

- http://www.gemstat.org
- GEMS/Water database
- Searchable online
- Station profiles
- Summary statistics and graphics, flux calculations
- Safe and secure off-site storage of data
- A suite of web services

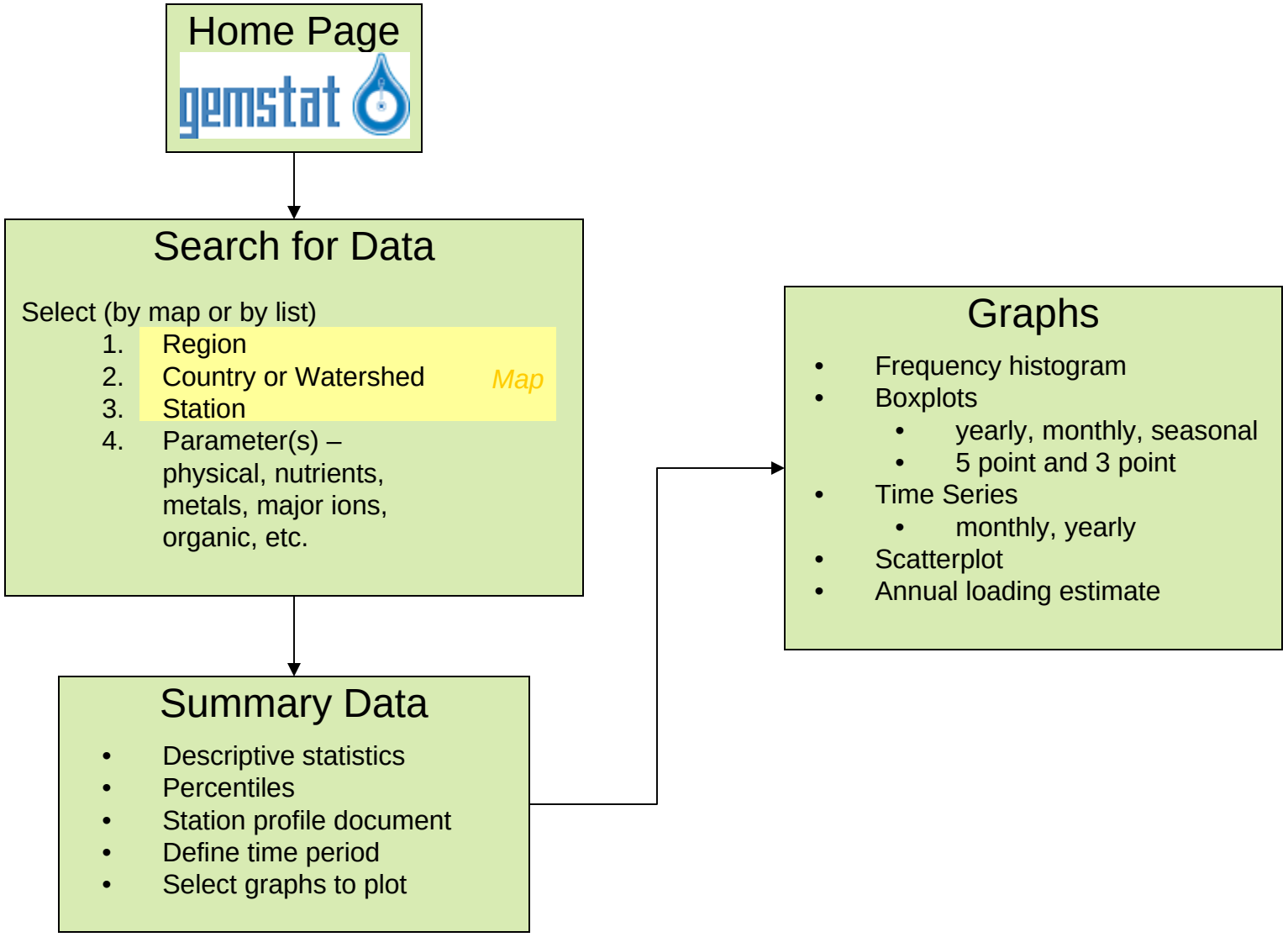


gemstat

GEMS/Water System Architecture



GEMStat – Site Map

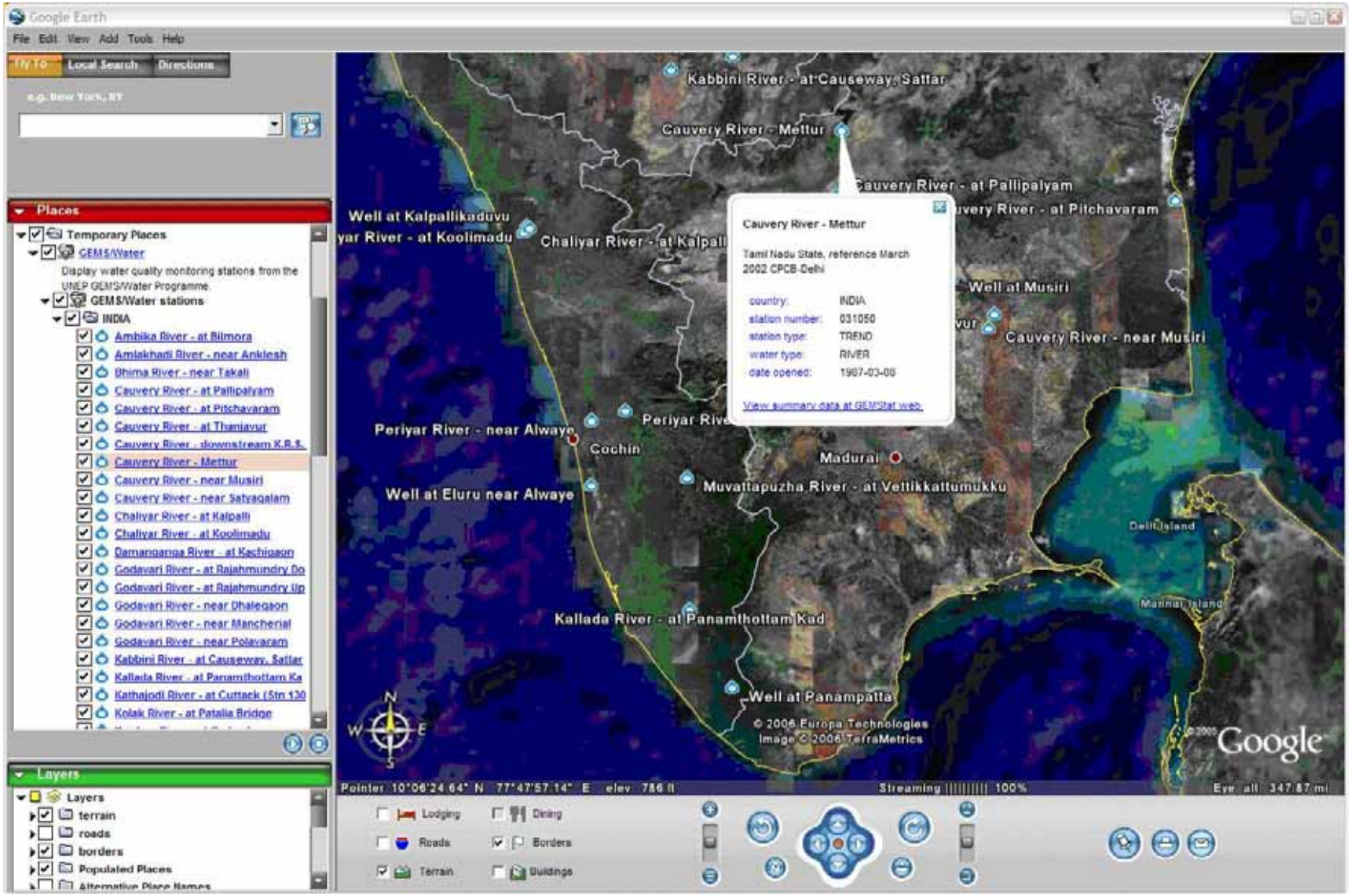


GEMStat Homepage –

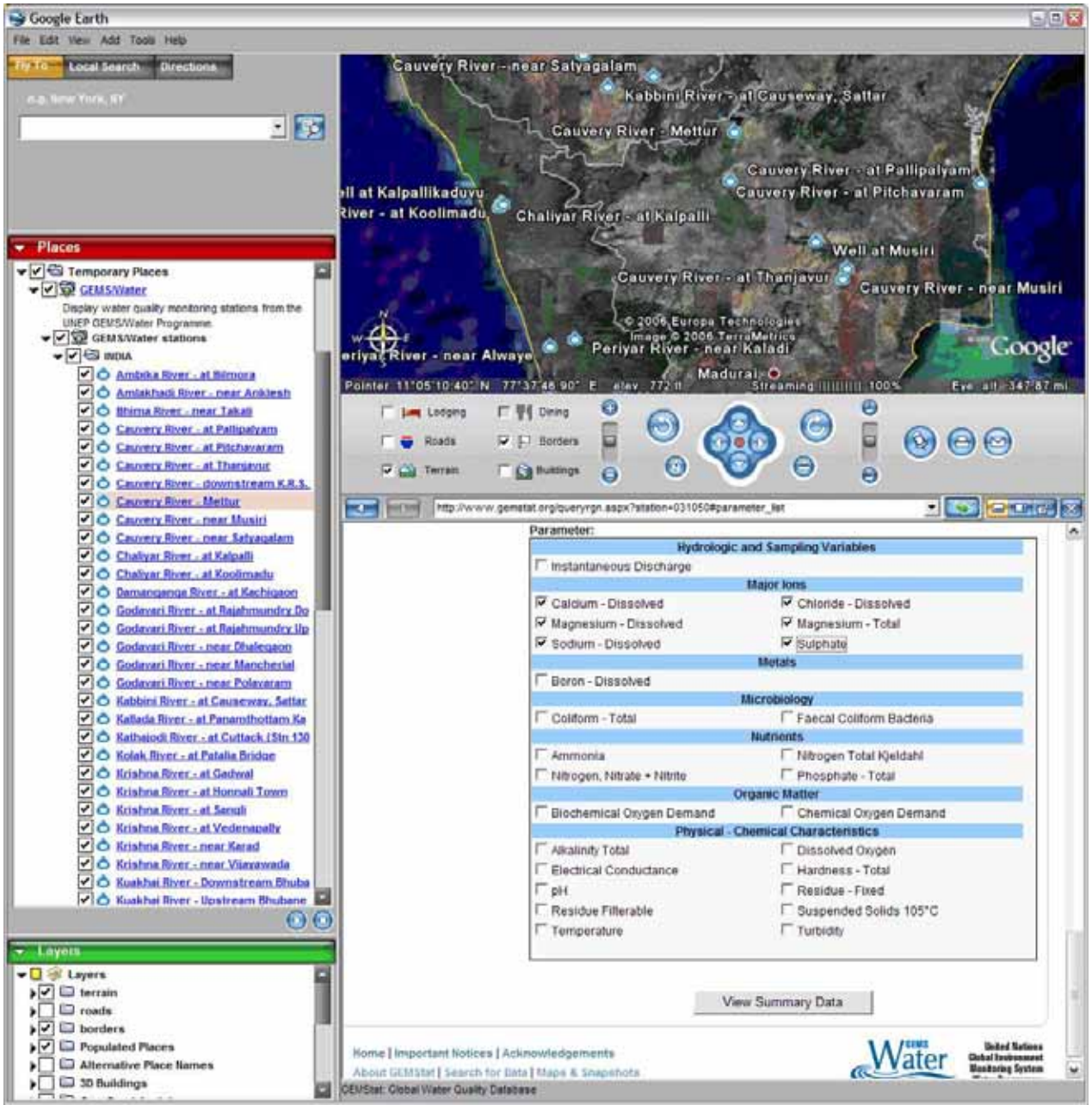
www.gemstat.org

GEMStat and Google Earth

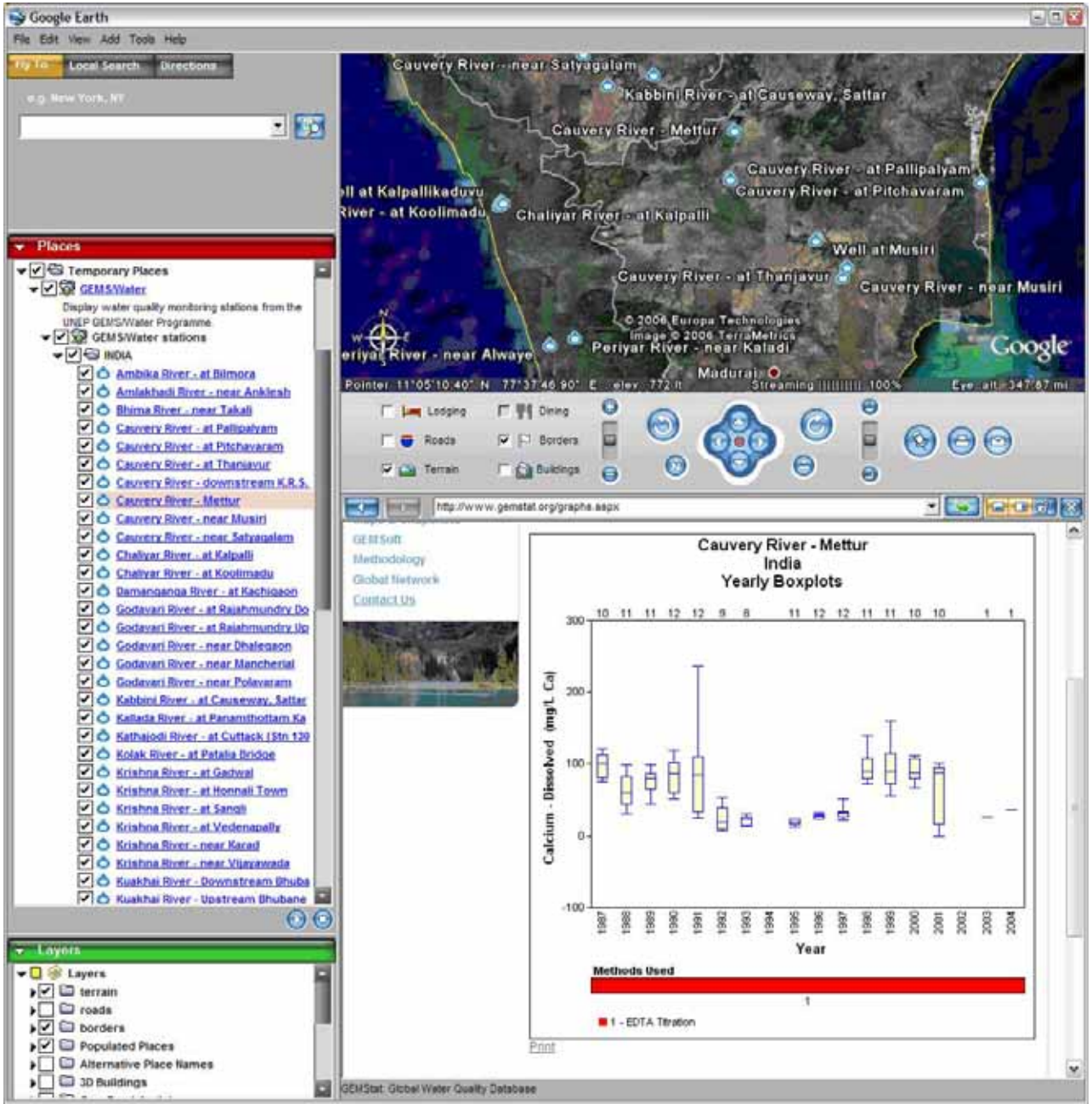
GEMS/Water and Google Earth



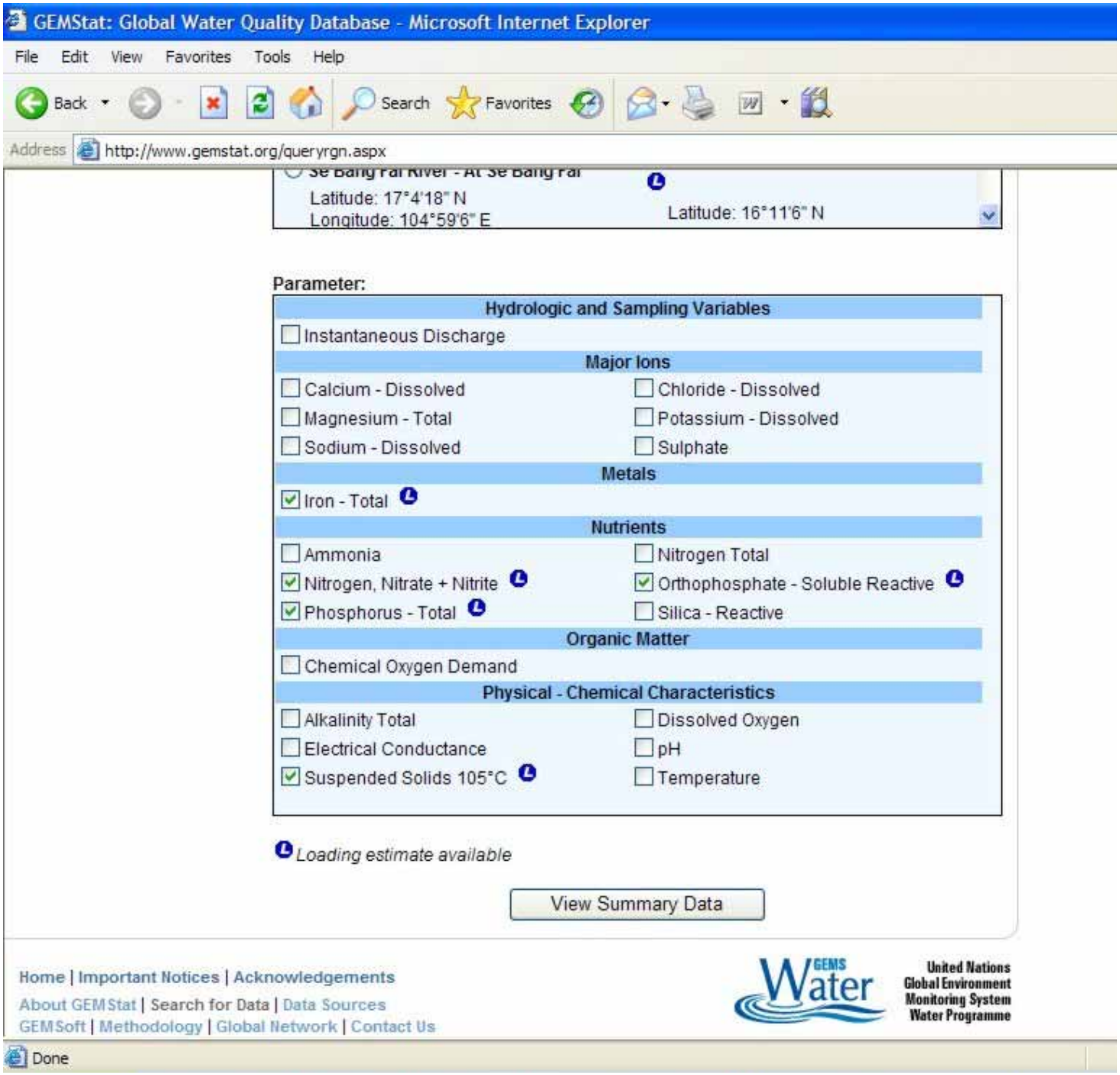
GEMStat and Google Earth – drop down menu for parameter selection



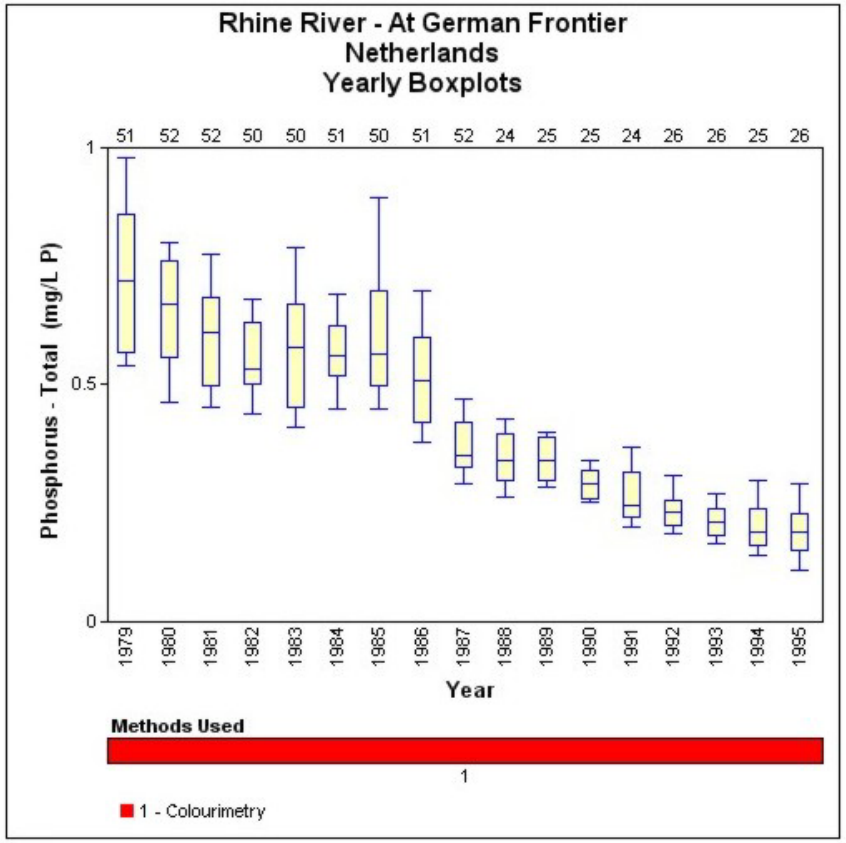
GEMStat and Google Earth – plotting selected parameters

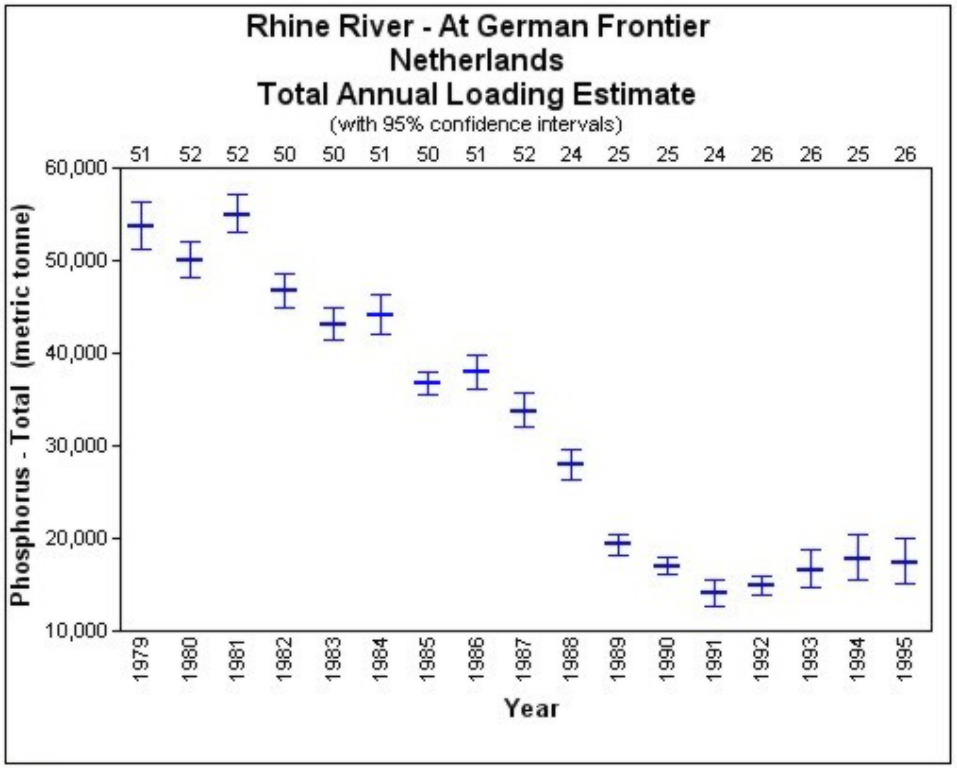


The “L” beside parameters indicates that flux data are available and can be plotted



Station_Number	GRDC_Number	Parameter_Code	Year	NWRI_Estimate	Lower_CI	Upper_CI	NumDataPoints
046001	6435060	Phosphorus Total	1979	53724.82352	51299.93554	56264.33311	51
046001	6435060	Phosphorus Total	1980	50048.33695	48153.32136	52017.92859	52
046001	6435060	Phosphorus Total	1981	54993.21517	52963.16196	57101.07936	52
046001	6435060	Phosphorus Total	1982	46699.04302	44927.77	48540.14831	50
046001	6435060	Phosphorus Total	1983	43135.79446	41396.41312	44948.26058	50
046001	6435060	Phosphorus Total	1984	44106.97811	41983.34907	46338.02593	51
				36658.74705	35435.3595	37924.37143	50
				37894.48429	36134.00975	39740.73039	51
				33774.01252	32030.5156	35612.41211	52
				28001.9055	26407.48077	29692.59802	24
				19290.33892	18250.55545	20389.36167	25
				17024.903	16157.61749	17938.74142	25





Total Phosphorus Loading Estimate

The Netherlands - Station 046001

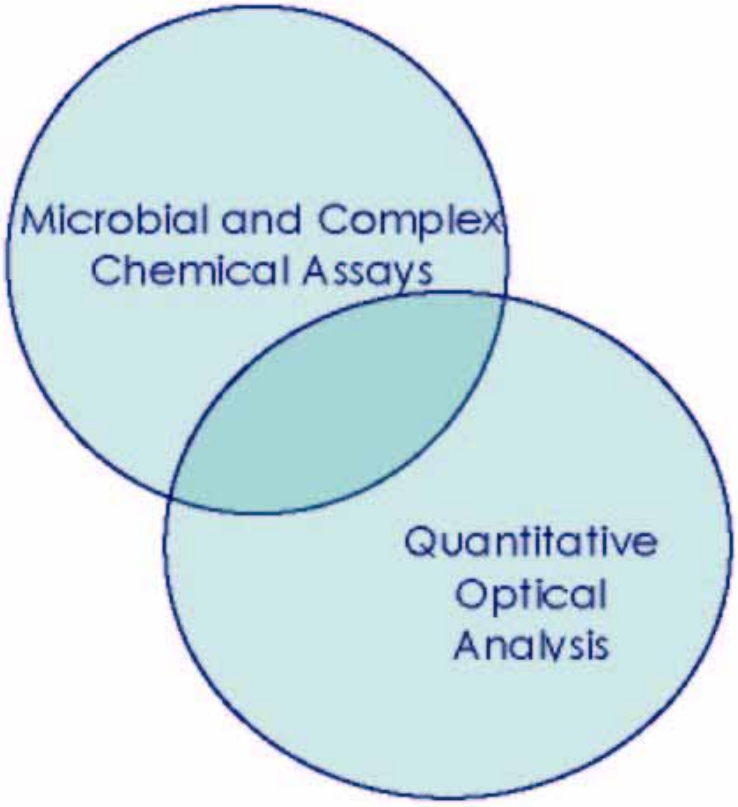
New technologies for water quality monitoring

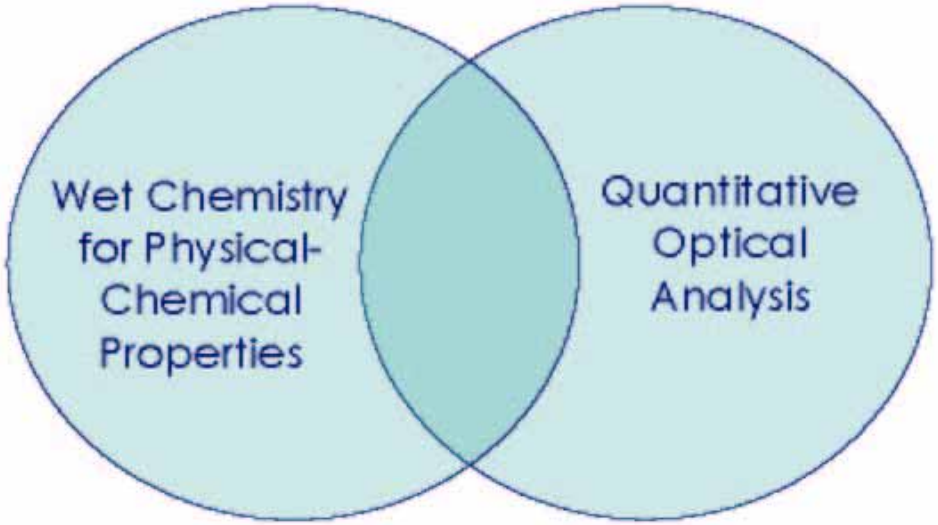
- Development of novel, accurate, and precise tests for the detection of physical-chemical properties, biologicals or pollutants in water has accelerated in the past decade as new technologies have become available.
- One of the most promising advances, the Sensicore WaterPOINT 870 Multi-Parameter Optical Water Quality Analyzer based on lab-on-a-chip technology, was introduced in 2006 and boasts up to 24 different physical-chemical results in just a few minutes.
- **Physical-chemical detection**: flow-injection immunoassays dipstick immunoassays, test strips coated with colloidal gold particles, liposome-amplified immunoassays, electrochemical immunoassays, chemi-luminescent immunoassays, magnetic immunoassays, and surface plasma resonance immunoassays.
- **Microbial contaminants**: new enzyme/substrate methods that incorporate high-sensitivity fluorescence detection instruments, quantitative Polymerase Chain Reaction (qPCR) and Rapid Bacteria Detection (RBD) system based on laser flow-through technology and capture of the antigen by antibodies on magnetic beads.

New technologies for water quality monitoring

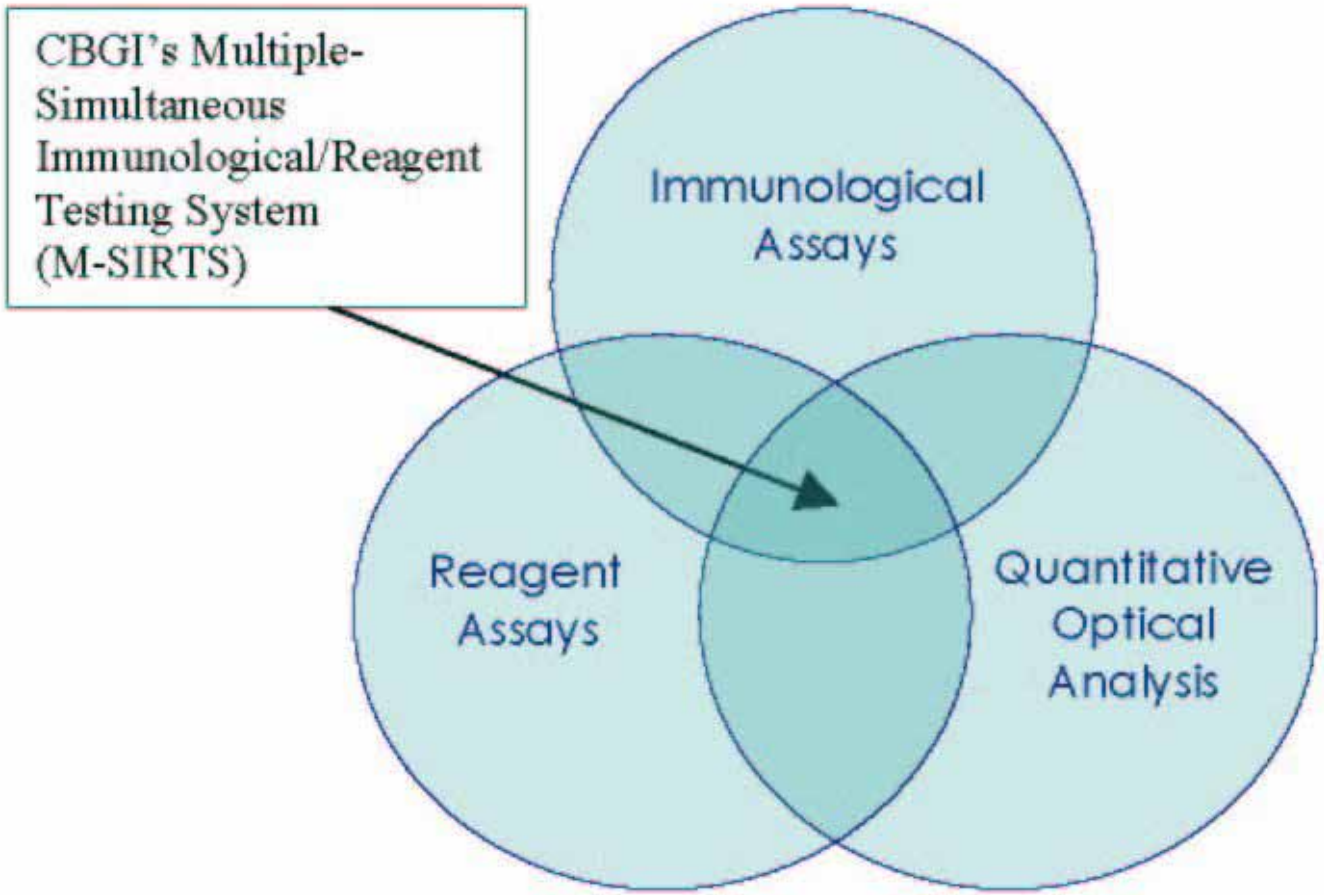
- All of the methods currently being developed for chemical and microbial analysis rely on sophisticated, expensive, lab-based equipment and highly skilled operators.
- New technologies must address limitations with current technologies to be effectively adopted into a water quality monitoring programme: it must either be faster, more portable, more user friendly, more accurate, more cost effective, and/or produce a broader range of parameters sought by water quality monitors
- There is currently no single supplier or known technology capable of performing analyses for both physical-chemical and microbial properties in environmental water samples.
- Chipotle Business Group, Inc. (CBGI) is developing the first water testing system capable of performing multiple immunological and reagent assays, side by side up to 100 total assays, simultaneously using the same quantitative optical detector, thus allowing a much easier, faster, cost effective, and comprehensive testing method.

Current approaches for water quality monitoring – parameters measured separately





New approach for water quality monitoring – integrated system



New approach for water quality monitoring – miniaturized kits