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Combining green, blue and grey infra:
Risks and benefits of nature-based urban drinking water production

Combining green, blue and grey infrastructures involves balancing local and broadly regional risks and benefits. We study them in the context of Nature-Based Solutions (NBS) to urban drinking water supply in a case of Managed Aquifer Recharge (MAR) utilizing river water and soil infiltration in an esker. This exemplifies key issues in projects spanning urban and rural settings, basins, environmental media, technologies, sectors and types of impact.

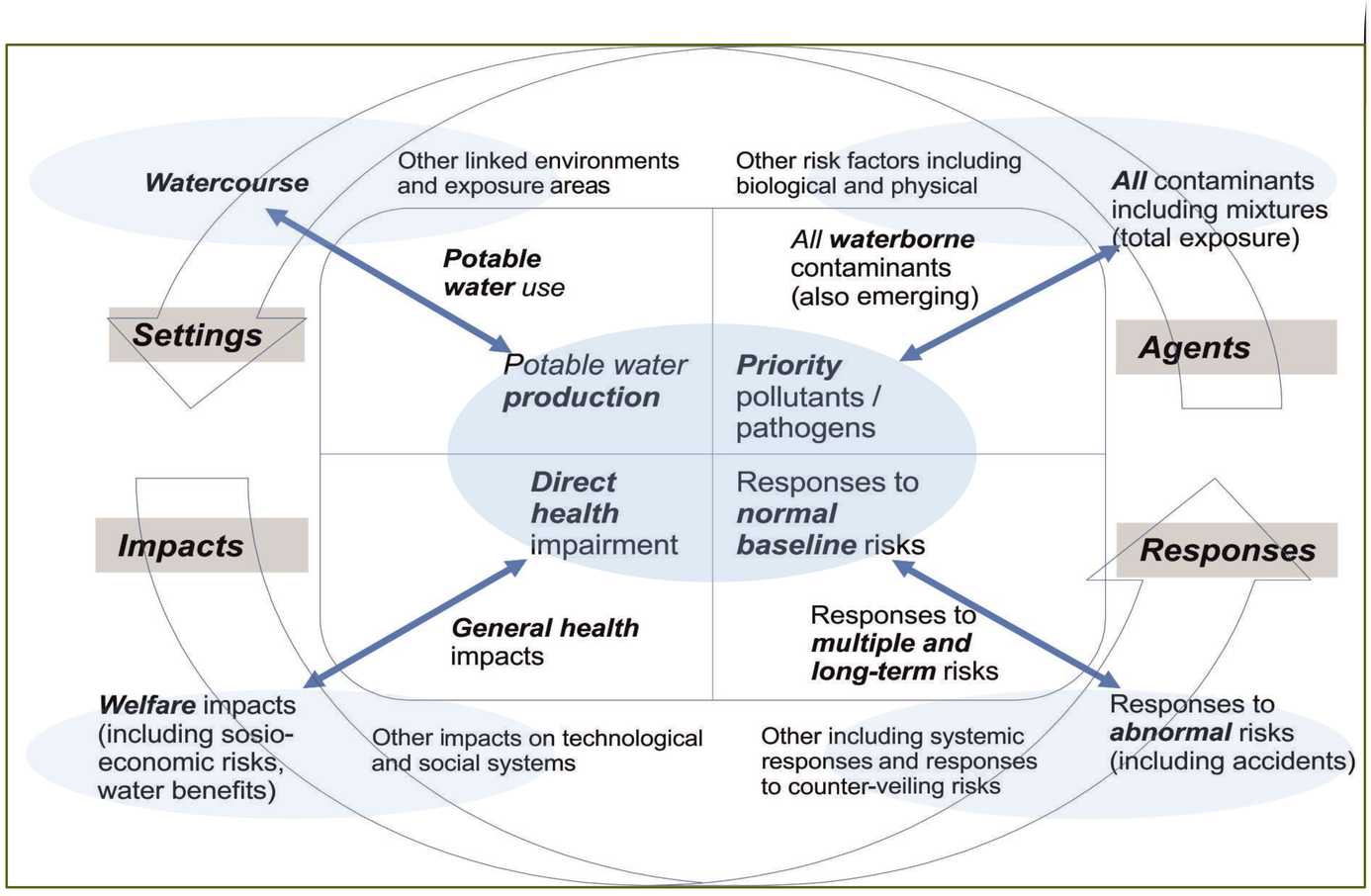

Fig. 2. Solution-oriented health risk assessment on multiple levels within substantive dimensions and response categories in potable water contamination specifically in connection with MAR. Note the shifts between basic framing (in center) and extended framing (in periphery).

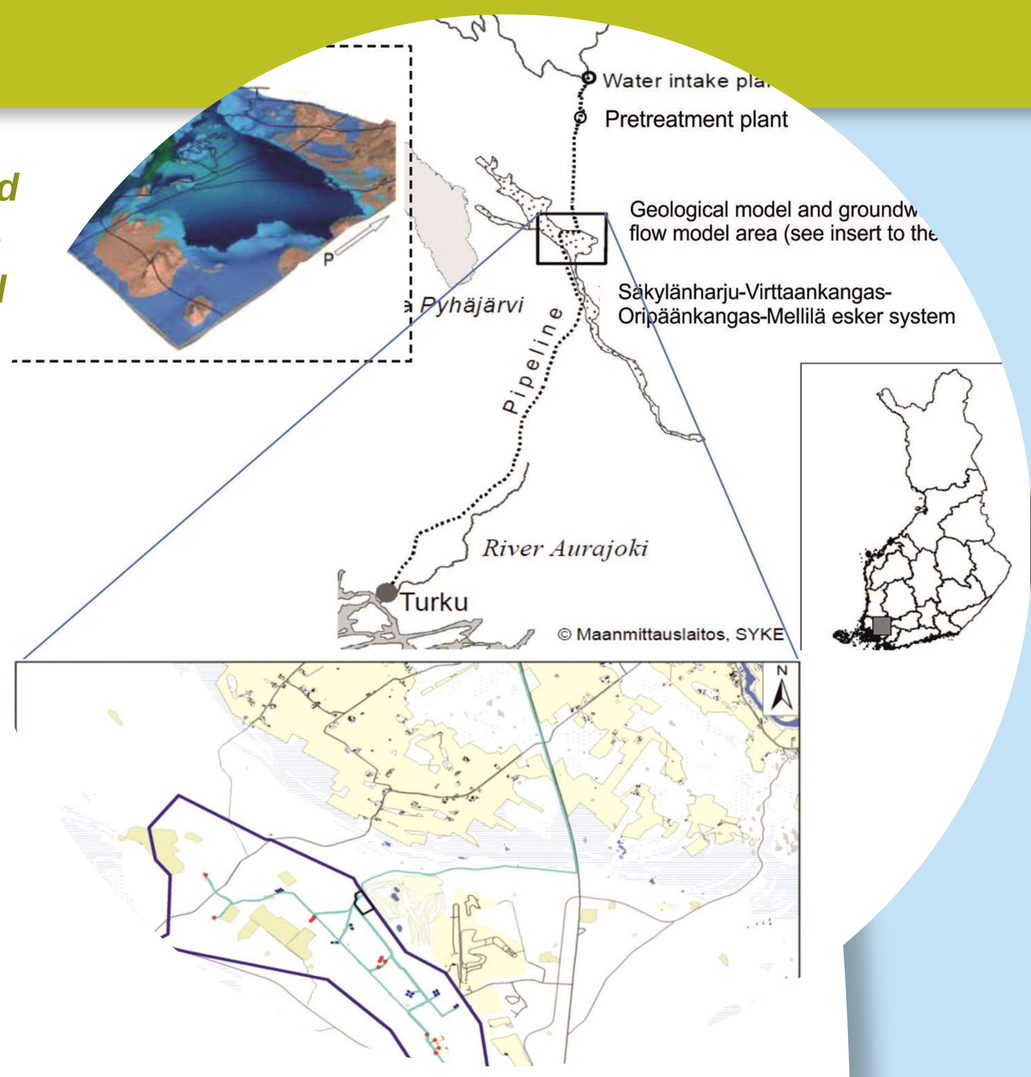

Fig. 1. Study area with the potable water production system: surface water intake from upsteam river basin including contamination sources; pretreatment plant; surface water infiltration and MAR plant in a sand and gravel esker (shown in 3-D hydrogeological model and detail map of the fenced facility area); transfer pipeline to water supply area.

DEFINITIONS AND APPROACHES

NBS often combine **green** (nature-dominated) infrastructure, **blue** (aquatic ecosystems) and traditional **'grey' infrastructure**, also in urban water supply.

The **risks** of concern are primarily to human health from pathogens and chemicals (Fig. 2). The **benefits** include improved water supply in a region previously short of good-quality potable water, and adjacent indirect benefits.

The risks and benefits are addressed by an **integrated multi-method approach** to support specific modeling of contaminant transport and effects, conduct and interpretation of field and laboratory studies of contaminant fluxes, and management analyses and interventions.

RESULTS AND DISCUSSION

1) **Risks and benefits** from alternative water supply solutions **involve many kinds of effects** along a hydro-social chain
2) **Risks need to be first framed broadly** for well-targeted governance
3) A key need in preventing and alleviating risks and in securing benefits lies in **applying NBS in integrated, long-term, broadly feasible, socially acceptable and sustainable ways**
4) In this process, **errors and opposition need to be overcome by careful and inclusive planning and implementation**, including foresight and hindsight in **social learning**.

CONCLUSIONS

- **MAR can improve water supply**, but its efficiency as a semi-NBS is potentially constrained by contaminants, also new ones emerging, and other risk factors
- The health risks and benefits involve **important socio-economic aspects** also through indirect systemic impacts
- For sustainability transitions, **wise mixes of innovative and traditional infra** and of their risks and benefits is crucial
- Such aspects and combinations require **many-sided analysis** and evaluation
- Due to multi-dimensional risks, impacts and uncertainties, **multi-actor deliberation** is needed on goals, means and action consequences.

References

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