Water Quality 3: Updates, posters and next steps

Maryna Strokal, et al

Task Group 3.9 in PROCLIAS Cost Action

Coordination team

Maryna Strokal

Michelle van Vliet

Simon Gosling

Martina Flörke

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WAGENINGEN UNIVERSITY & RESEARCH

ISIMIP Inter-Sectoral Impact Model Intercomparison Project

PROCLIAS

8 June 2023

Large international community: ISIMIP, Proclias, WWQA, inventWater and others

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Water quality sessions

- Session 1 (15.30-17.00): modelling protocol
- Session 2 (10.00-11.30): regional modelling
- **Session 3 (13.00-14.00): updates, posters, next steps**

Program

- **13.00-13.20 Updates (Maryna Strokal)**
- 13.20-13.35 ISMIP3b simulation (Edward R. Jones)
- 13.35-13.45 Regional modelling (Ann van Griensven)
- 13.45-14.00 Next steps and posters (Maryna Strokal)

Why Model Intercomparison Projects for Water Quality (WQ-MIP):

- Water quality is key in understanding **cross-sectoral processes**
- **1) Identify, assess and compare water pollution**
  - Hotspots
  - Sources
  - Trends
- **2) Identify and set priories for water quality**
  - Data collection
  - Data monitoring
- **3) Perform scenario analyses** to test strategies to
  - Improve water quality
  - Under climate change and socioeconomic developments

Five types of diversity challenge WQ-MIP

1) Different **modeling approaches:** 1) laws & assumptions; 2) spatial representation (lumped vs. distributed) and 3) temporal representation (static vs. dynamic)

2) Different **water quality constituents** and **dimensions**
- Different forms (dissolved vs. particulate)
- Loads, concentrations, export

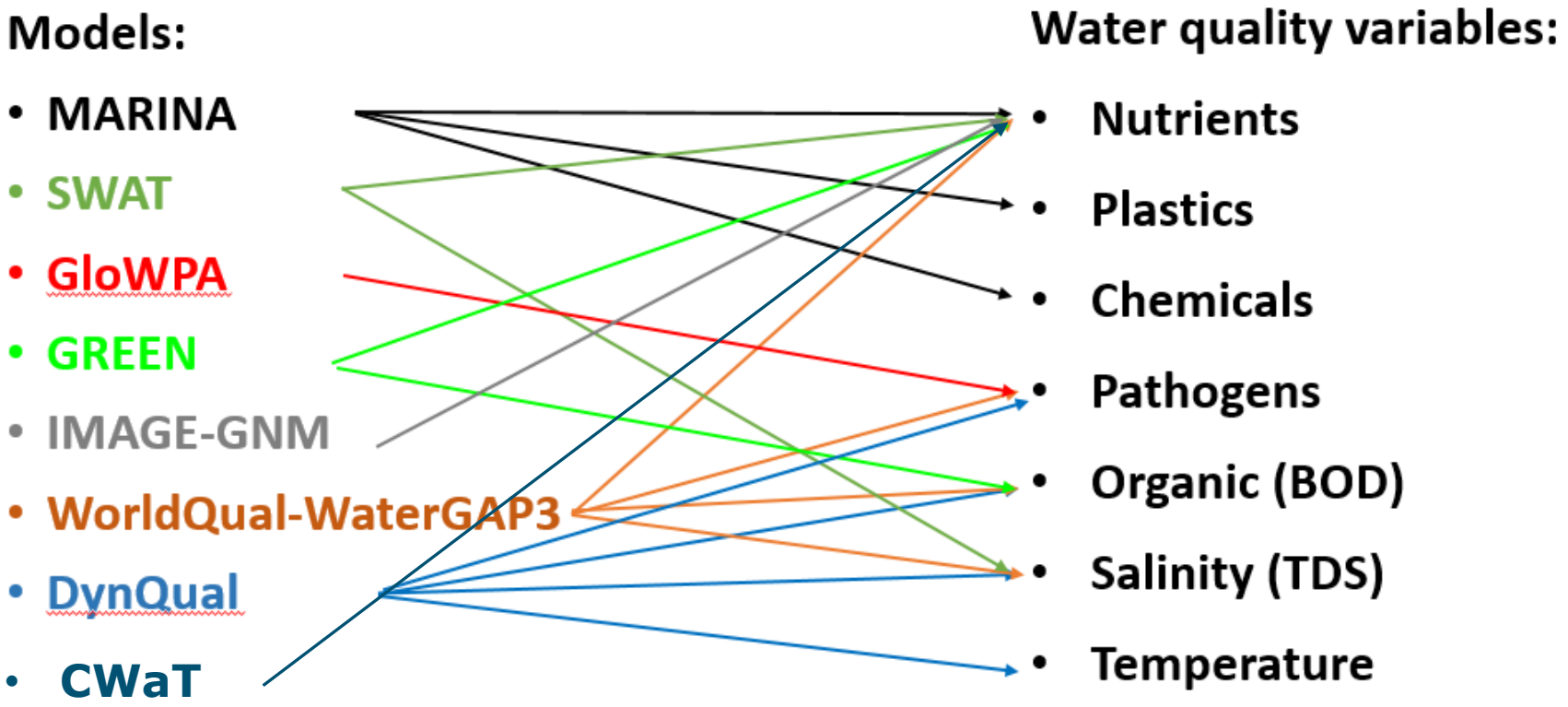
3) Different **types of water resources**:
- Streams, rivers
- Lakes, reservoirs
- Groundwater
- Coastal/estuarian areas

4) Different **spatial resolutions** and extend
- Basin, subbasin
- Gridded e.g. 0.5 deg (50 km), 5 arcmin (10 km)
- Hydrological response unit

5) Different **temporal resolutions** and time periods:
- Annual
- Monthly
- Daily

From the previous workshop (2022)

Examples of large-scale models



Based on the overview of the World Water Quality Assessment

Four main updates

1: ISIMIP/Proclias Water Quality Sector

- ISIMIP website: since 2022

Water (regional)

Valentina Krysanova

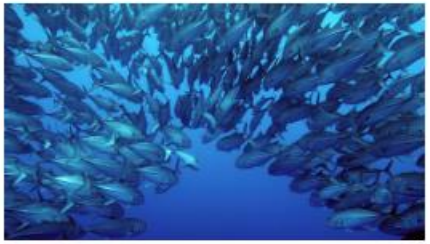
Fred Hattermann

Water Quality (in development)

Maryna Strokal

Groundwater (in development)

Robert Reinecke



Fisheries & Marine Ecosystems

Julia Blanchard (lead coordinator)

Energy Fluctuations and Extremes

Regional Forests

Christopher Reyer

Global Biomes

Jinfeng Chang

Agriculture Sector

Jonas Jägermeyr

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2: Four online water quality webinars in 2022

- 90 participants registered
- >20 countries and > 50 organizations

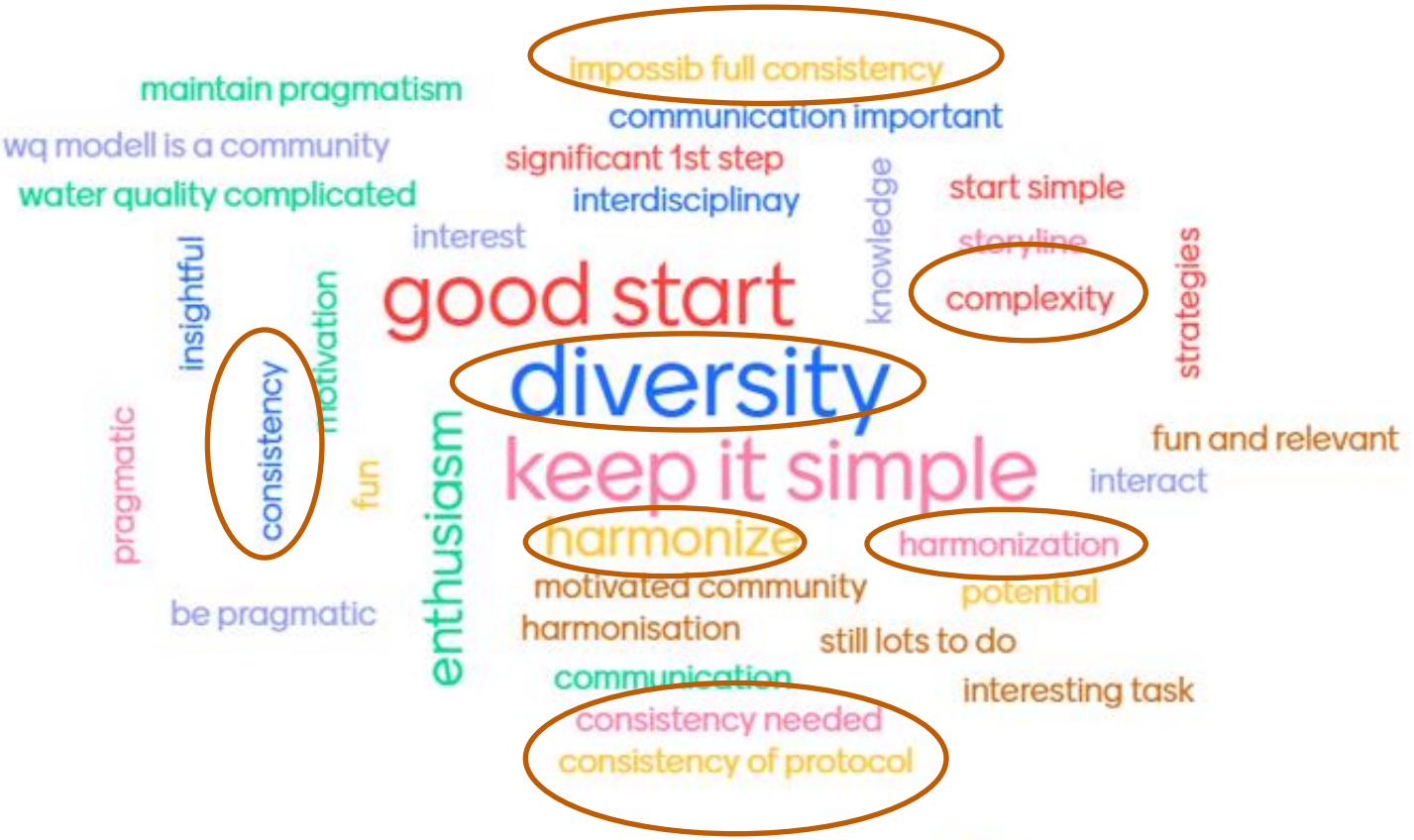
3: Fist draft water quality protocol in 2022

- **May 2022 (Potsdam)**
- **August 2022 (Wageningen)**

3: Fist draft water quality protocol in 2022

Challenges:

- Diversity and complexity
- Inconsistencies
- Data harmonization



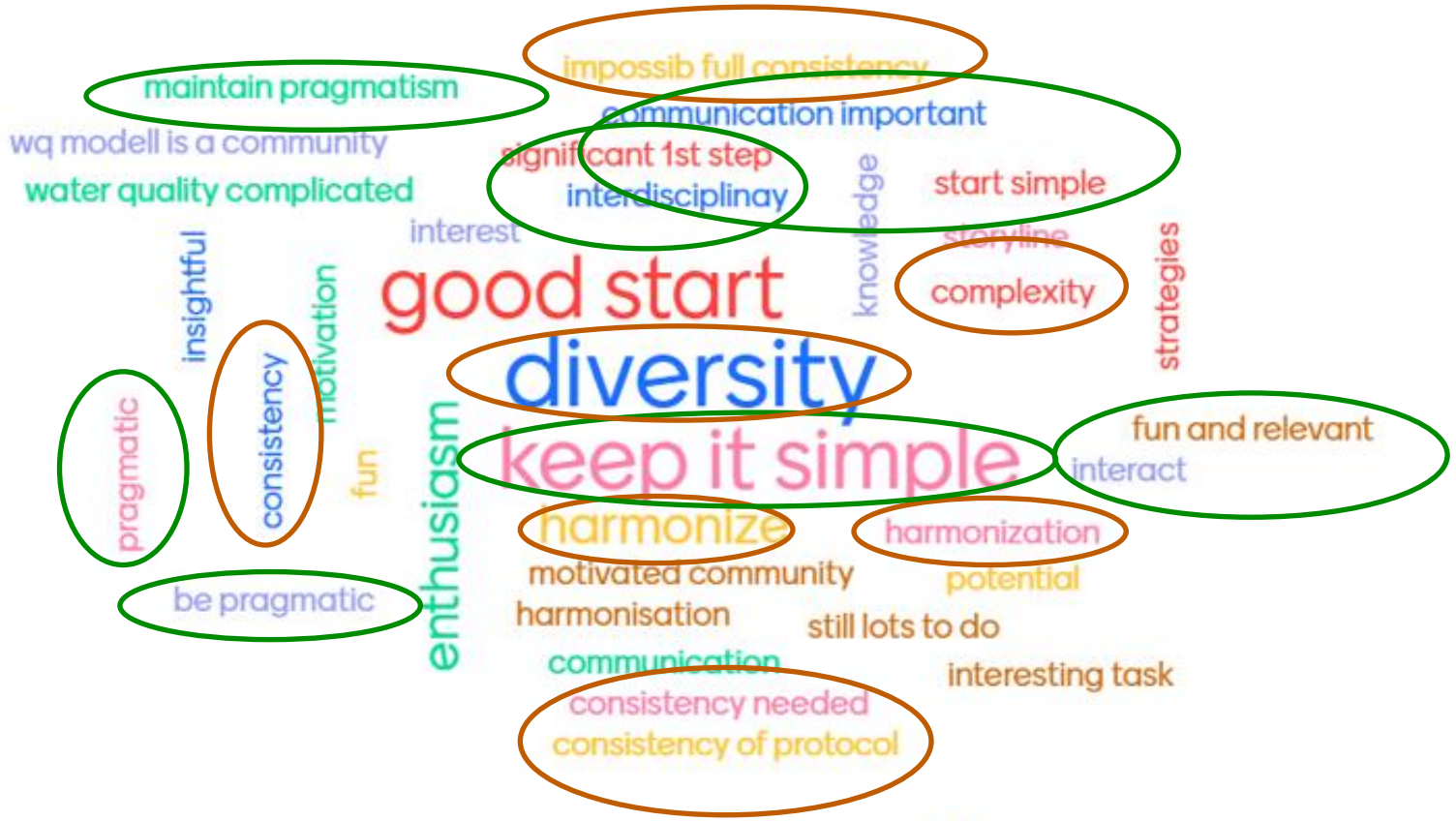
3: Fist draft water quality protocol in 2022

Challenges:

- Diversity and complexity
- Inconsistencies
- Data harmonization

Opportunities:

- Keep It Simple (KIS approach)
- Communication and interaction
- Interdisciplinarity



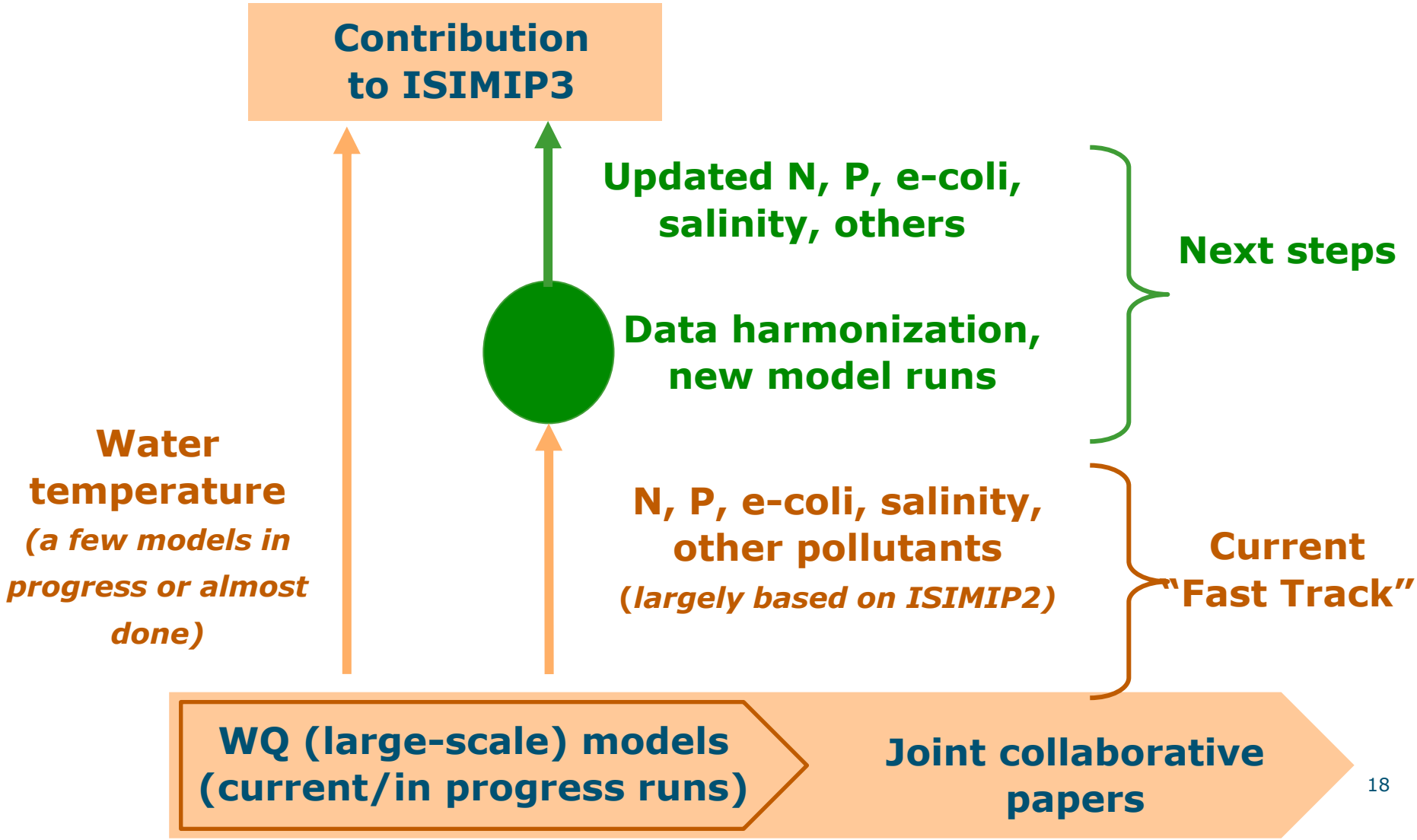
4: Second draft water quality protocol

- **7-8 June 2023 (Prague):** two sessions

4: Second draft water quality protocol

- **7 June modelling protocol** (yesterday, Wednesday)

Strategy to build our water quality community within ISIMIP



4: Second draft water quality protocol

- **A "Fast track" water quality protocol (2023-2024)**
- **Six aspects** – the basis of today's discussion to make the next steps
  - Aspect 1: ISIMIP2 (CMIP5) and ISMIP3 (CMIP6)
  - Aspect 2: Water quality constituents
  - Aspect 3: Spatial and temporal resolution
  - Aspect 4: Period
  - Aspect 5: Scenarios
  - Aspect 6: Units

4: Second draft water quality protocol

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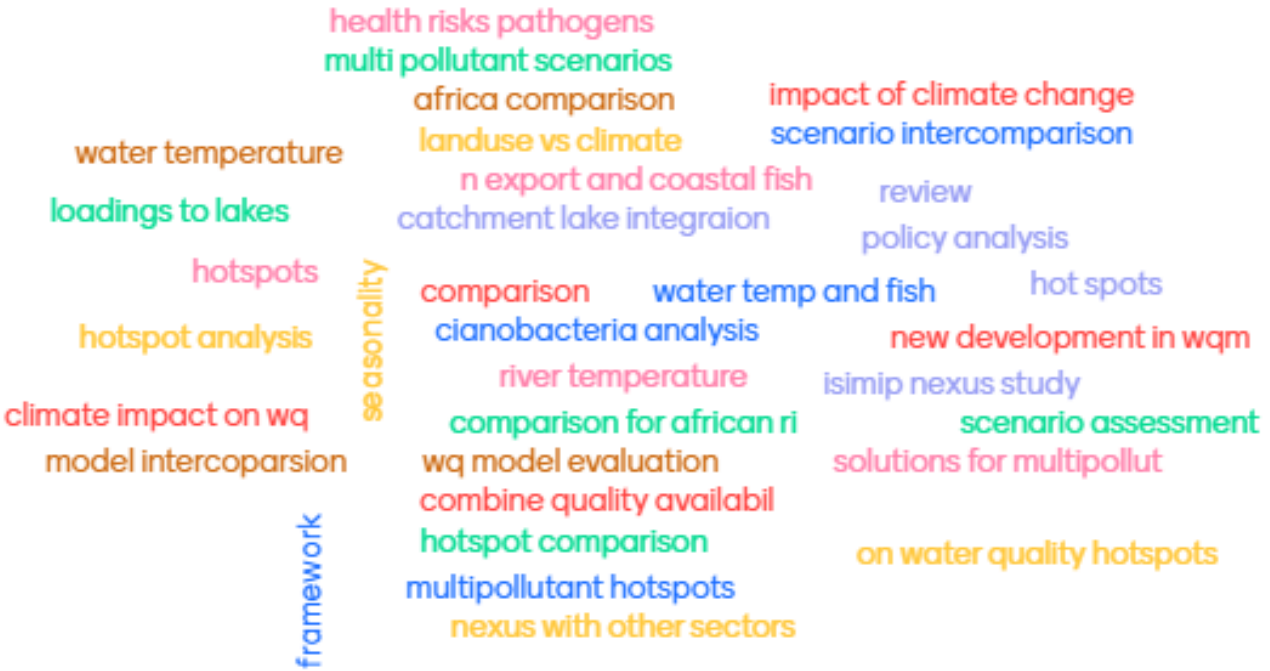
Ideas for collaborative papers

Write ideas for collaborative water quality papers

34 answers



Questions

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Edward R. Jones

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Ann van Griensven

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Next steps

- **August 28th-29th:** water quality workshop (finalizing the protocol)
- **Sept 2023:** Protocol submission to ISIMIP (by coordinators)
- **Oct 2023-Feb 2024:** Model output submission to ISIMIP and a few online meetings
- **March-June 2024:** A paper-writing workshop

Scenario Development for the World Water Quality Assessment (WWQA)

Nynke Hofstra[1*], Martina Flörke[2], Ilona Bärlund[3], Arthur Beusen[4], Lex Bouwman[4], Marc Gramberger[5]

1: Wageningen University, The Netherlands; 2: Ruhr-Universität Bochum (RUB), Germany; 3: Helmholtz Centre for Environmental Research (UFZ), Germany; 4: Utrecht University, The Netherlnds; PBL Netherlands Environmental Assessment Agency, the Netherlands; 5: Prospex bvba, Brussels/Keerbergen, Belgium

Contents of assessment (according to UN Water):

- Baseline assessment of the state of water quality,
- **Scenario analysis of water quality trends to identify dynamic trends over the next 10 to 50 years in water quality,**
- Assessment and analysis of mitigation options available, and
- Assessment and analysis of governance approaches

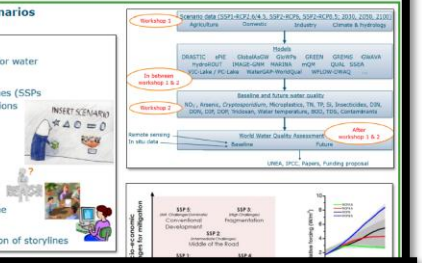
WWQA workstream objective:

To develop fast-tracked or 'light' water quality scenarios

'Light' Water Quality Scenarios

Pragmatic approach:

- Identification of variables required as input for water quality models
- Understanding of available reference storylines (SSPs and RCPs) & definition of SSP-RCP combinations
  - SSP1-RCP2.6/4.5
  - SSP2-RCP6
  - SSP5-RCP8.5
- Evaluation of available input data
- Identifying missing input data
- Quantifying missing input data using storyline interpretation and other information
  - Modelling and quantification of storylines



Multi-pollutant modelling for rivers and coastal waters

Ilaria Micella[1], Maryna Strokal[1], Carolien Kroeze[1], Ting Tang[2], Yoshihide Wada[2]
1: Water Systems and Global Change Group, Wageningen University, The Netherlands
2: International Institute for Applied Systems Analysis, Austria

MAIN REASERCH QUESTION & METHOD:

The **main research objective:**

- To assess **trends in flows of multiple pollutants from land-based sectors to water systems,**
- To **explore effective measures to achieve clean water for multiple sectors** in the future at the sub-basin scale worldwide.

MARINA-Multi Global

- **MARINA:** Model to Assess River Inputs of polluatNts to seAs
- Pollutants:
  - Nutrients,
  - **Microplastics,**
  - **Macroplastics,**
  - Triclosan (antibacterial agent),
  - Diclofenac

RESEARCH OUTPUT (Examples)

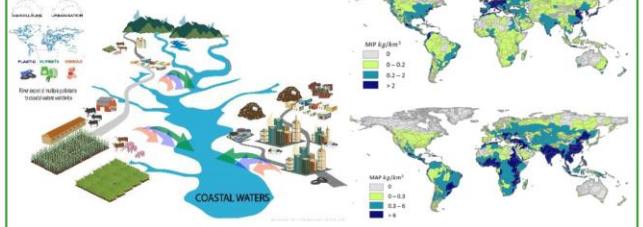


Figure 1. Multi-pollutant problems (left) and flows of micro (MIP, upper right map) and macroplastics (MAP, lower right map) from land-based sectors to coastal waters at the sub-basin scale worldwide (kg/km²/year). Source: the MARINA-Multi model (Ilaria Micella et al, under review in Marine Pollution Bulletin)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement 956623. MSCA-ITN-ETN – European Training Network
Innovative forecasting approaches to assess future trends in pollutant flows from land to water systems for advancing sectoral water quality service - WUR

Contact:
ilaria.micella@wur.nl

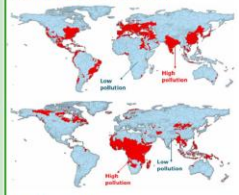
MARINA models for plastics, antibiotics, nutrients and other pollutants in surface waters

Joint effort of Maryna Strokal, Carolien Kroeze, > 15 PhD candidates and > 50 MSc students
Water Systems and Global Change Group, Wageningen University, The Netherlands

MAIN REASERCH QUESTION & METHOD:

MARINA is the family of Models to Assess River Inputs of polluatNts to seAs. The models are developed and applied for

MAIN RESEARCH OUTPUT



2010: Microplastics, nutrients and other pollutants in rivers from sewage (*https://doi.org/10.1016/j.cosust.2018.11.004*)

2100: Microplastics, nutrients and other pollutants in rivers from sewage with improved wastewater treatment (*https://doi.org/10.1038/s42949-021-00026-w*)

Main messages:

- Today, 80% of the global population live in polluted basins

Seasonal multi-pollutant modelling in rivers and lakes

(Another season, another cocktail)

Mirjam P. Bak, Maryna Strokal, Annette B.G. Janssen, Carolien Kroeze
Water Systems and Global Change Group, Wageningen University, The Netherlands

MAIN REASERCH QUESTION & METHOD

Aim: to better understand how seasonality in lake retentions affects river export of multiple pollutants worldwide today and in the future.

Method: global modelling study including

- **MARINA-Multi:** the Model to Assess River Inputs of polluatNts to seAs for 10,226 sub-basins (version 5.0)
- **PCLake+:** the food web model for lakes

Pollutants included:

- Nitrogen,
- Phosphorus,
- Microplastics,
- and others.

Required data: crop calendars, wasetwater treatment efficiency, seasonal retention and others

MAIN RESEARCH OUTPUT (examples)

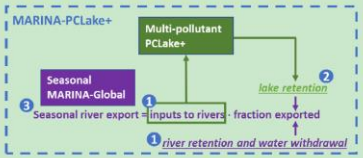


Figure 1. The project overview with expected outcomes such as datasets of seasonal river export of pollutants (i.e. microplastics) to seas by source and by sub-basin, accounting for lake retetions and newly developed the MARINA-PCLake+ model system

Contact:
mirjam.bak@wur.nl
Seasonality in pollution - WUR

Impacts of climate change and human activities on Kyiv Reservoir in Ukraine

Anna Kurovska [1]
[1]Agrosphere Ecology and Environmental Control of Department, Faculty of Plant Protection, Biotechnology and Ecology, National University of Life and Environmental Sciences of Ukraine, Ukraine

Ph.D. student in Ecology science
Anna Kurovska

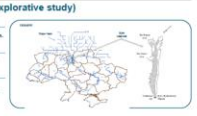
Background

- Kyiv reservoir is an important source of water for purposes such as industries, irrigation, fish farming, agriculture, urbanization, etc.

Objective

- To develop an integrated framework for assessing water quality in reservoirs for different water use purposes while accounting for the impact of climate change and human activities (e.g., urbanization, agriculture) taking Kyiv Reservoir as a case study in the Dnipro Basin

Kyiv reservoir (explorative study)



Climate and human activities

To identify the impact of climate change and main activities on water quality in Kyiv reservoir

Water quality and military actions

To analyze water quality parameters and identify the main implications of the Russian-Ukrainian war on reservoir water

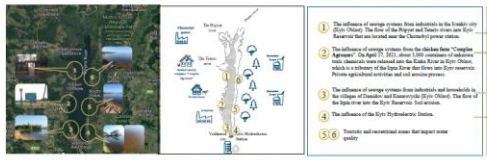


Figure 1. The main sources that influence water quality in Kyiv reservoir (Strokal and Kovpak, 2022a; Strokal and Kovpak, 2022b)

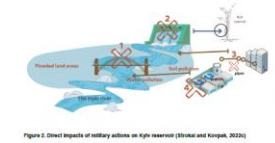


Figure 2. Direct impacts of military actions on Kyiv reservoir (Strokal and Kovpak, 2022c)

One of the main consequences of military actions on the water environment is water pollution with oil products and other harmful substances. After the de-occupation of a large part of the villages and cities of the Kyiv region, submerged military equipment containing lubricants and various iron elements was found in the reservoirs of the Pripyat and Irpin rivers. Accordingly, this caused the death of fish, some species of birds, and worse microorganisms, causing the deterioration of water quality.

References

Drivers of multiple pollutants in Ukrainian rivers

Vits Strokal [1]
[1]Agrosphere Ecology and Environmental Control of Department, Faculty of Plant Protection, Biotechnology and Ecology, National University of Life and Environmental Sciences of Ukraine, Ukraine

Associate professor
Vita Strokal

Background

- Water quality is suffering from multi-pollutant problems (nutrient pollution, micro- and microplastics, and heavy metals, pathogens).
- The three main drivers of multiple pollutants in Ukrainian rivers are:
  - human activities (agriculture and urbanization);
  - climate change;
  - military actions.

Objective

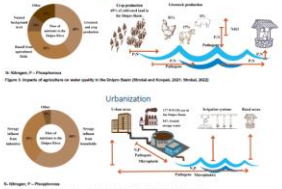
- Better understand the drivers of multiple pollutants in Ukrainian rivers today and in the future;
- Explore strategies for sustainable development and clean water in Ukraine.

Dnipro Basin (explorative study)

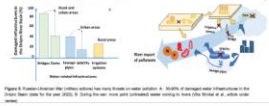
Driver 1: Climate change

- Global warming scenario
- North: more precipitation and risk for floods
- South: less precipitation and risk for droughts

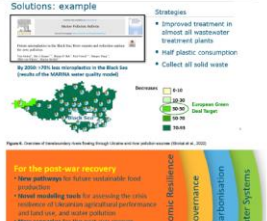
Driver 2: Human activities



Driver 3: Military actions



Solutions: example



References

Thank you

ISIMIP Inter-Sectoral Impact Model Intercomparison Project

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cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

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