Deliverable 8.4: Fact sheets including a set of illustrations

Version 1 (Month 18)

Lead contractor: UDE
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<th>Dissemination Level</th>
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<td>PP</td>
<td>Restricted to other programme participants (including the Commission Services)</td>
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<td>CO</td>
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Content

Introduction

MARSfact sheet #01: *Multiple stresses and freshwater ecosystem service provision: the MARS ‘cookbook’ methodology*

MARS fact sheet #02: *Freshwater Information Platform – www.freshwaterplatform.eu*

MARS fact sheet #03: *MARS scenarios and storylines*

MARS fact sheet #04: *Multiple stresses on Europe’s freshwaters: emerging challenges for science, policy and management*

MARS fact sheet #05: *Freshwaterblog: A tool for wide range dissemination*
Introduction

Europe’s surface waters are affected by multiple stressors, ranging from water pollution of urban point and agricultural diffuse sources to habitat alteration by river engineering and maintenance management. Effective multi-stressor mitigation not only requires in-depth knowledge on the causal pathways to convey practical management solutions, but also appropriate dissemination and communication strategies to impart the existing knowledge, to generate understanding and to distribute relevant evidence.

Multi-stressor settings and their effects on the ecosystem are complex and often complicated to grasp, even for the experts familiar with this topic. When, for instance, multiple stressors act simultaneously, interactions often occur that either exacerbate the impact on the ecosystem compared to the sum of the single stressor effects (so-called “synergistic effects”), or weaken the impact on the ecosystem (so-called “antagonistic effects”). Insights into these interactions are of paramount importance to water managers as the choice of appropriate management strategies depends on this knowledge.

The MARS project thus puts emphasis on practical outputs and the dissemination of scientific findings, allowing to establish strong linkages between the scientists and the practitioners 'on the ground'. One particular aim of the MARS communication and dissemination strategy is to encourage the scholars to leave their ‘ivory tower’ and to propagate their knowledge in a digestible format. Especially the freshwater blog run by the project already proved effective in this regard.

The report at hand forms an essential part of the MARS strategy to communicate the project’s key-approaches and -messages generated from the various research strands conducted in MARS. The fact sheets that constitute the core of this report are designed as “quick feeds” for a diverse target-audience, including academics, administrators, practitioners and policy-makers. Each fact sheet is written in a non-technical language of brief and concise style, not exceeding two pages in length. A set of high-resolution illustrations relevant in the particular context accompanies each fact sheet. These illustrations either visualize thematic contents or generate corporate design for specific MARS products.

The fact sheets are placed at a central position on the MARS public website (http://mars-project.eu/index.php/fact-sheets.html) to allow for easy internet access. The publication of this deliverable will be featured in a post on the freshwater-blog. Furthermore, the individual fact sheets will be circulated via email to the MARS consortium and external contacts, including members of the target-audience specified above.
This deliverable version covers the following fact sheet topics:

- MARS fact sheet #01: *Multiple stresses and freshwater ecosystem service provision: the MARS ‘cookbook’ methodology*
- MARS fact sheet #02: *Freshwater Information Platform – www.freshwaterplatform.eu*
- MARS fact sheet #03: *MARS scenarios and storylines*
- MARS fact sheet #04: *Multiple stresses on Europe’s freshwaters: emerging challenges for science, policy and management*
- MARS fact sheet #05: *Freshwaterblog: A tool for wide range dissemination*

We intend to update this document during the future course of MARS, collating fact sheets and illustrations of all relevant MARS achievements. The following provides a selection of topics that will be addressed in the document’s updates, envisaged for project month 26 (March 2016) and 48 (January 2018):

- Main multi-stressor combinations occurring in Europe;
- Selected MARS experiments and case-study catchments;
- MARS key deliverables.
Multiple stresses and freshwater ecosystem service provision: the MARS ‘cookbook’ methodology

The MARS project assesses the impacts of multiple stressors on the provision of ecosystem services from freshwater ecosystems, under different climatic and land-use scenarios. The European Union FP7 funded project has developed an innovative new assessment methodology – termed a ‘cookbook’ – to allow scientists, environmental managers and policy makers to quantify the relationships between multiple stresses and ecosystem service provision and value. The cookbook provides an invaluable tool to support the implementation of the Water Framework Directive in Europe.

Ecosystem Services and MARS

Ecosystem services are the benefits that people obtain from ecosystems, which contribute both directly and indirectly to human well-being. Their designation helps highlight and value the key roles that biodiversity and ecosystem functions play in providing multiple benefits to humans, such as food, clean water and sanitation. This in turn, helps support, legitimate and strengthen environmental policy and conservation.

The MARS cookbook is a new integrated assessment methodology that allows users to assess how the impacts of multiple stresses affect the services that freshwater ecosystems can provide. Increasingly complex ‘cocktails’ of multiple stresses such as nutrient pollution, water abstraction and flooding affect Europe’s freshwater ecosystems. Such multiple stressors can interact in an ecosystem to potentially intensify or weaken their individual, additive effects, posing new challenges for environmental management. In collaboration with a number of other European Union projects, MARS is undertaking experimental and modelling analyses to better understand the effects of multiple stressors on freshwaters, particularly in terms of the ecosystem services that they provide.

Service capacity, flow and benefits

Building on the expertise of project partners and insights from wider scientific and economic research, the MARS cookbook uses a cascade model methodology that links the structure and function of an ecosystem to its service provision. This methodology includes the capacity of an ecosystem to provide a service (assessed using biophysical data), the actual flow of the services used by humans (assessed using socio-economic data), and finally the benefits that ecosystem services provide.

By assessing both the capacity of an ecosystem to provide services, and the actual use of these services, the MARS cookbook methodology allows assessments on the sustainability of ecosystem use to be made. The unsustainable use of ecosystem services may become an additional stressor of the ecosystem’s health and status.

The MARS service cookbook

The MARS cookbook methodology is split into four steps. The first is scoping, the process by which the aquatic ecosystem and ecosystem services of interest are selected and mapped, and the spatial and temporal scale of analysis are defined. The second step is to develop the assessment framework, through which multiple stressors and ecosystem services are linked in a stressor-ecological status-ecosystem service series. A key step here is to check whether the ecological indicators used (e.g. biodiversity, ecological status) capture the effects of the stressors, and can be linked to the ecosystem services of interest.
The third step is assessment, where biophysical indicators are organised according to the ecosystem’s capacity to deliver a service, its actual use, and the resulting human benefits provided. Indicators are organised in three categories: capacity (e.g. biomass of commercial fish species); flow (e.g. fish catch); and sustainability (e.g. % of catch within sustainable limits). Their ability to indicate ecosystem stress and/or service provision is quantified through the computer modelling of existing ecological data.

The fourth step is valuation, to identify the benefits provided by ecosystem services and aggregate them at three scales: water body, catchment and European continent. The valuations are undertaken at appropriate scales to support decision making in River Basin Management Planning. In the valuation process, the ecosystem service, benefit and value are separated, because a service (e.g. water purification) can provide numerous societal benefits depending on the location (e.g. drinking water; swimming areas). The economic value of the ecosystem services provided can then be valued through revealed and stated preference methodologies, and cost-based and benefit transfer approaches.

Further reading

Figures

Figure 1: The cascade model - quantifying the capacity, flow and benefits of ecosystem services

- Identify and map the aquatic ecosystem of interest
- Select the ecosystem services to assess
- Establish the spatial and temporal scale of the analysis

Figure 2: The four steps of the MARS ‘cookbook’ methodology

- Develop the integrated assessment framework considering multiple stressors, status and ecosystem services
- Select the biophysical indicators organized according to the scheme: Capacity to deliver the service ↔ Flow of the service ↔ Benefit
- Compute the indicators on the basis of data and/or modeling results
- Identify the benefits provided by the services
- Water body / catchment scales: conduct a primary valuation study
- European scale: upscale meta-values estimating a value transfer function
Over recent years, many European Union funded research projects have investigated freshwaters – ranging from biodiversity related projects to others focusing on pressures and their effects on European inland waters, including appropriate rehabilitation strategies. However, the data generated by these projects is often difficult for water managers, policy makers, scientific communities and the general public to access and use. In order to make this detailed and wide-ranging knowledge of freshwater ecosystems accessible to all, the Freshwater Information Platform was launched: an interactive website integrating results and original data stemming from finished, on-going, and future freshwater research projects.

The platform contains several complementary sections, either providing access to original data or summarising research results in an easily digestible way. All sections are composed as ‘living documents’ that will be continuously improved and updated. Pressures such as water pollution, intense land use and climate change are increasingly threatening the health and diversity of European freshwater ecosystems. The Freshwater Information Platform also provides a collection of research tools, information about freshwater-related policies and relevant European and global networks relating to freshwater science and policy.

Scientists are invited to add their data to the platform and to share it with other users inside and outside the scientific community. We invite also other research projects to be part of the platform. As a connecting element we have developed a corporate design and a “member sticker”, which forms a linking element across different websites.

### Platform sections

The “Freshwater Biodiversity Data Portal” provides access to data on the distribution of freshwater organisms (such as fishes, insects and algae), both in Europe and worldwide. The portal helps scientists to advertise and publish their data(base) and to provide tools for the discovery, integration and analysis of open and freely accessible freshwater biodiversity data.

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<th>Freshwater Biodiversity Data Portal facts</th>
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<td>Georeferenced occurrences:</td>
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<td>Visitors per month (first half 2015):</td>
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The “Global Freshwater Biodiversity Atlas” provides a series of interactive maps with different data-layers on freshwater biodiversity richness, threats to freshwaters and the effects of global change on freshwater ecosystems.

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<td>Maps currently under development:</td>
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<td>Maps data requested/agreed on:</td>
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<td>Map data-layers:</td>
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<td>Visitors per month (first half 2015):</td>
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The “Freshwater Species Traits Database” integrates the knowledge on the ecology of about 20,000 species inhabiting European freshwater ecosystems, including information on their ecological preferences (e.g. species’ habitats, nutrition, pollution tolerance).

This easy way of publishing freshwater (biodiversity) related metadata is aiming to change the perception about data publishing in the freshwater scientific community.

The vibrant and widely-read “Freshwater Blog” publishes features, research highlights, interviews and podcasts on freshwater science, policy and conservation.

Further reading


Corporate design

Logo

Button for websites

Simple icon for websites or other uses

Colors

RGB: 0 60 143  
CYMK: 98 85 1 0  
HEX: #003d90

RGB: 37 126 79  
CYMK: 82 28 78 10  
HEX: #257E4F

RGB: 151 191 13  
CYMK: 50 0 99 0  
HEX: #97BF0D
MARS scenarios and storylines

The multiple combinations of drivers and pressures for a given aquatic system for the current situation are shaped by its historical and present climatic, managerial and socio-economic conditions. The future combinations of drivers and pressures depend on the future climatic and socio-economic scenarios considered plausible for this system. Within MARS, scenarios and storylines are used to project the impacts of multiple stressors on aquatic ecosystems. They deliver a qualitative framework and, where possible, quantitative data for modellers to run simulations.

Various future climatic and socio-economic scenarios have been chosen within MARS to define three storylines at European level. Each storyline frames the conditions leading to certain combinations of drivers and pressures for Europe. These storylines have been downcaled to case-study catchment-level using the expert knowledge of the scientists working on the 16 MARS case-study catchments, and the stakeholders of these catchments.

What are storylines and scenarios within MARS?
A storyline is a narrative about a fictive sequence of events that could take place in the near future. Within MARS, storylines describe several aspects of economic, environmental, political and climatic developments and are mainly defined focusing on the different fashions to manage and regulate drivers and pressures impacting aquatic systems.

A scenario is a coherent description of alternative hypothetical futures that reflects different perspectives on past, present and future developments. Within MARS, we used climatic and socio-economic projections as scenarios that served as the basis to define our storylines.

Development of MARS storylines
Storylines in MARS are built on scenarios. The combination of certain climate scenarios and socio-economic scenarios set the basis for the narratives. We used the Representative Concentration Pathways (RCPs) and the Shared Socioeconomic Pathways (SSPs) to define our storylines.

Figure 1: Development of the MARS storylines

MARS storylines
The time-horizon for the storylines of MARS is 2030 and 2060.

Storyline 1: ‘Techno world’ or ‘Economy rules’
This is a world driven by economy. A fast economic development increases the use of energy. Policies are not focused on the environment but on enhancing trade and benefitting the economic growth. Climate is changing rapidly. This world is based on a combination of SSP5 and climate scenario 8.5.

Storyline 2: ‘Consensus world’
Economy and population grow at the same pace as now. Policies to protect the environment are continued after 2020, and the preservation of nature is regulated by the government. This world is based on a combination of SSP2 and climate scenario 4.5.
Storyline 3: ‘Fragmented world’
This world is characterized by an unequal development of the different countries. International trade agreements are stopped and each country needs to fight for its own survival. Environment is just protected by rich countries at a local scale, but in general no attention is paid to the preservation of nature. This world is based on a combination of SSP3 and climate scenario 8.5.

MARS quantitative storylines
These qualitative storylines have been translated to quantitative data. Grids of 0.5 x 0.5 degrees resolution were provided for several parameters (e.g. temperature, precipitation, water abstraction, run off, flood risk areas, nitrate losses), covering Europe for the three storylines and the two time-horizons. The quantitative values used in predictive modelling were derived from existing projects and modelling tools (e.g. ISI-MIP, SCENES, CLIMSAVE).

Further reading
Multiple stresses on Europe’s freshwaters: emerging challenges for science, policy and management

The interactions and impacts of multiple stressors on aquatic ecosystems is one of the key challenges for freshwater science, policy and conservation. Whilst there are many success stories of pollution being reduced on rivers and lakes across the continent, Europe’s freshwaters are still subject to multiple stresses, many of which are complex and poorly understood. In order to safeguard the health and diversity of Europe’s freshwaters, and the ecosystem services that they provide to humans, we need to better understand and manage the challenge of multiple stressors.

Multiple stressor combinations in European freshwaters

A 2012 report by the European Environment Agency ‘European Waters - Assessment of Status and Pressures’ outlines how multiple stressors such as water pollution, water scarcity, flooding, water abstraction and flow modifications increasingly affect Europe’s surface waters (i.e. rivers, lakes, transitional and coastal waters). From data collected as part of the Water Framework Directive monitoring, it is evident that more than 40% of European water bodies are negatively impacted by multiple stressors.

In European lakes and rivers, the most common two-stressor combination is diffuse water pollution combined with hydromorphological pressures. For example, this might describe a river fragmented by weirs and dams and subject to nutrient pollution from agricultural fertilisers. In transitional and coastal environments, the most common stressor combination is diffuse pollution with a group of ‘other’ stressors including overfishing, the impact of alien species and waste disposal.

Similarly, a 2015 literature review by MARS scientist Peeter Nõges and colleagues dealing with multistressor effects found that most scientific studies also address the combined impact of nutrient pollution and hydrological alteration.

Interactions and impacts of multiple stressors: synergism and antagonism

New scientific research suggests that such stressors can interact in complex and dynamic ‘cocktails’ to potentially intensify or neutralize their individual and additive effects on the environment. However, these interactions are not yet fully understood: a knowledge deficit which poses challenges for the management of aquatic environments and the ecosystem services they provide, particularly in the context of on-going climatic change. The cumulative impact of multiple stressors on the environment does not always equal the sum of the individual parts. Instead, synergistic and antagonistic interactions between multiple stressors are increasingly being observed.

Synergistic interactions between multiple stressors create effects that are greater than the sum of the individual stressor effects. Synergistic interactions can be expressed in a formula as $1+1=3$. Antagonistic interactions, on the other hand, occur when certain stressors cancel out the impacts of others. Antagonistic interactions can be expressed in a formula as $1+1=1$.

The interactions and impacts of multiple stressors: challenges for aquatic science, policy and management

Both interactions pose challenges for the management of aquatic systems. Synergistic interactions mean that ecosystem change and decline might...
be underestimated if assessed on the cumulative sum of individual stressors. Similarly, new stressors in an ecosystem may have unpredictable effects as a result of such synergistic interactions. Antagonistic interactions mean that environmental management of a single stressor may have the unintended effect of worsening detrimental ecosystem effects, because the antagonistic, nullifying between-stressor effects are removed.

There are additional uncertainties about the variable impacts of multiple stressors in different types of aquatic ecosystems. Peeter Nõges and colleagues found that in lakes, the impacts of multiple stressors had more significant impacts on ecological change than single stressors. However, in transitional and coastal waters, single stressors were more damaging than multiple combinations.

Further reading


The MARS project: addressing the challenge of multiple stressors

Multiple stressor conditions in aquatic environments are no longer the exception, but the norm. However, scientific knowledge on their interactions and impacts is still incomplete and inconclusive. The European Union FP7 MARS project is designed to address the shortfall in knowledge, and to provide policy-relevant information on multiple stressors at a range of scales necessary to inform the Water Framework Directive and River Basin Management Planning.
Figure 1: Multiple pressures acting on EU surface waters
Data source: WISE WFD database (EEA 2015; n = 108,130 water bodies of 26 EU Member States)
TraCs: Transitional and Coastal waters

Figure 2: Two-pressure combinations acting most frequently
Data source: WISE WFD database (EEA 2015; n = 26,345 water bodies of 26 EU Member States)
TraCs: Transitional and Coastal waters
Freshwater Blog - a tool for wide range dissemination

With the start of MARS one of the first tasks was to transition the blog from the BioFresh project to the MARS project, involving a renaming and rebranding of the site and associated social media. Since then, one blog post on freshwater science, policy or conservation was published on a weekly base. The blog is an excellent tool for a wide spread dissemination and communication and to reach a large group of readers all over the world on a regular base.

Editorial framework

We have assigned writing the blog posts to a native speaker with biological and journalistic background. He has devised an editorial framework for publishing, which effectively targets different audiences relevant to the work of MARS, comprising four broad types of posts. This framework ensures that there is a diverse, topical and engaging range of material on the blog at all times, which can be accessed and enjoyed by a variety of different target audiences.

1. MARS and related projects

These are posts that directly communicate and profile the work of the MARS project and individual scientists; or of related EU projects such as DESSIN and GLOBAQUA. Such posts provide an in-depth and engaging look ‘behind the scenes’ of the project, and provide simple explanations of the project’s key (and often complex) focuses. Some examples:

- The MARS ‘Meet the Team’ Series
- Reflecting on the Symposium for European Freshwater Sciences in Geneva
- Introducing the MARS river and lake experiments

2. New and relevant freshwater science and policy

These are posts that offer analysis and invite debate on new and important scientific publications and policy topics relating to freshwaters. They are designed to attract an interested audience of freshwater scientists, water managers and policy makers. Some examples:

- Microplastic pollution: an emerging freshwater stressor
- Underwater sound pollution leaves juvenile European eels vulnerable to predators
- Why are global crayfish populations declining?

3. Institutional networking

These are posts that intentionally engage with other institutions working on freshwater topics: partly as a means of keeping the blog populated with current, cutting-edge information; and perhaps more importantly as a means of networking with important individuals and institutions, and ensuring the Freshwater Blog and MARS links are circulated around their networks, and in so doing raising the visibility of the MARS project. Examples:

- WWF Living Planet Report suggests 76% decline in freshwater biodiversity globally since 1970
- Do anglers make good conservationists? An interview with Mark Lloyd of the Angling Trust

4. General public topics

These are posts on topics that are likely to have wide public appeal. These are always targeted to subtly introduce MARS topics (e.g. multiple stress, ecosystem services) but within a wider topic that is easy to engage with, and has the potential to be widely shared. Examples:

- Of Soil and Water: outdoor swimming in a naturally filtered urban pool
- Beneath the Waterline: an interview with underwater filmmaker Jack Perks
In 2014, 52 blog posts were published from February onwards (archiv 2014), in 2015, 30 blog posts have been published to the end of July (archiv 2015).

Within MARS more then 90,000 visitors have been to the blog website (220,000 visitors in total since the blog is online). In 2015 the number of visitors per month was growing from 4,000 to 12,600 (Jan-June). Readers are coming from all over the world.

MARS social media communications metrics
Aside the blog we use all social media channels for dissemination and communication.

Twitter
The Freshwater Blog twitter is predominantly followed by water scientists, conservationists, managers and other professionals around the world, and has 1.730 followers who receive each post.

LinkedIn
The Freshwater Blog LinkedIn group has 242 members, largely drawn from water scientists, researchers and managers. It is used to post updates from the Freshwater Blog, and to facilitate discussions amongst members.

Soundcloud
The Freshwater Blog Soundcloud page is used to host the project podcasts, which users can then stream, embed and download. The first MARS podcast, an interview with MARS scientist Steve Ormerod, has been streamed 262 times.

Facebook
The Freshwater Blog facebook page was transitioned from the BioFresh Cabinet of Freshwater Curiosities page, and has 284 followers. It is used to share Freshwater Blog posts, and to facilitate discussion amongst an audience of predominantly freshwater and conservation students, researchers and professionals.
Figures

Figure 1: Blog statistics. Development of readers.

Figure 2: Blog statistics. Readers’ origins.