2015-UN ANNUAL INTERNATIONAL ZARAGOZA CONFERENCE
15-17 JANUARY 2015, ZARAGOZA, SPAIN

Risk assessment as a tool to improve water quality and the role of institutions of higher education

Professor Joan B. Rose
rosejo@msu.edu
Homer Nowlin Chair
Center for Water Sciences

Kyana Young[1], Joan B. Rose[1], John Fawell[2], Rosina Girones Llop[3], Hung Nguyen-Viet[4] and Maureen Taylor[5]

[1]Michigan State University
[2]Cranfield University
[3]University of Barcelona
[4]Hanoi School of Public Health & International Livestock Research Institute (ILRI)
[5]University of Pretoria

MICHIGAN STATE UNIVERSITY

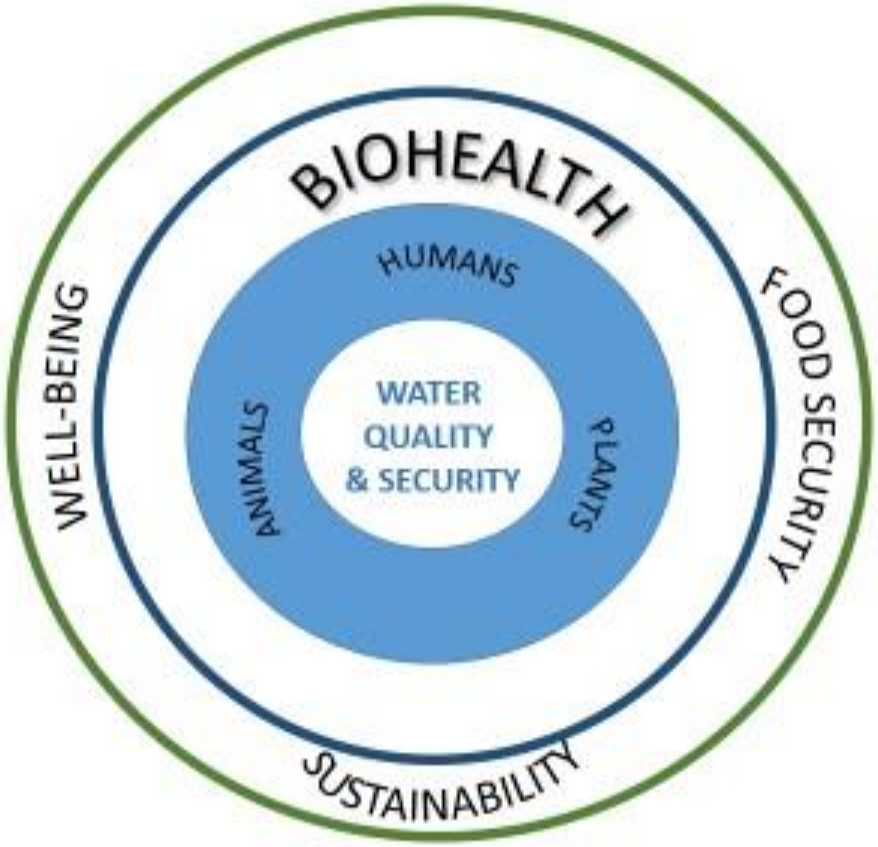
Session Discussion Questions

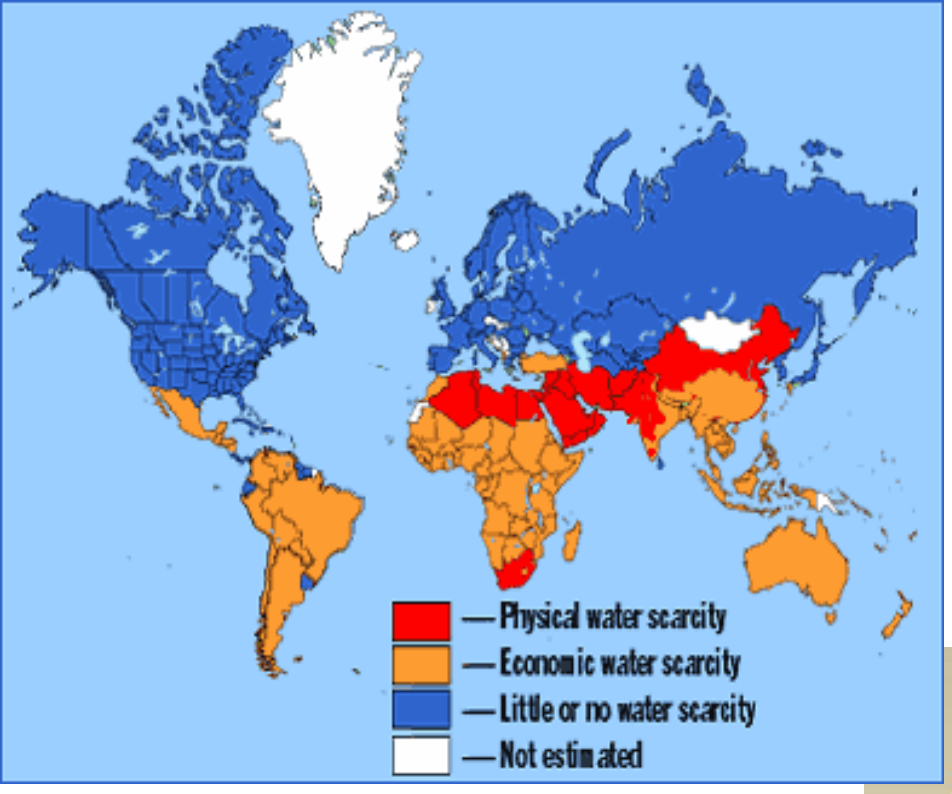
- How is water quality and health fairing globally in the era of the Anthropocene?
- How can the risk analysis framework integrate science and policy and promote the translation of science into action?
- What key technology can be used for water diagnostics to improve resolution of the evidence for decision making?
- What does the 21st century water curriculum for future water scientists and engineers look like?
- What role of the academic institution in building capacity in all disciplines needed to undertake effective risk analysis?.
- Stakeholders' roles: What are the views of academia about the roles of other stakeholders (Governments, business, civil society, and media) in Risk Assessment?

The United Nations Rio+20 Summit in 2012 Began the Conversation on the New Global Sustainable Development Goals

"Protection of Earth's Life Support System including the atmosphere, oceans, forests, waterways, biodiversity and biogeochemical cycles is a prerequisite for a thriving global society" Griggs, *Nature, Mar, 2013, vol 495 p303*

Water is at the core of the global goals for ONE HEALTH





Sustainable Development Goals (SDGs)
For the Blue Planet
WATER =LIFE
QUALITY=HEALTH

QUANTITY IS WELL STUDIED
& PRESENTED
QUALITY IS MORE COMPLEX


THE NATION'S NEWSPAPER

Special Reprint Edition

USA TODAY

NO. 1 IN THE USA . . . FIRST IN DAILY READERS

October 21, 199

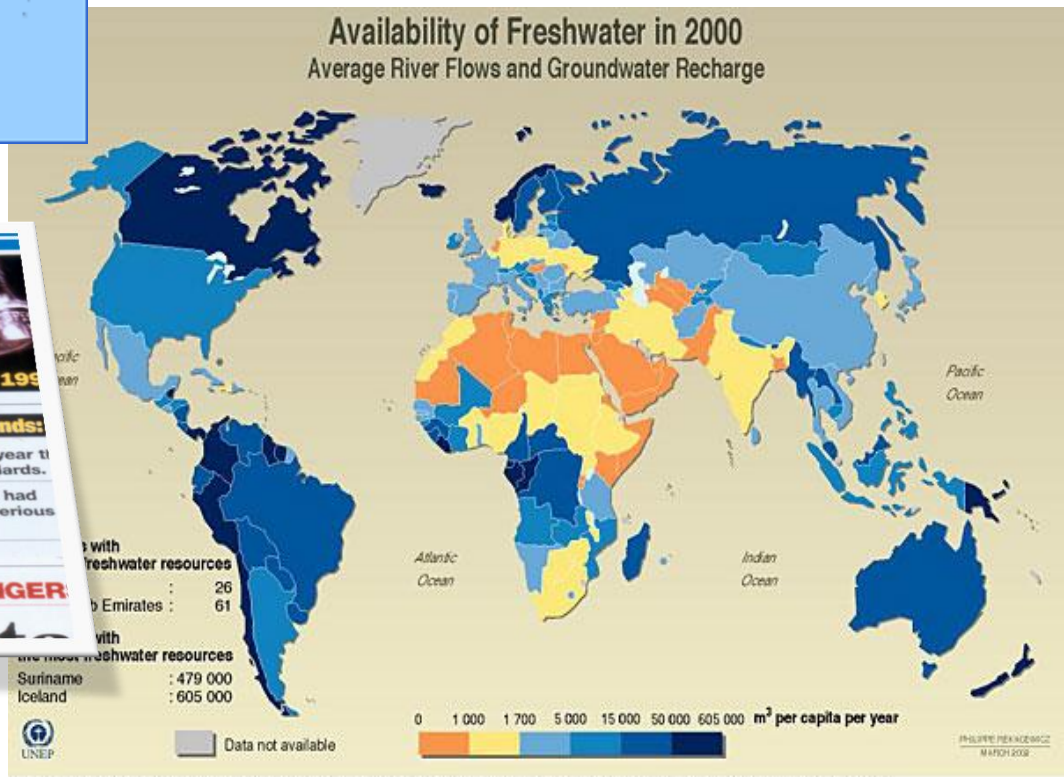
SPECIAL REPORT

How safe is your water?

A USA TODAY investigation finds:

- 58 million people got water last year t violated testing and purity standards.
- 25 million people got water that had 'significant' violations posing 'serious threats to public health.'

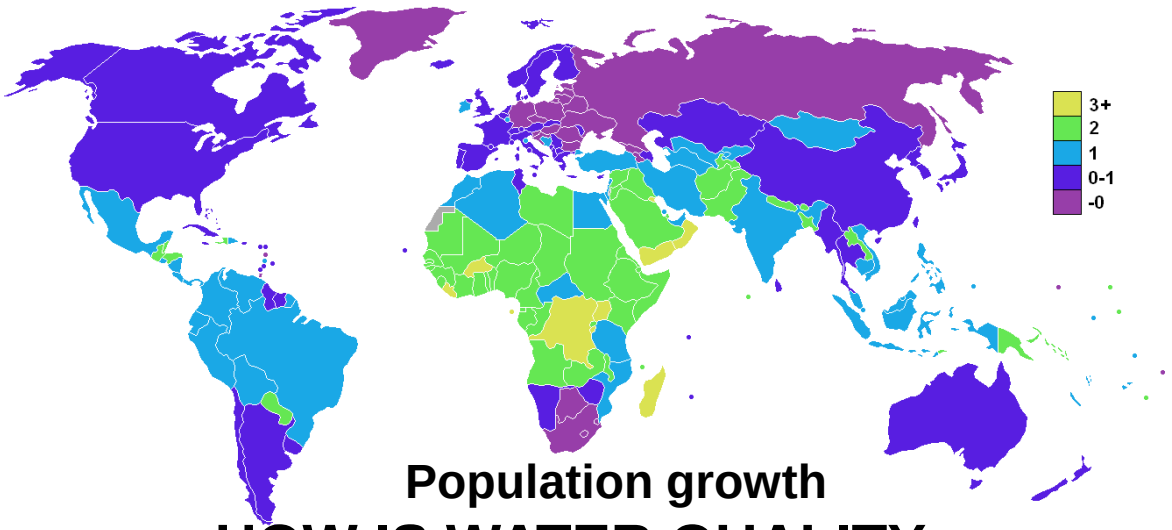
SPECIAL REPORT: DRINKING WATER'S HIDDEN DANGER



Source: *World Resources 2000-2001, People and Ecosystems: The Fraying Web of Life*, World Resources Institute (WRI), Washington DC, 2000.

Global trends in the era of the Anthropocene

- Urbanization
- Population Growth
- Regional Growth
- Travel and Tourism
- Global Corporate Growth
- Global Food Market
- Water Recycling, Reuse



Population growth

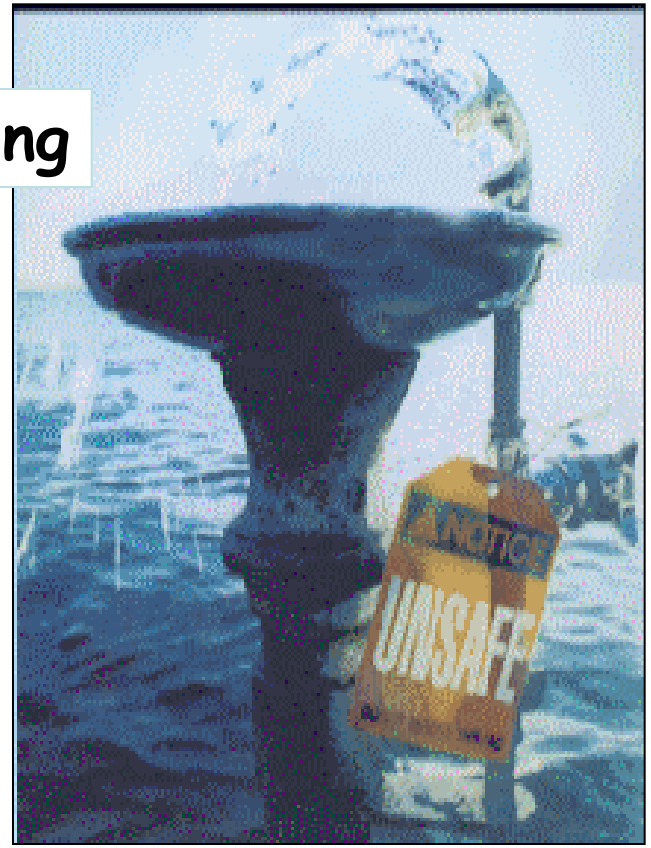
- HOW IS WATER QUALITY CHANGING?
- WHAT ARE THE SOURCES OF THE CONTAMINANTS?
- WHAT ARE THE RISKS TO HUMAN HEALTH?
- HOW DOES ECOSYSTEM HEALTH RELATE TO HUMAN HEALTH?
- HOW DO WE RESTORE AND PROTECT WATER SYSTEMS?

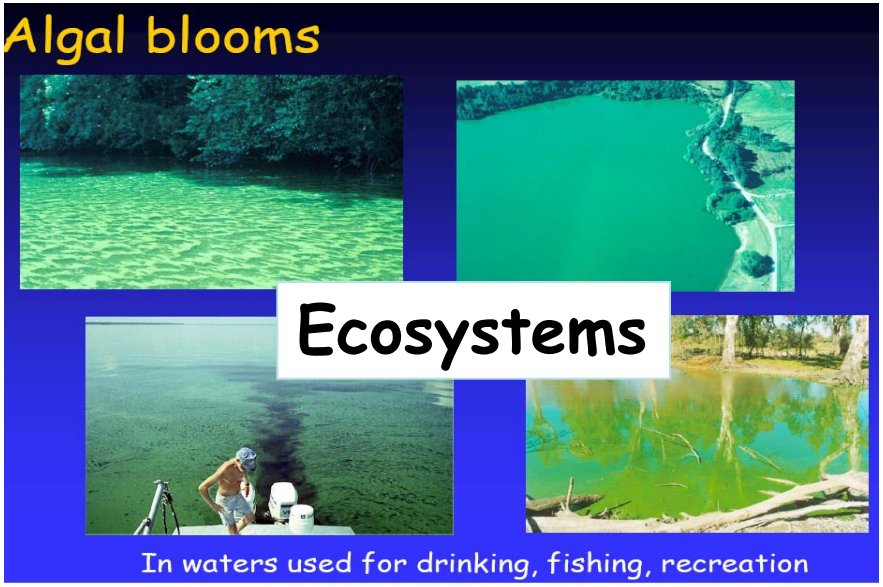
FRESH WATER RESOURCES ARE DEGRADING

Recreational

Irrigation

Drinking



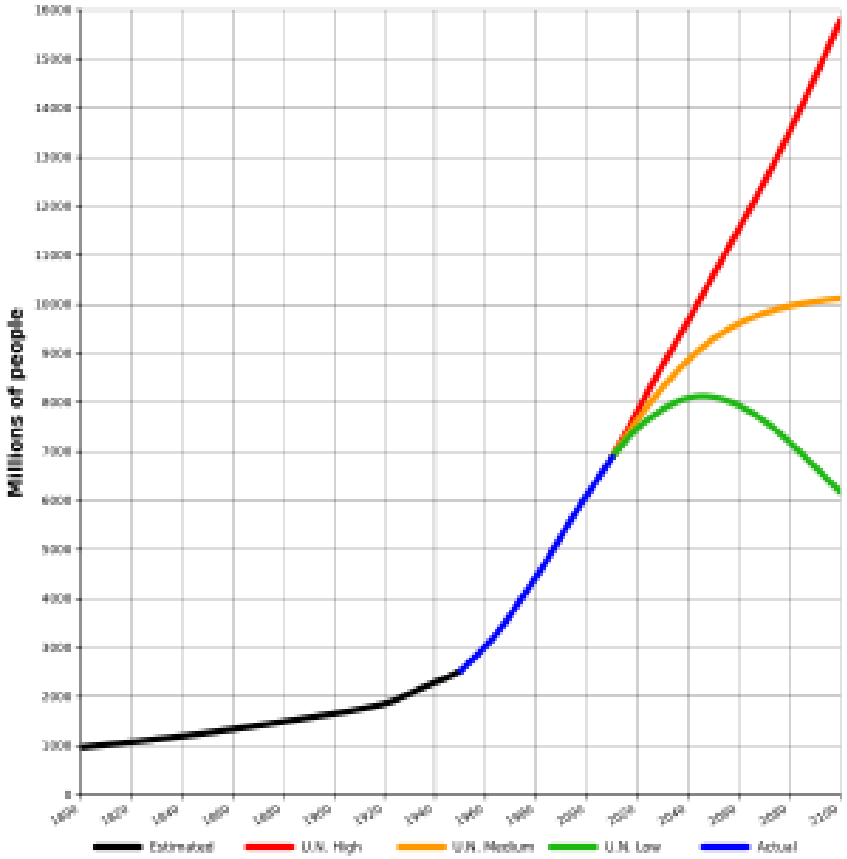


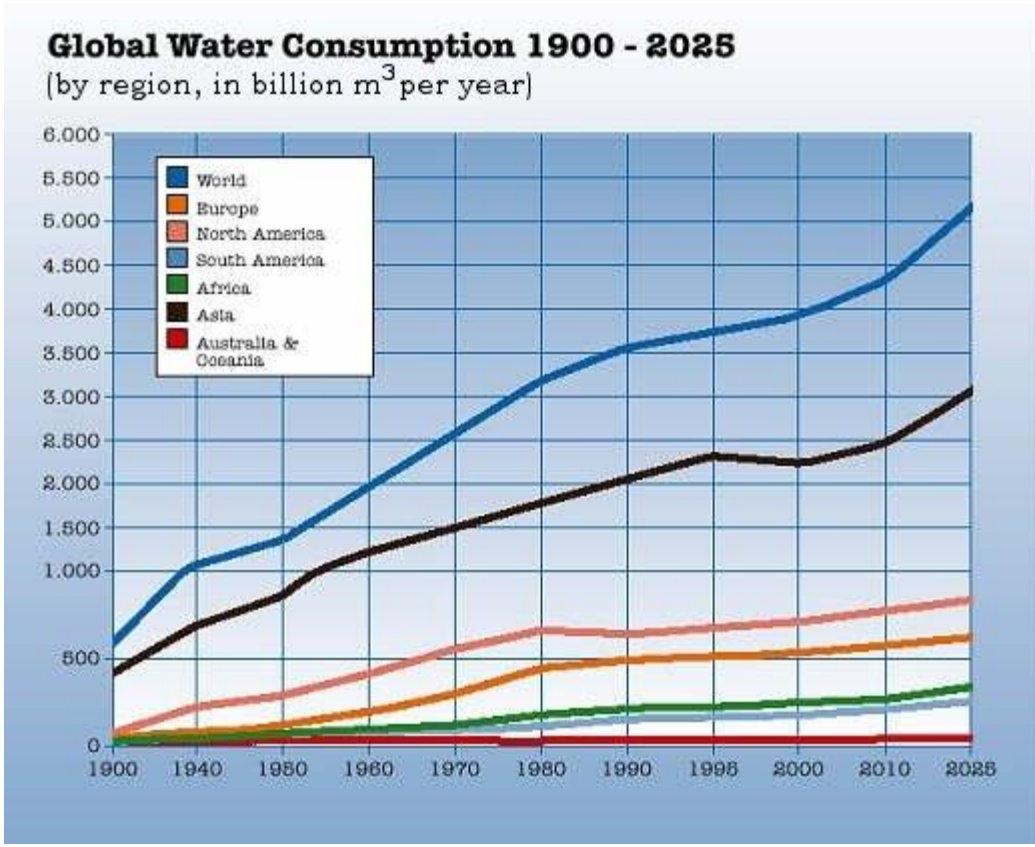
Ecosystems

THE PROBLEM: THE GREAT ACCELERATION

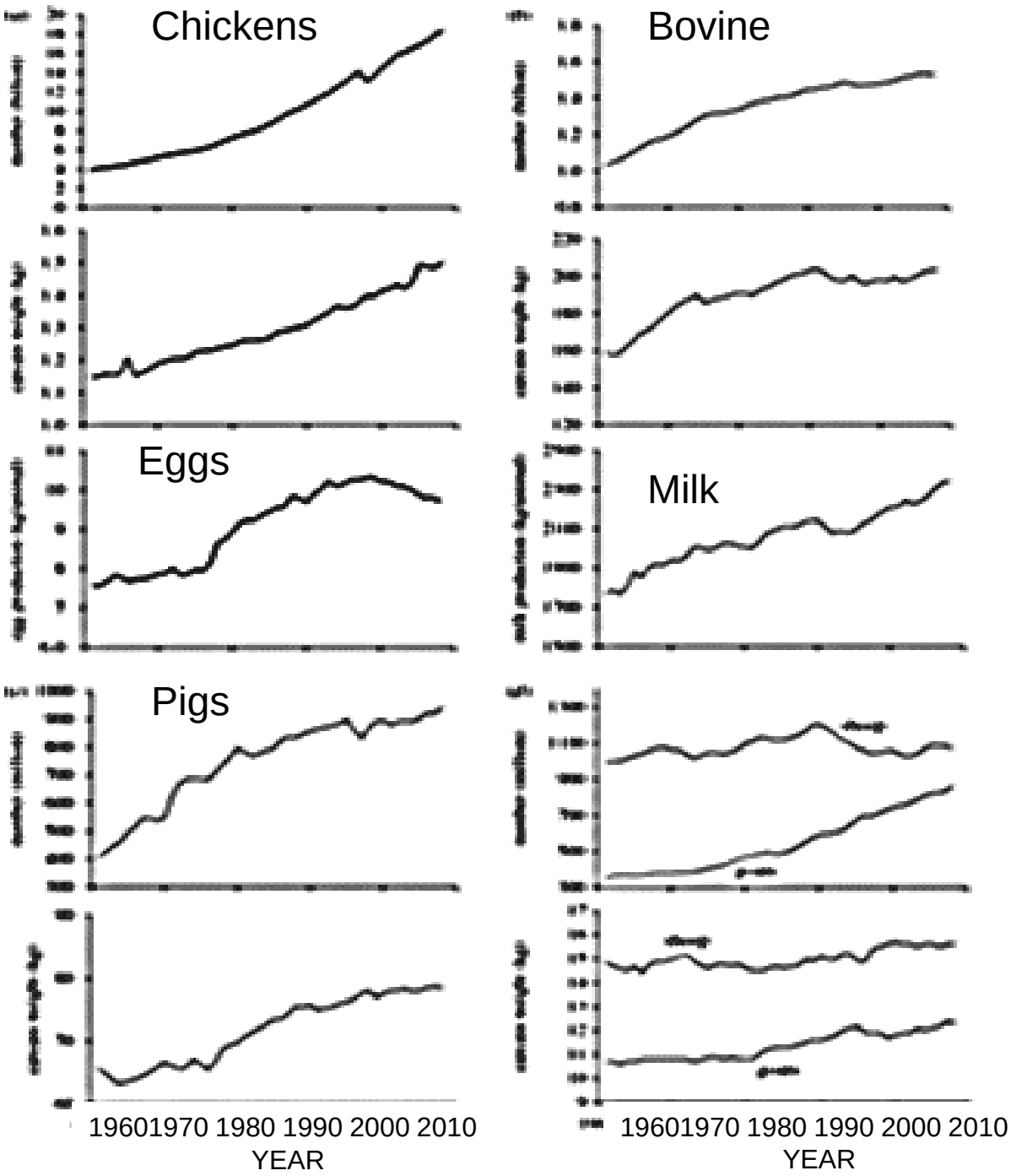
http://blogs.triplealearning.com/2011/03/diploma/dp_biology/world-water-day-3/

GLOBAL POPULATION TRENDS 1800S TO 2100





http://esa.un.org/wpp/unpp/panel_population.htm



Data from FAO (2010).

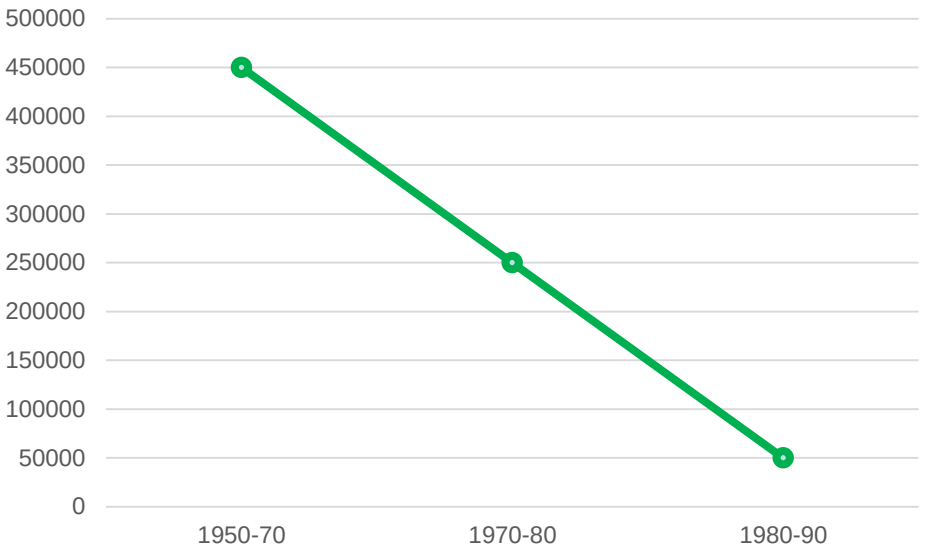
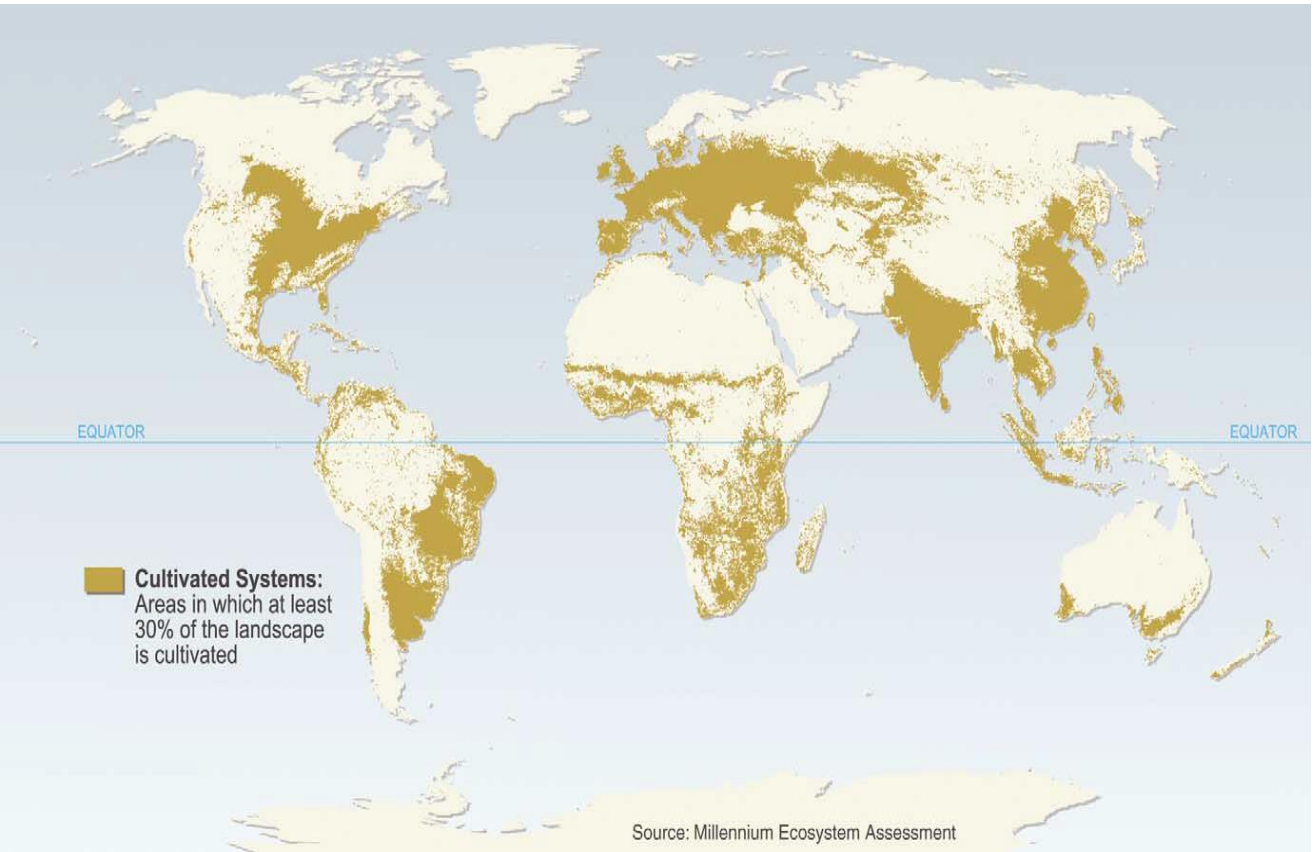


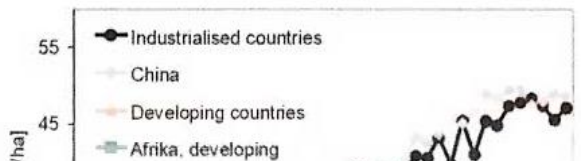
Figure I. Cultivated areas of the world. Brown regions indicate areas in which at least 30% of the landscape is cultivated. Reproduced from the Millennium Ecosystem Assessment 2005 (http://www.MAweb.org), UNEP.

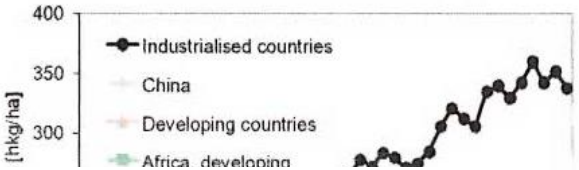


LOSS OF WETLANDS KM^2
From 1950s to 1990s in the US.

Verhoeven et al. TRENDS in Ecology and Evolution Vol.21 No.2
February 2006

Knudsen Et al. 2005. Global Developmen Organic Agric Challenges a Promises (ed Halberg, H.F. M.T. Knudsen E.S. Kristens





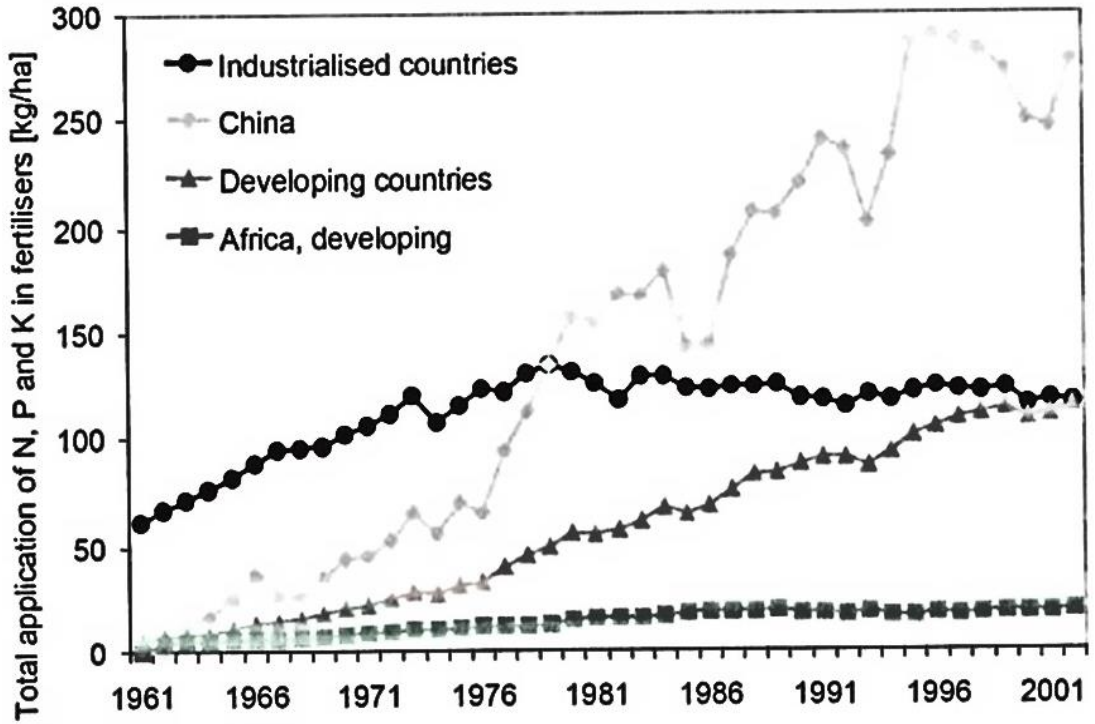


Figure 1.3. Total fertiliser application of N, P and K in industrialised and developing countries plus China and Africa, developing from 1961 to 2002 (kg/ha) (FAOSTAT data, 2005)

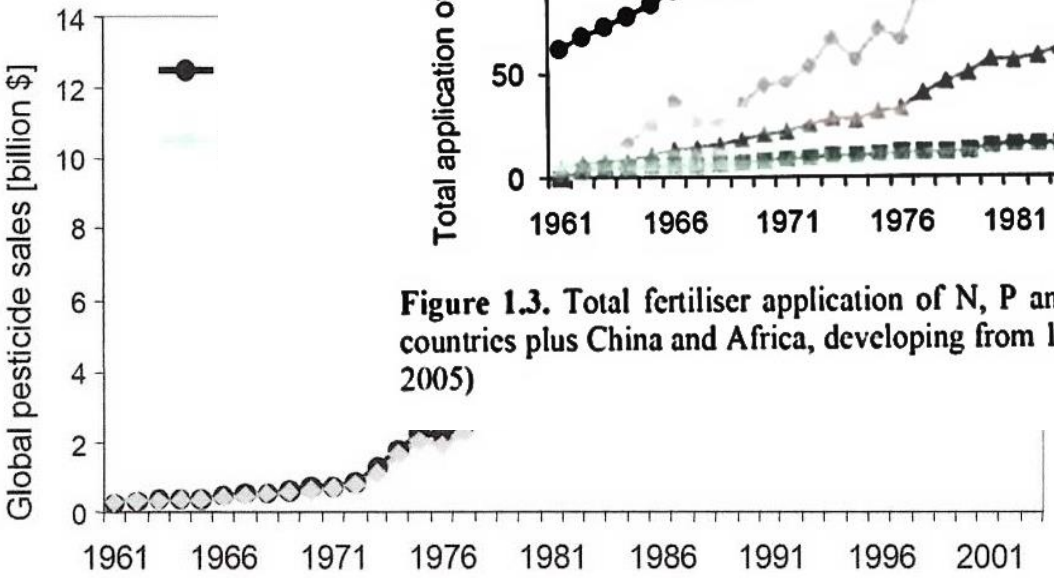
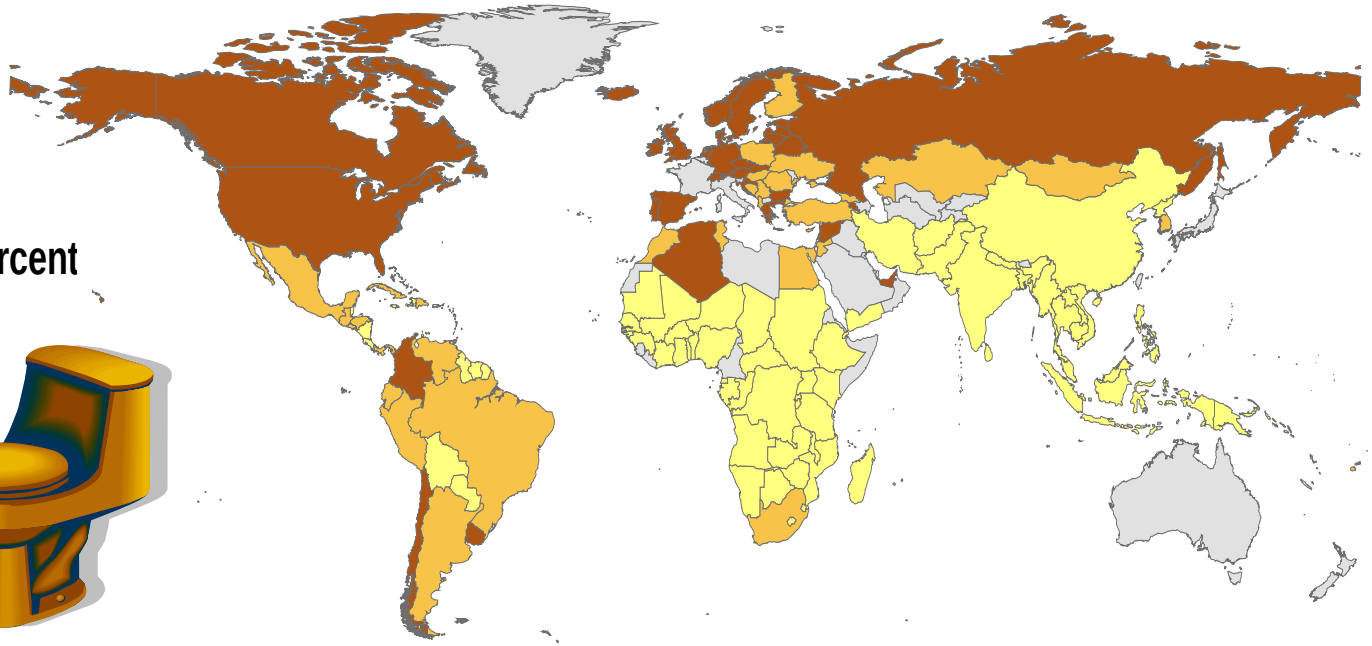


Figure 1.4. Imports and exports value of global pesticide sales from 1961 to 2003 (FAOSTAT data, 2005)

Fecal contamination of water Remains one of the largest threats to the biological safety of water today.

44% of the World’s global population (7 billion people) lives within 150 km (93 miles) of the coastline (that is 3 billion people who flush or dispose daily and send fecal pollution into the environment and eventually into waterways). The world's rivers (ten of the longest rivers = 55,734 km or 34,629 miles) are so badly affected by human activity that the water security of 5 billion people are impacted.



How do we solve the water pollution problems, protect water quality and biohealth of the planet?

ASSESSMENT

TECHNOLOGY

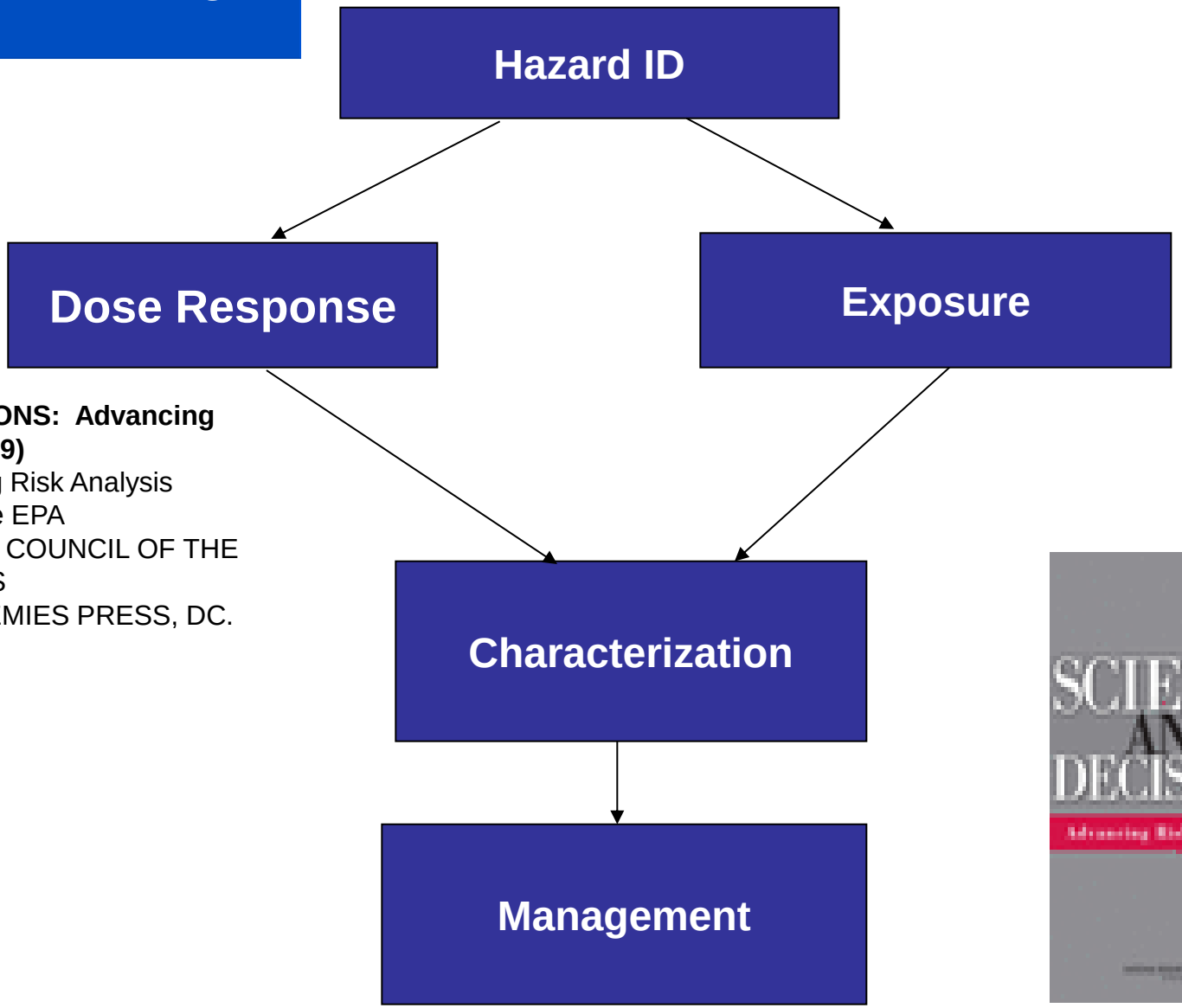
EDUCATION AND TRAINING

IMPROVED KNOWLEDGE & DECISION MAKING

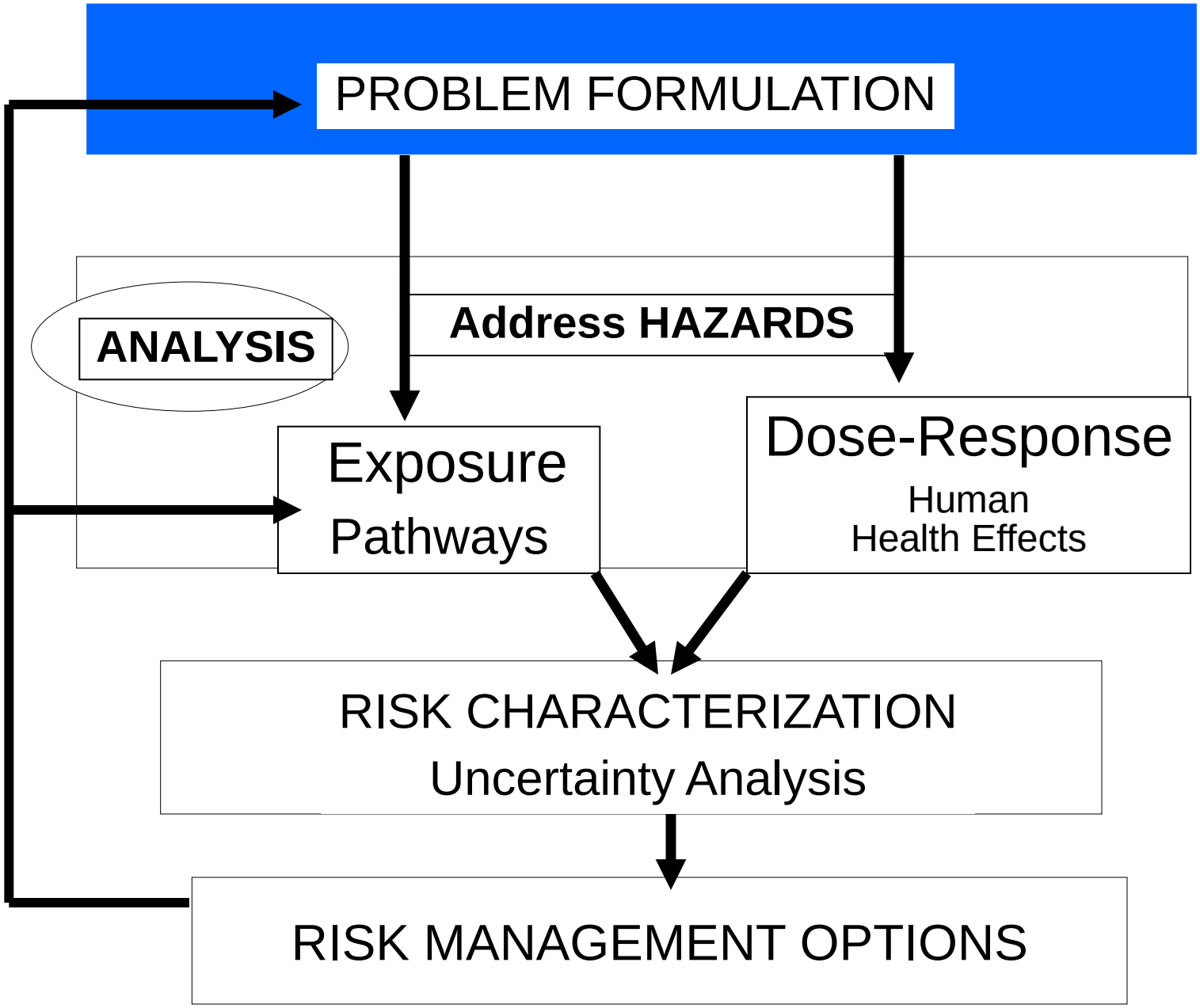
WE NEED TO

- BUILD WATER QUALITY PROGRAMS WITHIN WATER SAFETY PLANS AND QMRA FRAMEWORKS.
- INVEST IN WATER QUALITY DIAGNOSTICS AND INVESTIGATIVE MONITORING TO ACHIEVE THE BEST RETURN ON WATER IMPROVEMENTS.
- TRAIN ANALYSTS TO TEST FOR PATHOGENS IN WATER SOURCES USING A MULTIDISCIPLINARY HOLISTIC APPROACH WITHIN NEW WATER SCIENCE CURRICULA.

NATIONAL ACADEMY OF SCIENCES RISK ASSESSMENT PARADIGM



SCIENCE AND DECISIONS: Advancing Risk Assessment, (2009)
Committee on Improving Risk Analysis Approaches Used by the EPA
NATIONAL RESEARCH COUNCIL OF THE NATIONAL ACADEMIES
THE NATIONAL ACADEMIES PRESS, DC.
www.nap.edu


PROBLEM FORMULATION
ANALYSIS
Address HAZARDS
Exposure Pathways
Dose-Response
Human Health Effects
RISK CHARACTERIZATION
Uncertainty Analysis
RISK MANAGEMENT OPTIONS

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CENPHER
TRUNG TÂM Y TẾ CÔNG CỘNG VÀ HỆ SINH THÁI
CENTER FOR PUBLIC HEALTH AND ECOSYSTEM RESEARCH

ILRI
INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

Capacity development in health risk assessment and Water Safety Plan implementation in Vietnam

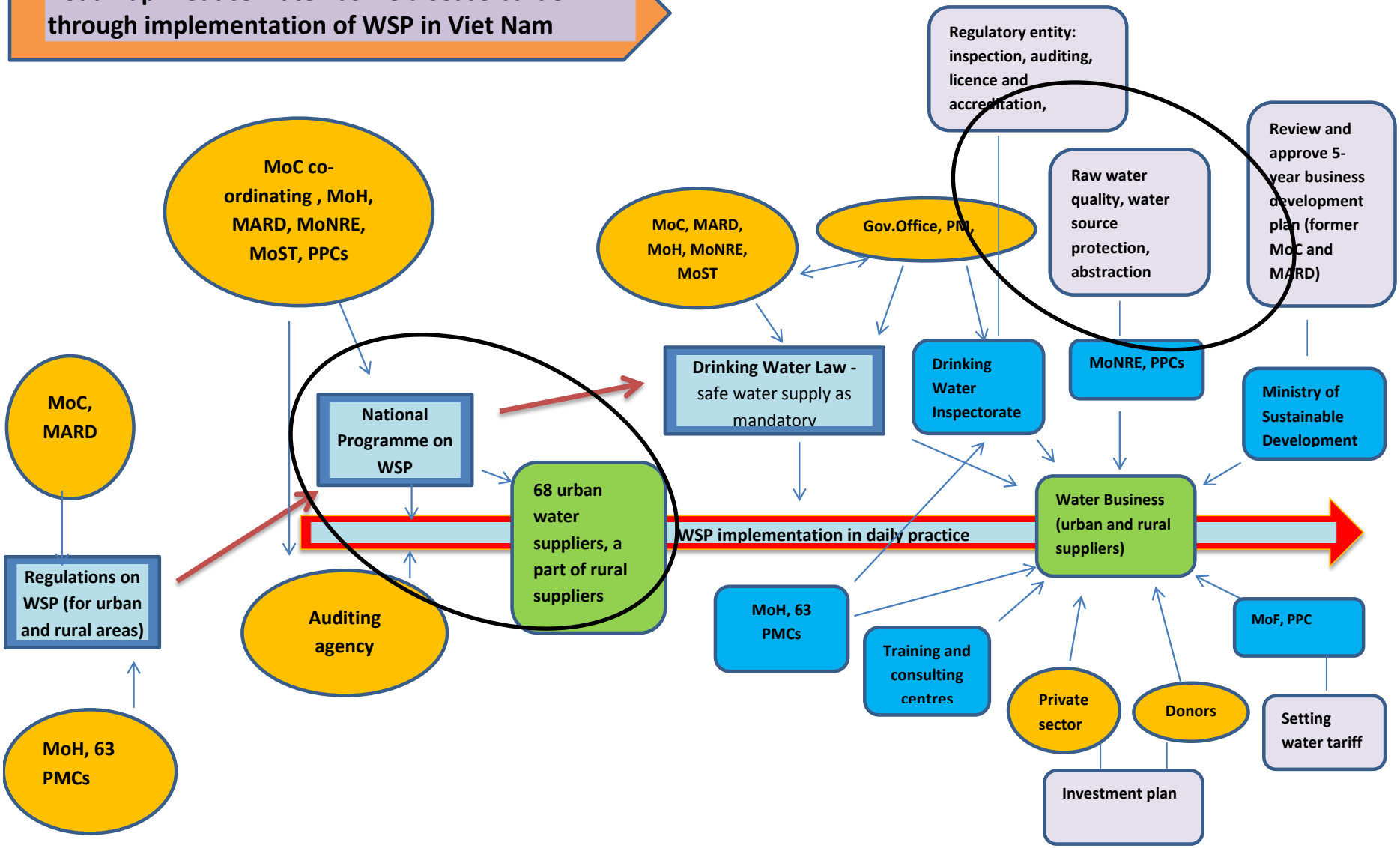
Hung Nguyen-Viet

2015 UN-Water Annual International Zaragoza Conference
15–17 January 2015
Water and Sustainable Development
From vision to action
UN WATER
WATER FOR LIFE 2005-2015

Water Safety Plan roadmap in Vietnam

Bo Xay Dung

Roadmap: Reduce water-borne disease burden through implementation of WSP in Viet Nam



Bridging the gaps
Science – Policy – Practitioner

- Address the gaps between *academia*, the *government* and *water companies* in risk framework and WSP implementation

- Need more interaction between these 3 sectors for improving capacity of WSP stakeholders and scale up WSP and health risk assessment related to water.

Improving Vietnam's drinking water: success of Water Safety Plan implementation by TRAN THI MINH TAM

- From an institutional impact, communication and collaboration among WSP team members, stakeholders and customers has been improved.
- Operational impact benefits: improved the system infrastructure according to *improvement plan* such as advanced and expanded laboratory, building new water treatment plants.
- Thus social and economic development of the province is being promoted by improving public health condition.

Improving Vietnam's drinking water: success of Water Safety Plan implementation by TRAN THI MINH TAM

Challenges remain:

Water source protection is a challenge which requires cooperation between multiple stakeholders, especially with WSP team members. Catchments and raw water sources are still not controlled.

Public confidence in drinking tap water directly is still not high. The custom of boiling water has been popular for long time and it is not easy to change customs, so one challenge for HueWACO is how to communicate the programme for safe drinking water more effectively.

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The Need to Invest in Water Quality Monitoring to Achieve the Best Return On Water Improvements.

Prof John Fawell,

Cranfield University, UK

Importance of Monitoring

- The post 2015 Millenium Development Goals recognise the importance of quality.
- Improved supplies may still be capable of delivering unsafe water. Bain et al (2014) estimate that in a number of key countries those with safe water are 10-20% lower than recorded by access to improved water supplies.
- the WHO/UNICEF JMP Task Force on Monitoring Drinking-water Quality recommends monitoring of microbial contamination and selected chemicals.

What is Monitoring

- It can take a number of forms.
- The first and probably the most useful for chemical contaminants is investigative monitoring to understand what important contaminants might be present in a water supply or proposed water supply prior to improvement.
- For microbiological contaminants investigative monitoring is a useful first step in characterising the quality of a source but continued monitoring is also important for assessing changes in that source over time and whether contamination is occurring after collection of the water, needing household treatment. All are linked to knowledge of geology and data from sanitary surveys.
- Operational monitoring is a means of checking that the system is working properly and is usually not laboratory based and is carried out locally using test kits or systems for parameters such as chlorine and turbidity.

Analytical Capacity

- Without the capacity to carry out both investigative and check monitoring the need cannot be addressed.
- Capacity development requires investment in training and equipment. As a minimum there is a need for at least one central laboratory in a country that provides the basis for ensuring that the quality of microbial and chemical analysis is adequate.
- This requires facilities and training for technical staff who can carry out microbiological testing in the laboratory and the field and analysts who can carry out analysis for key chemical contaminants such as arsenic, fluoride and other contaminants as appropriate.

Training of Others

- There is also a need to make the capacity self sustaining. Staff who are being trained in technical expertise also need to be trained to train others and to establish a solid base for quality assurance that the data generated are accurate.

Why is this necessary?

- Water Safety Plans and QMRA are the basis of WHO's Framework for Safe Water.
- Without knowing the hazards it is difficult to make provisions for ensuring safe water.
- There is a need to be able to verify that interventions are working properly.
- Increasing the capacity for analysis can be a key role for academia but investigative and other monitoring needs to be targeted to achieve the necessary result.

Links to Research

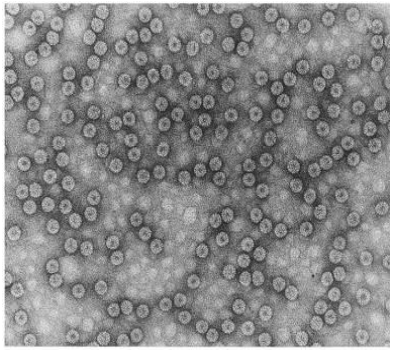
- There are also requirements for developing equipment and techniques to support monitoring in the field, e.g. measuring microbial indicators, measuring turbidity below 1 NTU, field measures for chemicals that are cheap but robust and effective.

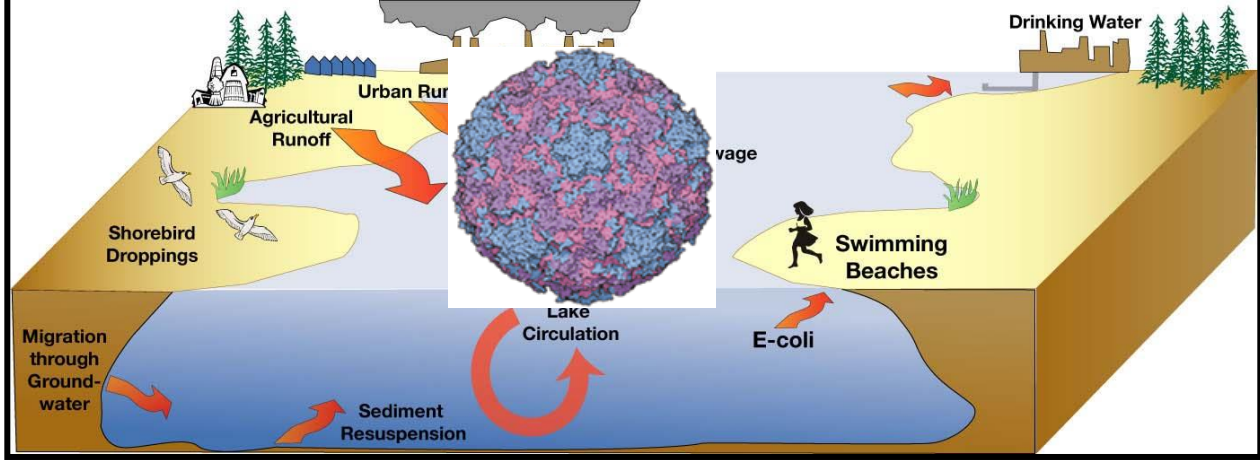
Case Study

- Bangladesh tube wells contaminated with arsenic. Significant costs in terms of human health and the need for remediation could have been avoided by appropriate investigative monitoring.

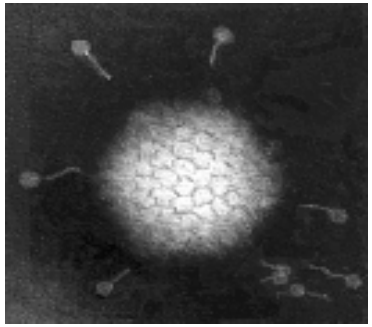
- Achieving the post 2015 goals is not possible without monitoring capability.

THE HAZARD





Hundreds of different viral pathogens found in sewage.
Excreted in high numbers
Persistent & Resistant
High potency
Cause chronic diseases



THE DISEASES: diarrhea, respiratory illness, liver damage, kidney failure, heart disease, cancer, nervous system disorders; birth defects, death.

Universitat de Barcelona
Dos campus d'excel·lència internacional
B:KC Barcelona Knowledge Campus
HUB Health Universitat de Barcelona Campus

Laboratory of virus contaminants of water and food

Case study: Management and use of Water and Water Resources in the European Union

Rosina Girones

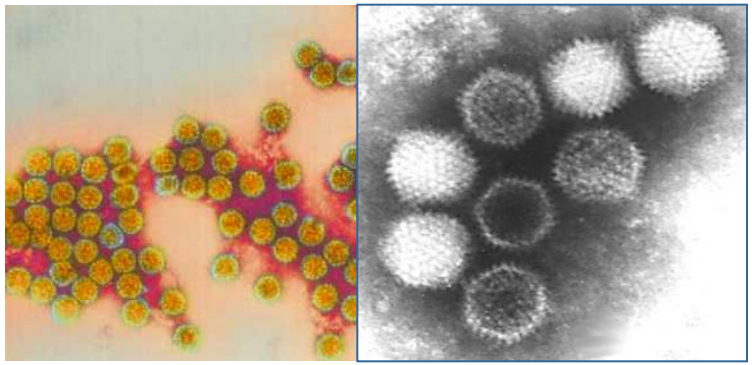
Risk Assessment as a tool to improve water quality: Using Advanced Technology

Issues addressed:

- **Water resources management .** Integrated water resources management. Watershed management of wastewater. Move toward improving treatment for virus control. Water reuse needed under climate change.

- **Water quality.** Improving technologies for water quality control. Inadequate sewage treatment. Pathogens in water. Impacting ecosystem services (drinking water, recreational water, food security, economic development).

- **Risks.** Quantification of exposure levels. Illnesses.



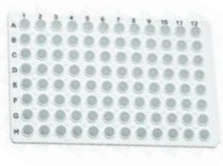
Analysis of VIRAL Pathogens and MST tools

Floculation
50mL sewage
or 10L river

5 ml

2x140 µl

Extraction
140 µl



qPCR detection
and quantification
2x10 µl

(HAdV)
(JCPyV)
(**Viral pathogens**)

(PAdV)

(BPyV)

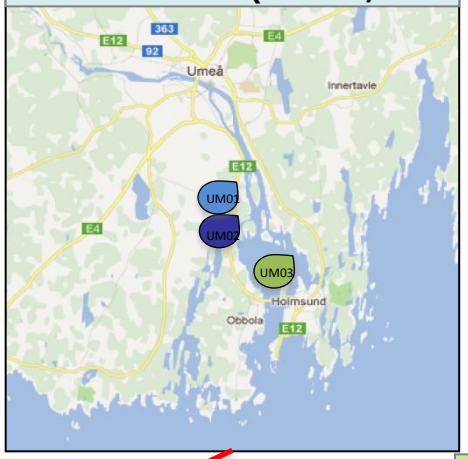
(OPyV)

(Ch/TyPV)

100 ml of the original sample

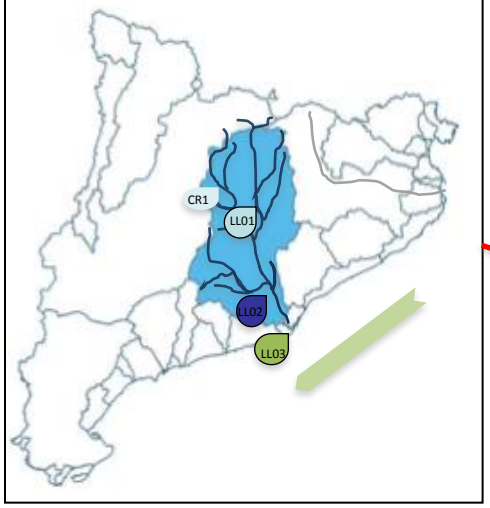
MST 5 case studies:

Umeälven (Sweden)

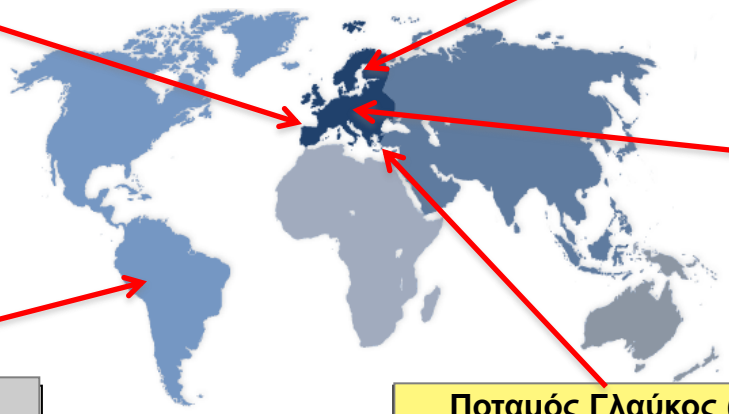


Flow: 450 m^3/s
Basin: 26,814.8 Km^2
Length: 470 km

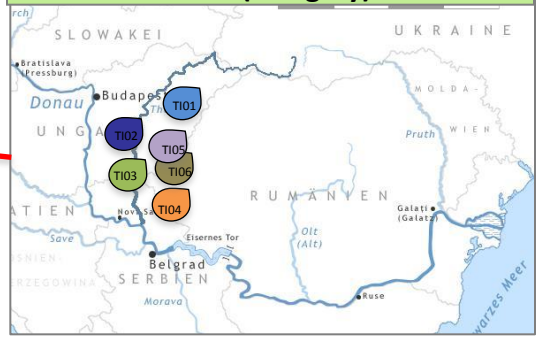
Riu Llobregat (Catalonia)



Flow: 16,9 m^3/s
Basin: 4984Km^2
Length 170 Km



Tisza (Hungary)

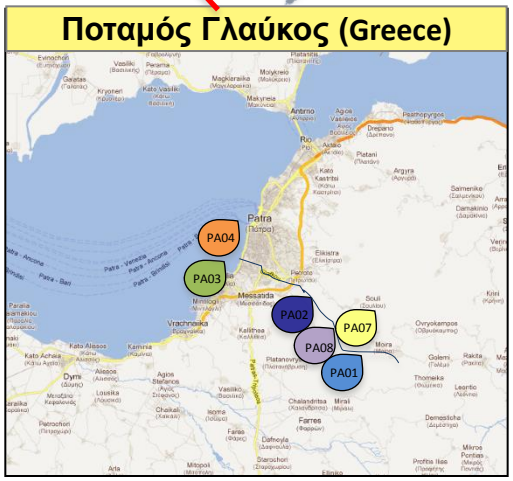


Flow:: 792 m^3/s
Basin: 156,087 Km^2
Length:: 965 k_m

Rio Negro (Brasil)

Flow: 28.000 m^3/s
Basin: 691.000 Km^2
Lenght: 2250Km

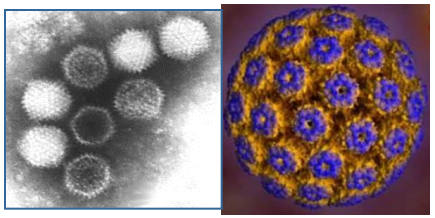
Ποταμός Γλαύκος (Greece)



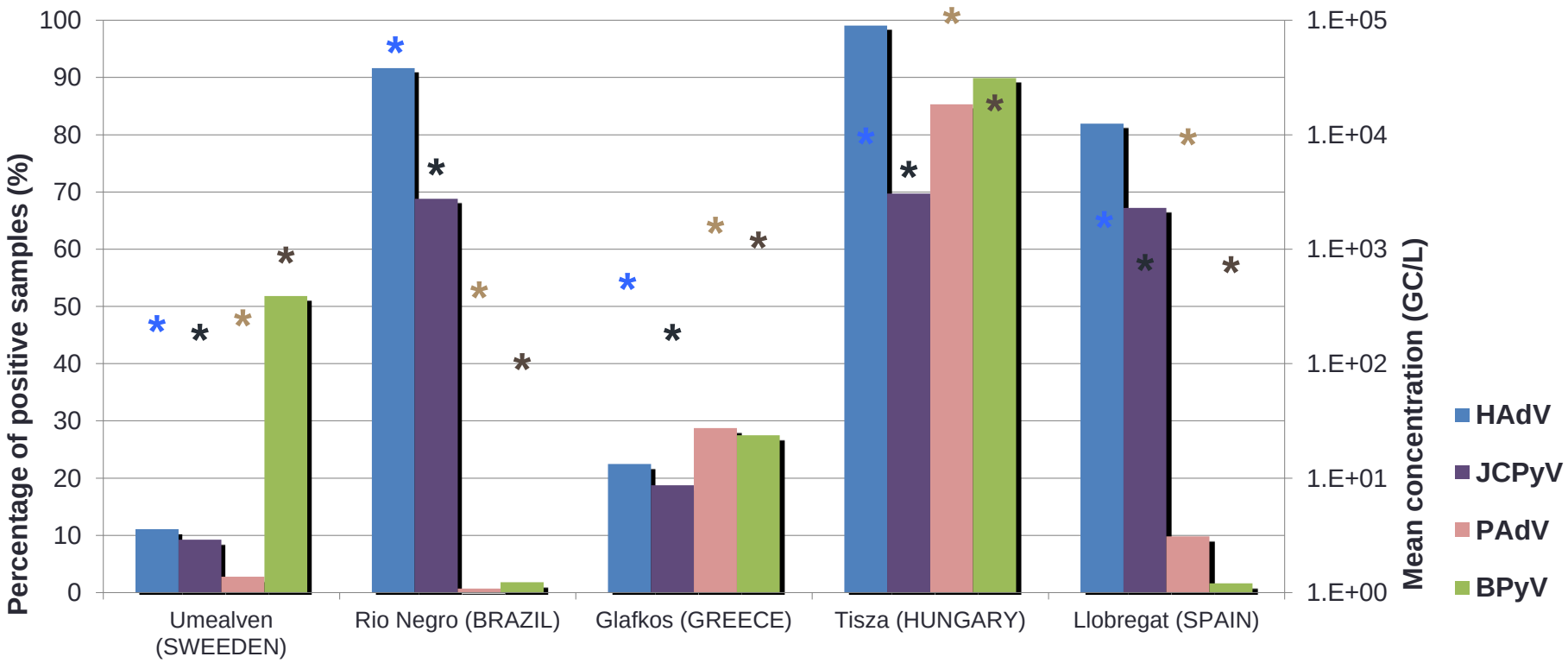
Flow: 1m^3/s
Basin: 24 Km^2
Length: 98km

Viroclime

Viroclime

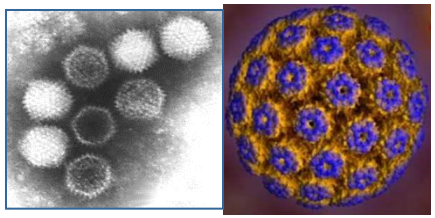


Human and animal viruses in diferent river cathments

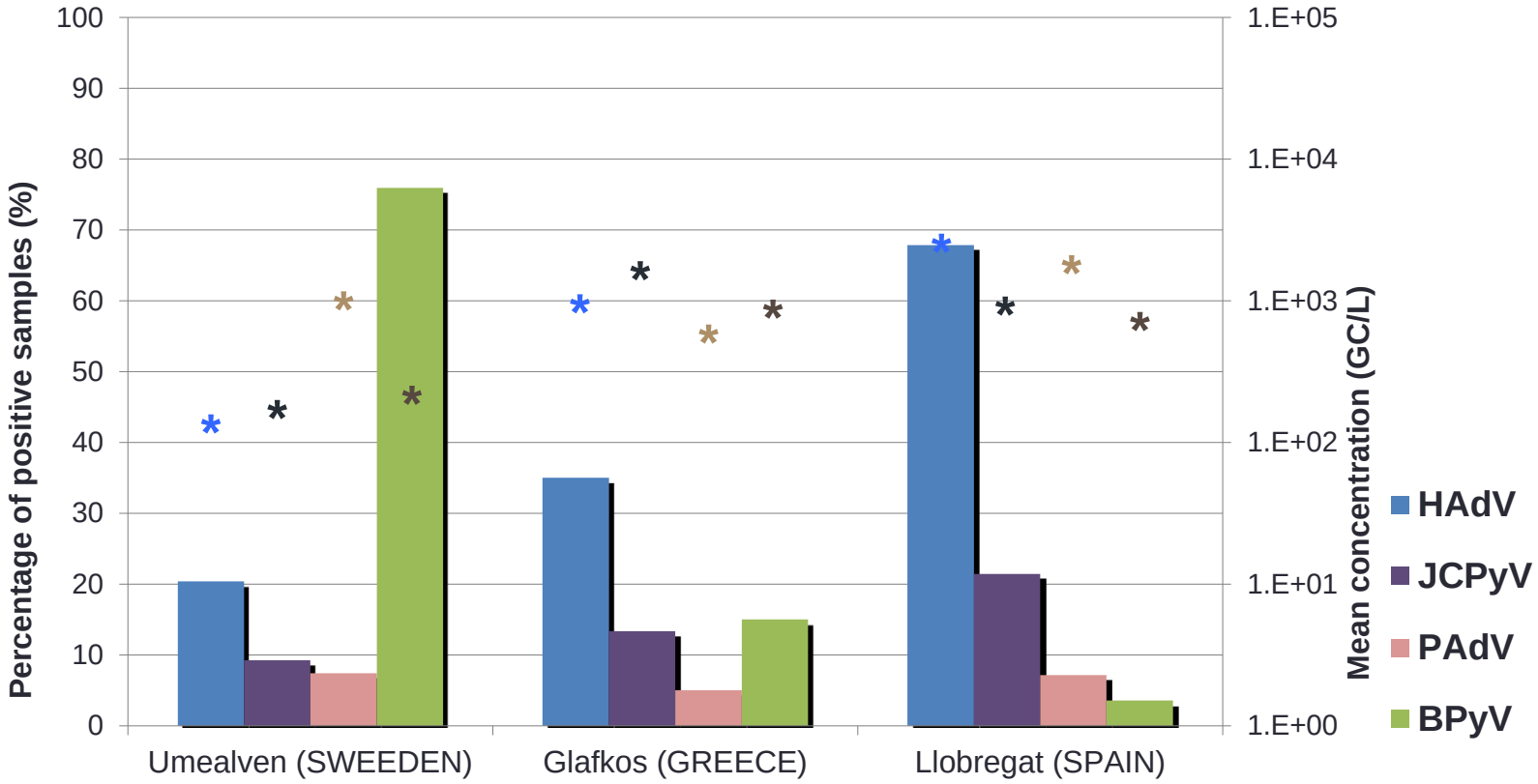


Rusiñol M, Fernandez-Cassi X, Hundesa A, Vieira C, Kern A, Eriksson I, Ziros P, Kay D, Miagostovich M, Vargha M, Allard A, Vantarakis A, Wyn-Jones P, Bofill-Mas S, Girones R. Water Res. 2014, 59:119-29

Viroclime



Human and animal viruses in seawater



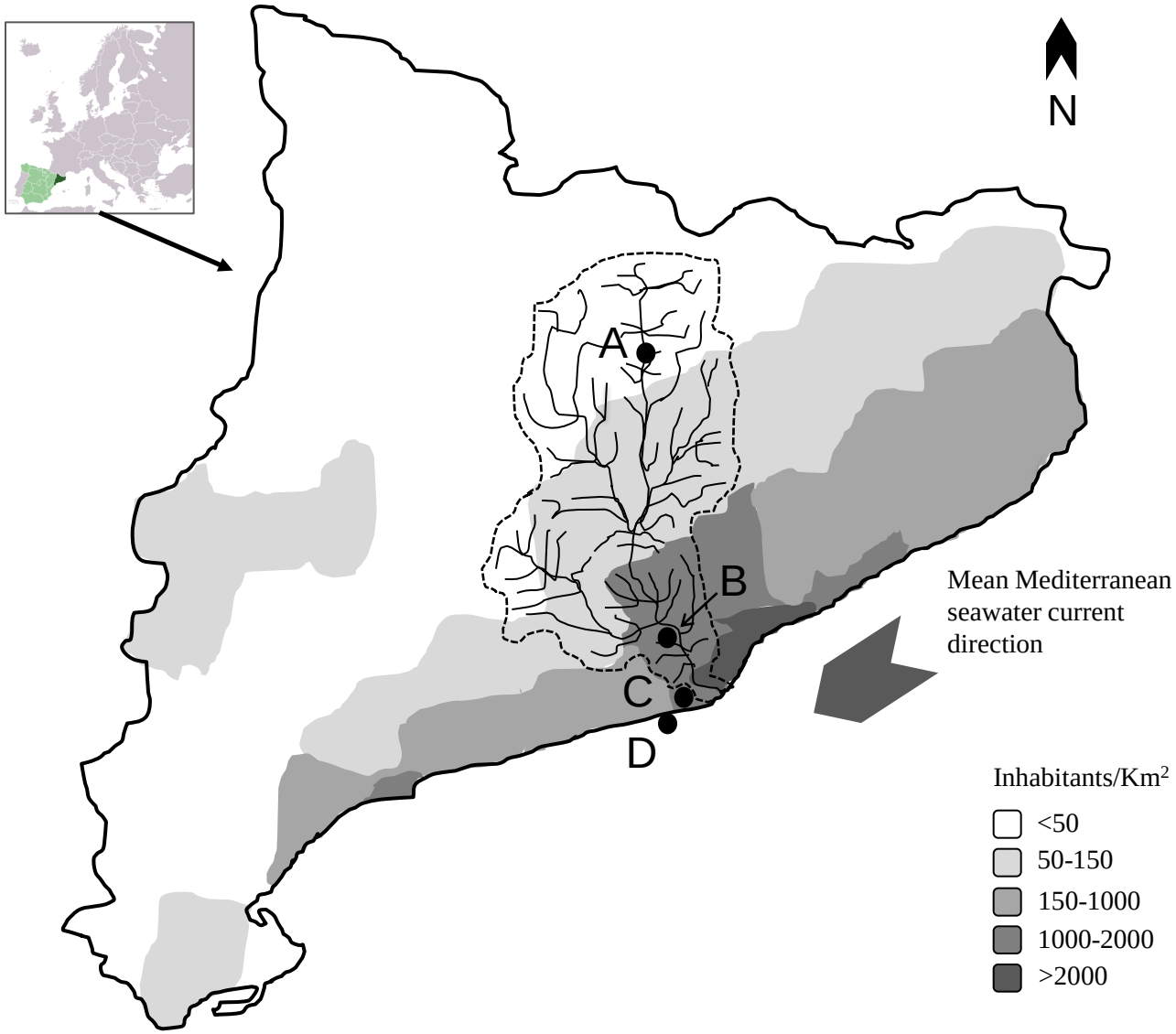
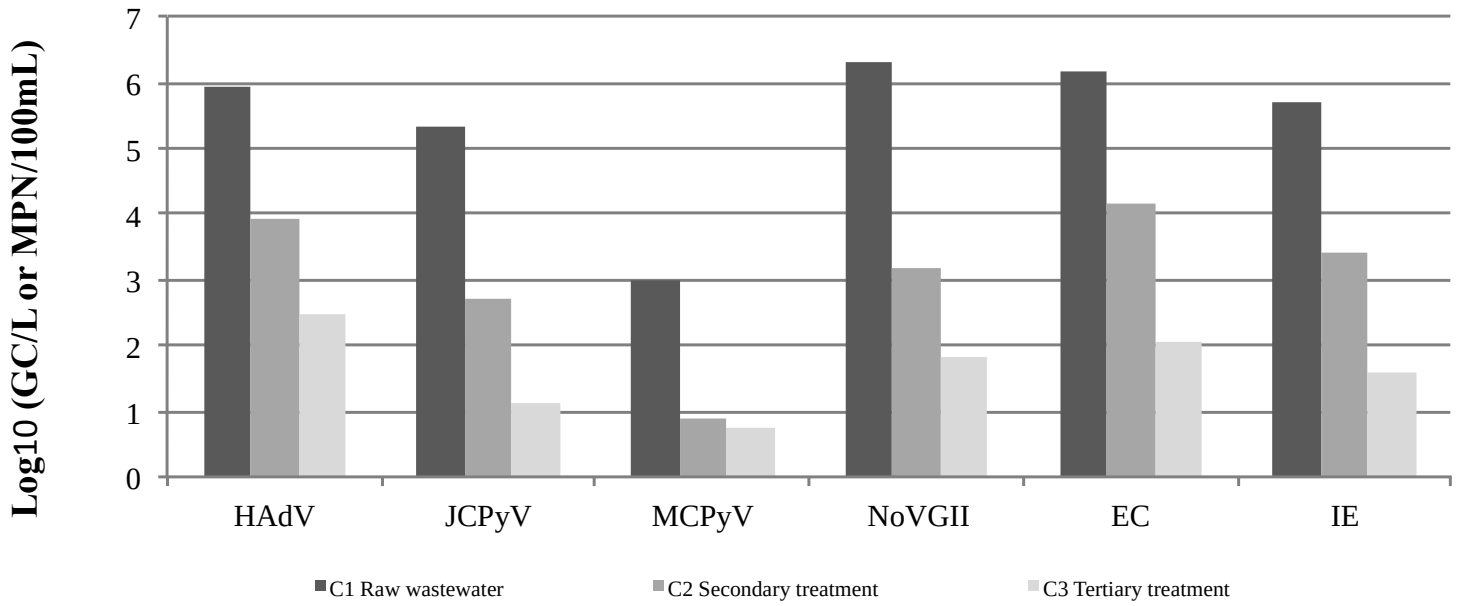


FIGURE 1, Sampling sites location in the Llobregat river catchment (Catalonia, Spain). Site A: upstream river water; Site B: downstream river water; Site C: raw sewage (C_1), secondary (C_2) and terciary (C_3) effluents from a WWTP; Site D: seawater.



	HAdV	JCPyV	MCPyV	NoVGII	EC	IE
Secondary (C2)	2.00	2.61	2.11	3.14	2.01	2.27
Tertiary (C3)	1.44	1.58	0.11	1.38	2.12	1.84
TOTAL(C2+C3)	3.44	4.19	2.22	4.52	4.13	4.11

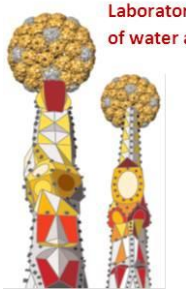
FIGURE 3. Summary of WWTP log10 concentrations and log10 reduction values by treatment for each viral and bacterial pathogen.

Risk Assessment as a tool to improve water quality: Using Advanced Technology

Specific pending issues:

- Analysis of risk associated with the contamination by viral pathogens, need more data on viral concentrations and stability
- Wastewater management will be the key to prevent environmental dispersion of human fecal pathogens
- Acceptable water quality levels may be guaranteed only if wastewater containment and treatment are improved
- Application of viral MST tools for the identification of the main sources of contamination in water

Viroclime



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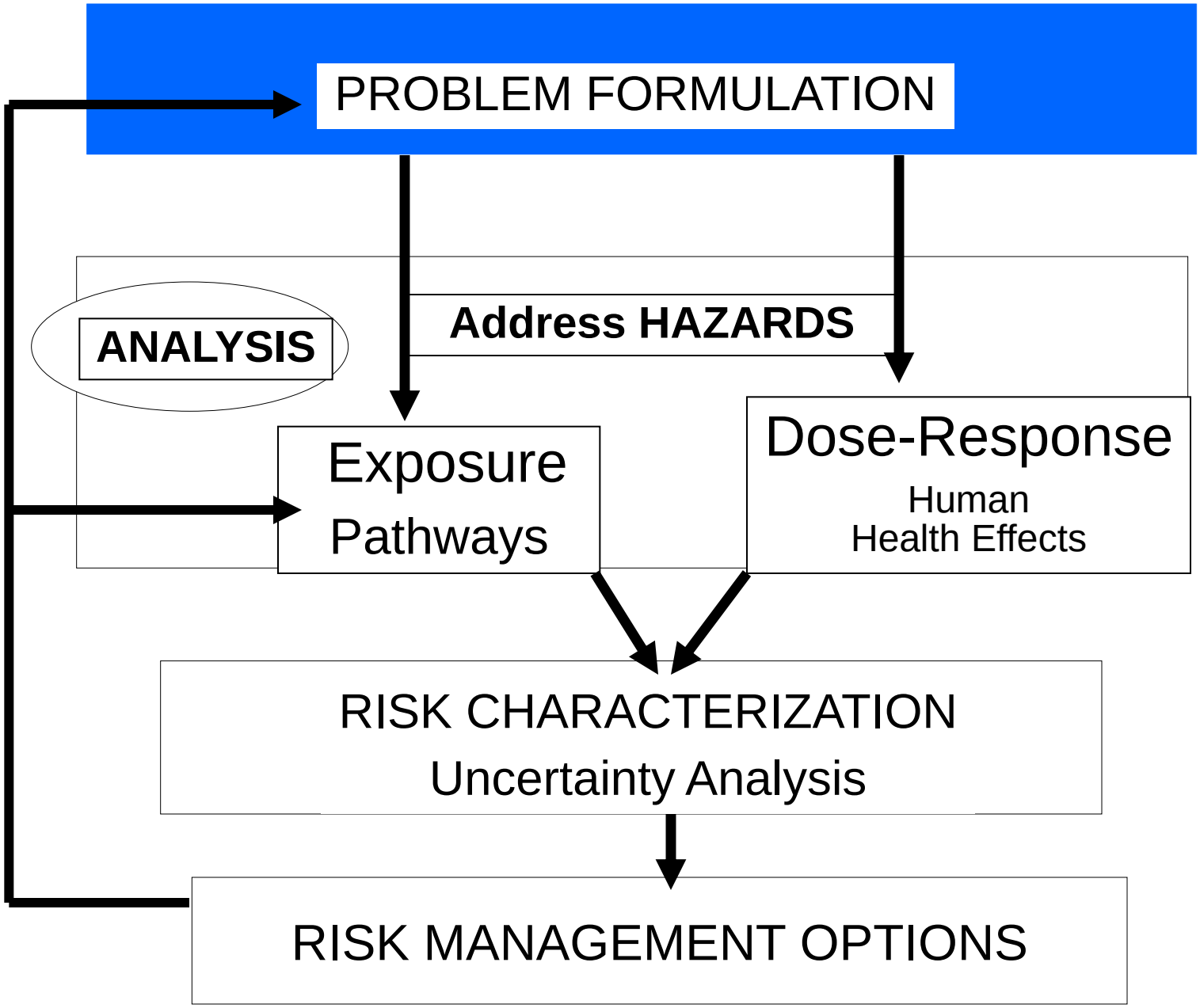
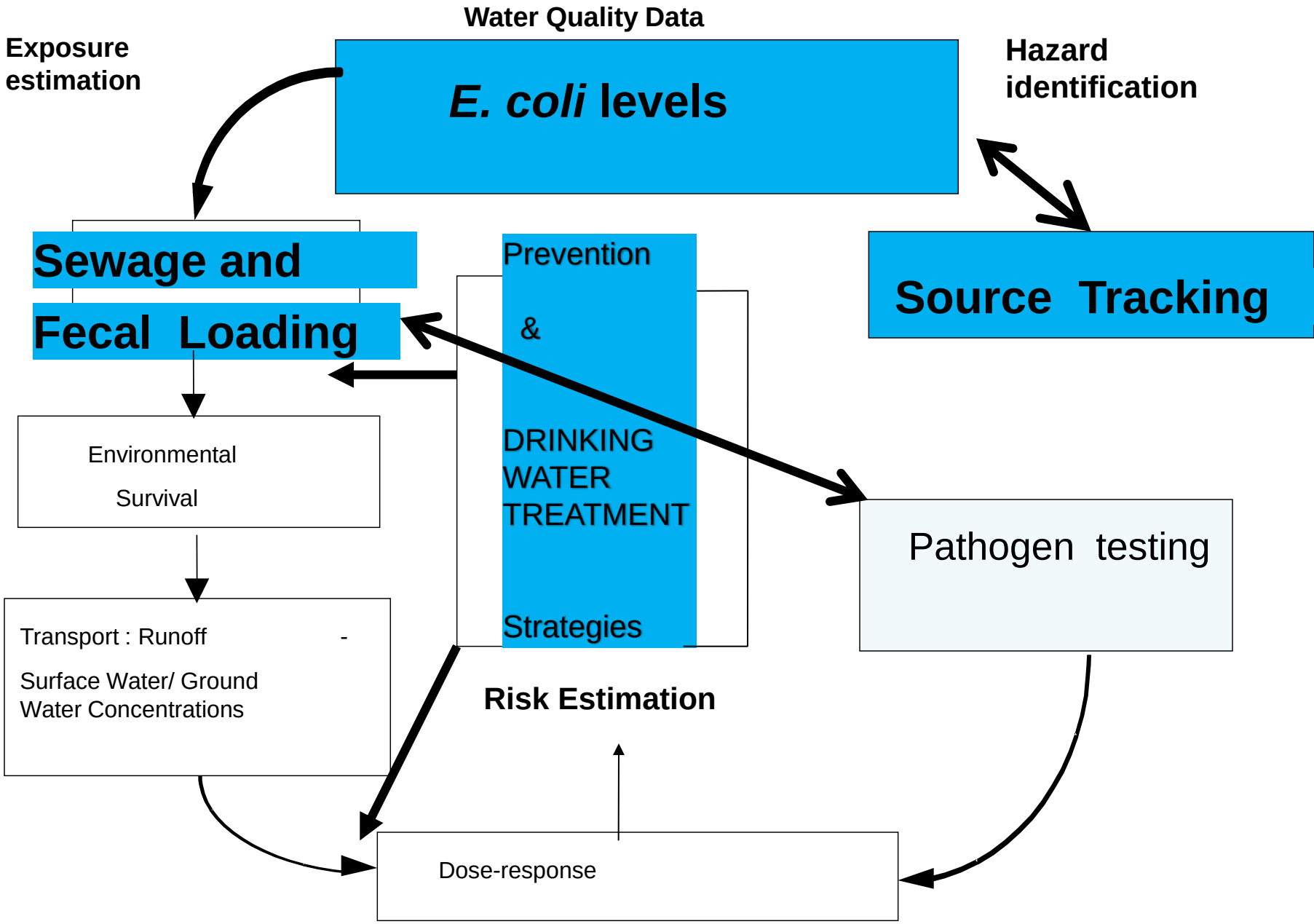
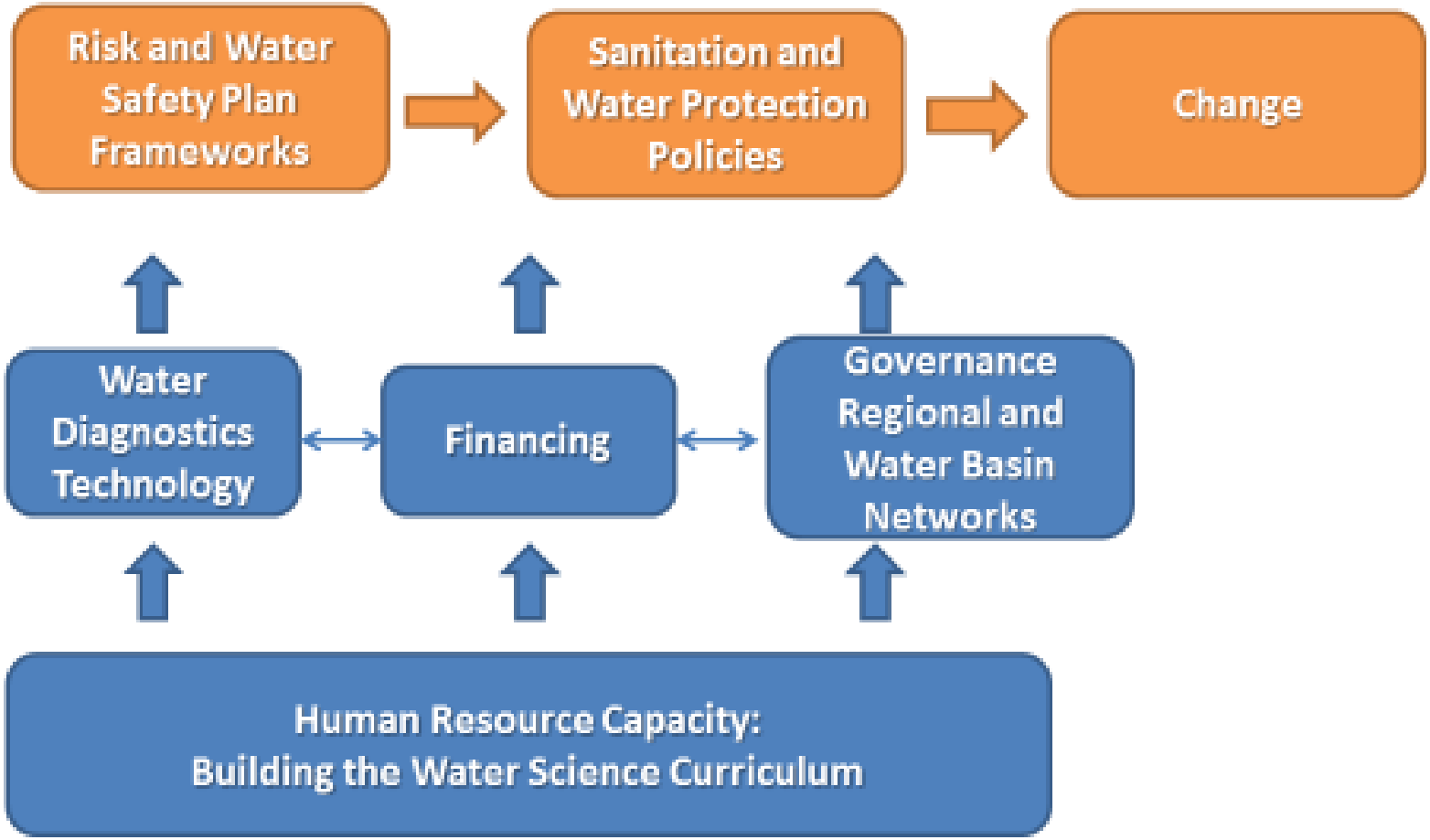

PROBLEM FORMULATION
ANALYSIS
Address HAZARDS
Exposure Pathways
Dose-Response
Human Health Effects
RISK CHARACTERIZATION
Uncertainty Analysis
RISK MANAGEMENT OPTIONS


Water Quality Data
Exposure estimation
E. coli levels
Hazard identification
Sewage and
Fecal Loading
Prevention
&
DRINKING WATER TREATMENT
Strategies
Source Tracking
Environmental
Survival
Pathogen testing
Transport : Runoff
Surface Water/ Ground Water Concentrations
Risk Estimation
Dose-response

Knowledge path for interfacing science, technology and policy to meet water quality goals



2015-UN ANNUAL INTERNATIONAL ZARAGOZA CONFERENCE
15-17 JANUARY 2015, ZARAGOZA, SPAIN

ADVANCING THE WATER SCIENCE CURRICULUM AND BUILDING CAPACITY TOWARD PATHOGEN TESTING IN AFRICA

MAUREEN B TAYLOR
RAND WATER CHAIR IN PUBLIC HEALTH
DEPARTMENT OF MEDICAL VIROLOGY

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
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2015 UN-Water Annual International Zaragoza Conference
15–17 January 2015
Water and Sustainable Development
From vision to action
UN WATER
WATER FOR LIFE

INTRODUCTION

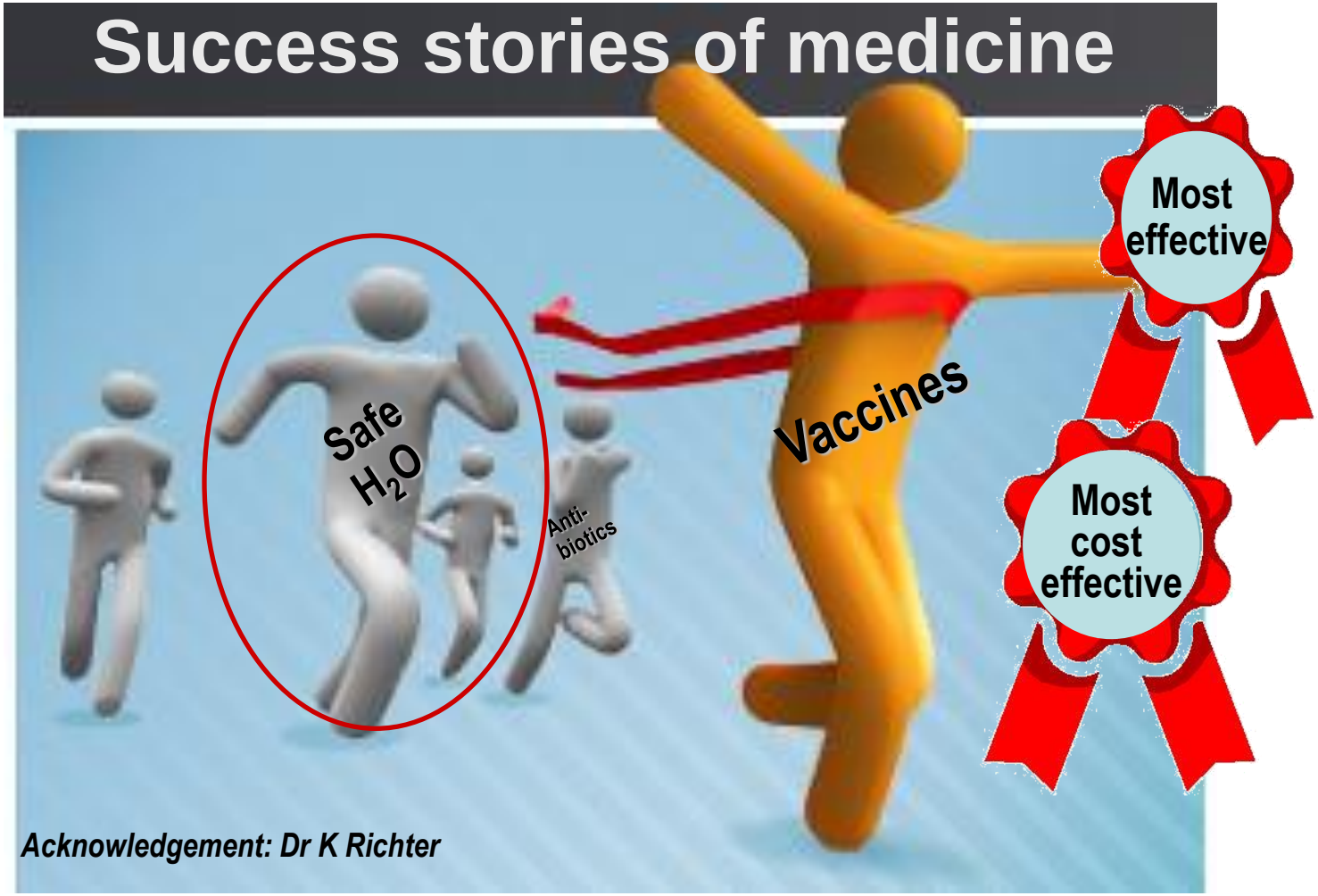
- **2010: UN General Assembly**
  - *access to sufficient, continuous, safe, acceptable, readily available and affordable water is a basic human right*

- **2010: MDG 7C achieved**
  - *halve the proportion of the world's population without sustainable access to safe water*

- **2012**
  - *89% world's population had access to improved drinking-water*

  - *Sub-Saharan Africa not on track: since 2000 only 25% region's population have access to improved drinking-water*

WATER AND HEALTH



ADVANCING WATER SCIENCE

- **Water quality and water-related disease**
  - *complex and diverse topic*
  - *capacity building essential*
    - ** evidence-based policy and intervention strategies*

- **Multidisciplinary holistic approach**
  - *understand the needs to the community/country*
  - *build institutional and national capacity*
  - *develop infrastructure that is locally meaningful*
  - *sustainable programme*

- **Challenges**
  - *financial constraints*
  - *different educational backgrounds and communication skills*
  - *academic isolation/lack of critical mass*

ADVANCING WATER SCIENCE

- **Curriculum development**

  - core subjects

  ** flexible*

  - technical skills

  ** hands-on-learning*

  - water-related education

  ** water and water resource management*

  ** economic sustainability*

  - continuing professional development

  ** new technology*

  ** self improvement*

ADVANCING WATER SCIENCE

- **Case studies**

  - intercountry partnerships

  **** agreements between Research Councils,***

  e.g. South African National Research Foundation/Kenya Research Cooperation programme

  - private/public partnerships

  **** water utilities & tertiary institutions***

  e.g. Rand Water / University of Pretoria & Tshwane University of Technology

Capacity development in risk assessment

- **Developing, organizing and teaching short courses related to water, sanitation and food safety**
  - Curriculum Development: Risk assessment related to water, sanitation and food in Vietnam
  - Manual for microbial risk assessment for food safety (VFA – WHO)
  - Microbial risk analysis in food safety in Vietnam (WHO)
  - Risk analysis for One Health
  - Risk assessment for food safety in informal market (RGU and ILRI)
- **Research on health risk assessment**
  - As contaminated water
  - Food contamination: *Salmonella*, antibiotic residues
  - Waste water reuse and health risk

Recommendations

- Assess global water quality and health using QMRA framework for wastewater treatment. Develop QMRA frameworks for high rain/flood events.
- Use the risk analysis framework integrate science and management/policy and promote the translation of science into action around sewage sources.
- Use advanced technology for water diagnostics to improve resolution of the evidence for decision making, including MST tools for the identification of the source of contamination.

Recommendations

- Develop the 21st century water curriculum for future water scientists, technicians and engineers.
- Establish regional Centres of Excellence
- Improve wastewater management and the recycle/reuse to address future drought and safe water availability. Obtain 2 to 3 log removal of viruses as a goal for treatment. Address high flow events. This will protect and restore water-related ecosystems.

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Anna Carratalà
Ayalkibet Hundesa
Marta Rusiñol
Laura Guerrero
Natalia Timoneda
Xavier Fernandez Cassi
Eloy Gonzales Gustavson
Sílvia Bofill
Natalia Figuerola
Rosina Girones

www.ub.edu/microbiologia_virology

Laboratory of virus contaminants of water and food

Universitat de Barcelona

Viroclime

Aberystwyth University
David Kay
Peter Wyn-Jones

The team of Viroclime:
Apostolos Vantarakis
Annika Allard
Marize Pereira Miagostovich
Marta Vagha

Thank You!

Discussion Questions

- What implementation challenges are addressed by the different technologies and approaches?
- What are the examples on Governance tool/s to be used to contribute to the effective implementation for each of the different targets of the water related SDGs?
- What are some of the obstacles you have diagnosed when implementing the different Governance tools presented in the conference for the different themes? What are the solutions have been identified to overcome them?
- What are the conditions for success to replicate and effectively implement those Governance tools in a different context (geographical, hydrological, institutional, etc.)?
- What is the role of Academia in overcoming the obstacles and implementing the tools? And scaling-up and/or trickling down good practices to foster better implementation in support of the water related-SDGs?