MARS fact sheet #14

MARS PROJECT

Managing Aquatic
ecosystems and
water Resources
under multiple Stress

Four key messages of the MARS project

After four years of in-depth research on multiple stressors, the MARS project delivered a large quantity of results, including > **50 scientific reports**, > **150 paper publications**, various tools and further achievements. Four key messages emanated from the project activities, which provide a quintessential summary of the endeavours.

Message 1: Mitigating pressure-effects on aquatic ecosystems requires an understanding of multi-stressor impacts.

WFD water management is designed using the Driver-Pressure-State-Impact-Response concept. Significant pressures on aquatic ecosystems are identified first. These pressures are assumed to have impacts on ecological status of a river, lake or estuary. Mitigation actions are then selected on the basis of these pressures (known as the "pressure-response shortcut").

This approach may not fully account for the complex interactions and impacts of multiple stressors. As a result, MARS advocates aquatic science research that investigates the direct causes of deteriorated ecological status. Such an approach would allow for more informed management decisions targeting the actual, multi-stressor reasons for ecosystems not reaching good status.
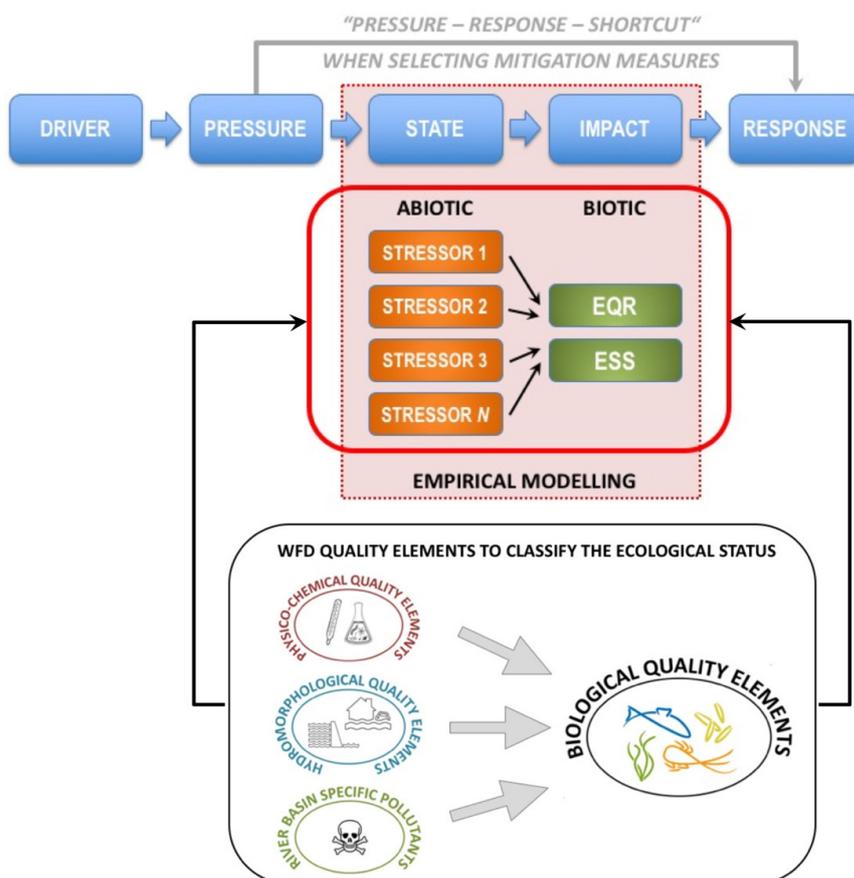

Figure 1: Multi-stressor – impact relationships lie at the heart of informed river basin management. The WFD monitoring programmes generate valuable data sources for such analysis. EQR = Ecological Quality Ratio; ESS = Ecosystem Services.

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Message 2: Environmental 'noise' can obscure evidence from multi-stressor – impact relationships in river basins. Experiments can help unravel multi-stressor interactions and impacts.

Water managers deal with water bodies in the 'real world'. Here, multi-stressor effects on aquatic biology often interfere with other (natural) factors like weather conditions or river flow dynamics. Distinguishing multi-stressor effects from such complex environments is a bit like trying to identify a musical tune played in a noisy room. Nevertheless, water managers need to understand the multi-stressor combinations acting in their basin to devise appropriate mitigation measures.

Multi-stressor experiments (like those conducted by **MARS in the Austrian Alps**) help uncover the 'noise-free' pathways of multi-stressors interactions and impacts, and thus offer valuable insights for informed management decisions.
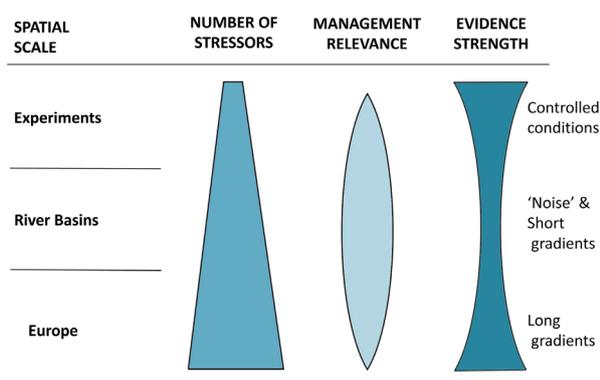

Figure 2: Multi-stressor evidence at the river basin scale (most relevant for water management) is more obscure compared to the evidence gained at experimental scale (under controlled conditions) or European scale (with many and long stressor gradients).

Message 3: Multi-stressor interactions are common in rivers and lakes across Europe and need to be considered in River Basin Management. Interactions are highly context-specific, requiring targeted, localised research to inform management.
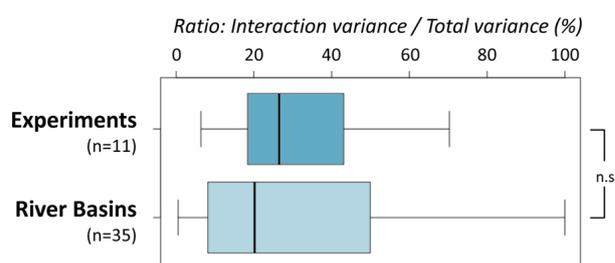

Figure 3: Strength of interaction effects. About one-third of the 156 MARS case studies analysed showed significant interaction effects (in paired-stressor – impact relationships). The strength of interaction effects at river basin scale is as large as at experimental scale (n.s. = non-significant difference).

Message 4: River Basin Management in Europe will benefit from (more) data-driven analyses, modelling and interpretations which are tailor-made for the river basin to be managed.

WFD monitoring data from surface and ground waters across Europe is increasingly available, allowing researchers new opportunities to analyse multi-stressor – impact relationships. This evidence can feed into basin-specific prognostic or diagnostic models that enhance our understanding of aquatic systems, and help facilitate their effective management. Practitioners from applied aquatic science and water management can work together as interdisciplinary 'water body doctors'.

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MARS is helping create the conditions for such work by offering these tools:

The Freshwater Information Tool
http://fis.freshwatertools.eu
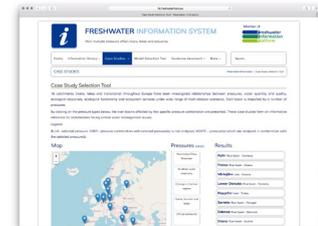
The Multi-Stress Analytical 'Cookbook'
https://goo.gl/L8dSh4 (ResearchGate)

The Model Selection Tool
http://fis.freshwatertools.eu/index.php/mst.html

The Diagnostic Tool
http://www.freshwaterplatform.eu/index.php/
mars-diagnostic-tools.html
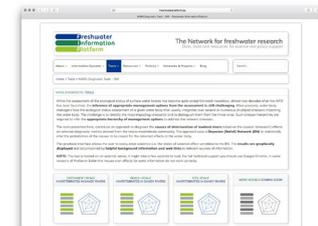
The Scenario Analysis Tool
http://www.freshwaterplatform.eu/index.php/tools.html
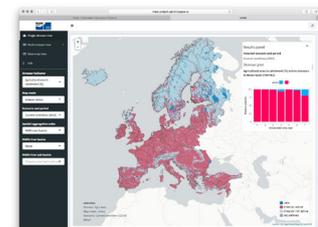
The Guidance for River Basin Management
under multiple stress
Available on www.mars-project.eu