STARS4Water

Web-based Story Maps on water resources availability in river basin hubs

Deliverable 4.3

June 2026

Web-based Story Maps on water resources availability in river basin hubs

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CI	Classified, as referred to EU Decision 2015/444 and its implementing rules	

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Summary

This public deliverable (D4.3) compiles and presents a coherent suite of web-based story maps that communicate future water resources availability and risks across the STARS4Water River Basin Hubs. Developed within Work Package 4 and co-created with basin stakeholders, the story maps translate quantitative assessments and model outputs into accessible, visual narratives for non-scientific audiences and decision-makers.

The report documents: (a) collectively agreed layout and style specifications to ensure clarity, consistency, and engagement (visual-first design, plain language, optional local translations, and use of ArcGIS tools such as maps, swipe, map tours, images, and video); (b) an overview table with key messages, author teams, maintainer contacts, and web links; (c) concise summaries of each basin Story Map (Danube, Drammen, Duero, East Anglia, Messara, Meuse, Rhine, Seine), highlighting shared themes of climate and socio-economic pressures on low flows, water demand, allocation trade-offs, and adaptation options; and (d) a maintenance plan committing to functionality and potential content updates for at least three years beyond project end.

Together, the Story Maps showcase how next-generation data services and modelling (as developed and validated in WP4) inform basin-specific challenges and actionable pathways. They support stakeholder dialogue, policy development, and public awareness by making complex, scenario-based insights discoverable, comparable across basins, and directly linked to further resources and reports.

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1. Introduction

1.1. STARS4Water project

STARS4Water (Supporting Stakeholders for Adaptive, Resilient, and Sustainable Water Management) is a four-year Horizon Europe research project focused on improving water resource monitoring to support the European Green Deal and EU water policies.

The project aims to:
- Improve understanding of climate change impacts on water availability and related vulnerabilities.
- Develop advanced data services and models to support sustainable freshwater management.

STARS4Water collaborates with seven River Basin Hubs—Rhine, Danube, Messara, Duero, East Anglia, Seine, and Drammen—using a co-creation, living lab approach to ensure stakeholder-driven solutions. It also integrates new datasets and models into existing water management tools, improving projections and decision-making for more resilient water policies (Figure 1).

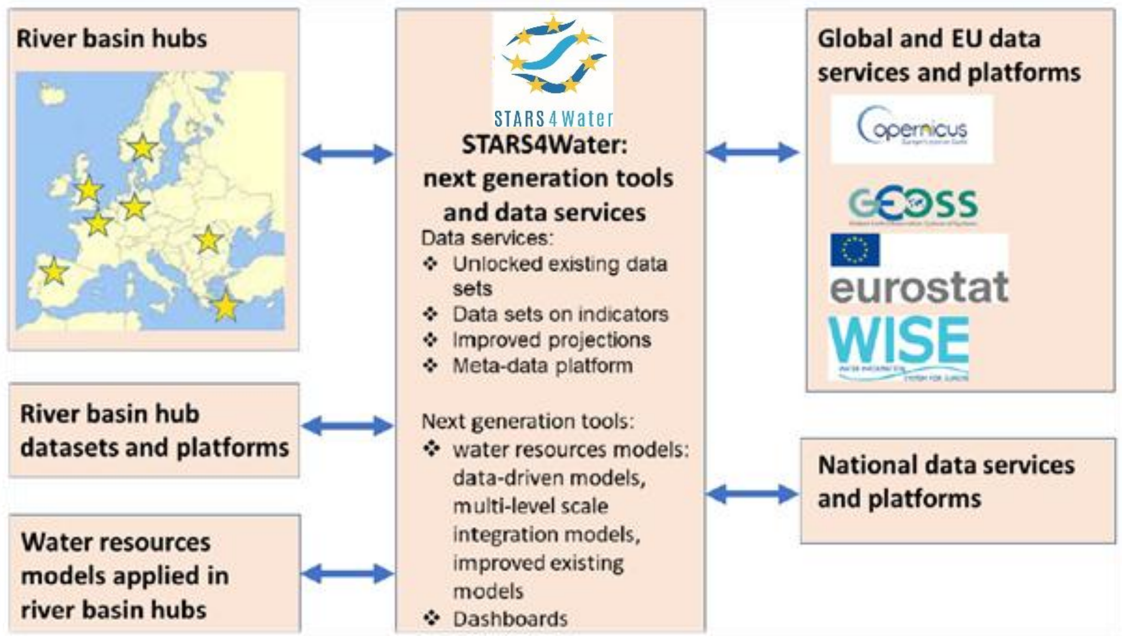


Figure 1.1: Overview of STARS4Water activities within the context of stakeholders and data providers.

1.2. Integrated assessment of future water resources

Work Package 4 (WP4) focuses on the anticipation of water resources availability (Figure 1.2). In greater detail, it is dedicated to the validation and application of the new data services and modelling tools for an integrated risk assessment of the future Europe's freshwater resources. The driving force behind this objective is to provide water managers with better data and models, which will be developed in collaboration with stakeholders and will therefore not only have a strong application focus, but will also incorporate and reflect the needs of river management.

The main activities in this work package are:

- Calibration and validation of the next generation models in the 7 river basin hubs (Task 4.1)
- Assessment and reporting of water resources availability under risk by climate change in the 7 river basins, by interacting with stakeholders (Task 4.2)
- Story Maps on climate change and socio-economic developments within the 7 river basin hubs (Task 4.3)
- Upscaling of basin-wide assessment of climate change risks and impacts to EU-level (Task 4.4)

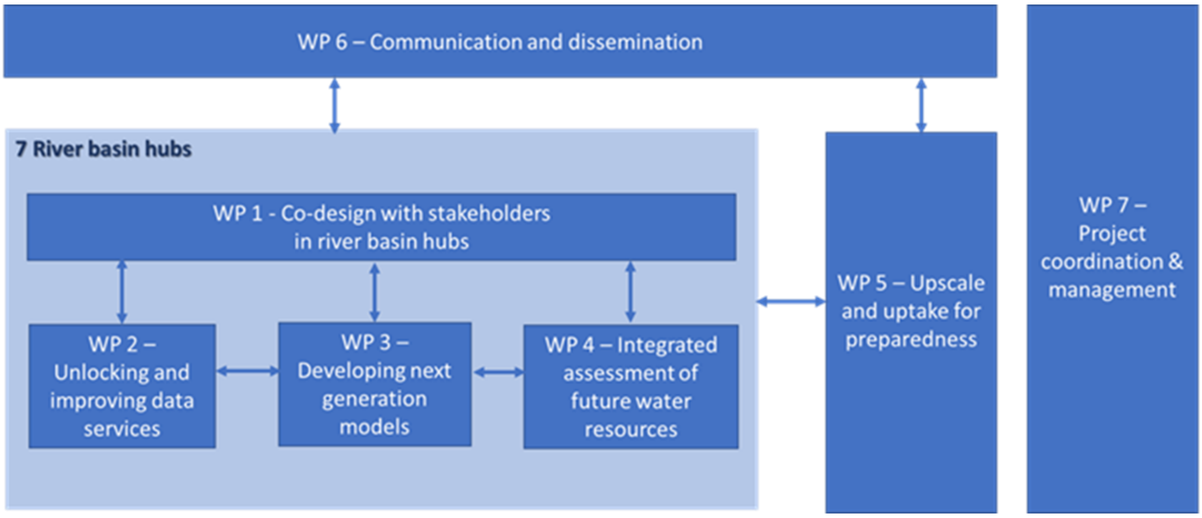


Figure 1.2: Work package structure of the STARS4Water project: the development of the next generation models (WP3) through a co-creation approach (WP1), benefitting from data sources available (WP2) and calibration and validation activities in WP4 to explore future water resources availability in European river basins (WP4).

1.3. Report outline

This report (Deliverable D4.3) summarises

a. Collectively agreed Story Map author guidelines
b. Story Map overview (access, key messages, contact persons)
c. Summary of content of each Story Map
d. Story Maps maintenance

2. Layout and style specifications of the Story Maps

The layout and style specifications for the STARS4Water Story Maps were first agreed in several meetings with the story map contributors and project colleagues responsible for communication and dissemination. It was then distributed to the partners for feedback and alignment. The partners committed to discussing it with their stakeholders to ensure the story maps reflect their needs, requirements, and feedback. They were subsequently presented at the project partner's meeting in Norway in September and confirmed as the basis for all basins' Story Maps. The chapter below captures these agreed standards to ensure consistency and clarity across the collective report.

2.1. The aim of the Story Maps

This section outlines what each Story Map should accomplish, ensuring a clear focus on audience needs, project value, and alignment with STARS4Water objectives:

- To compile information for non-scientific audiences.
- To demonstrate the added value of the STARS4Water approach and outputs in the river basin hubs.
- To tell the story of the river basin now and in the future, grounded in insights related to one of the two main objectives of STARS4Water: "improve the understanding of climate change impacts on water resources availability and the vulnerabilities for ecosystems, society and economic sectors at river basin scale," supported by Task 4.2 information.

It is important to visualise and summarise changes in future water resources availability and vulnerabilities for a wide range of water users and audiences in an easily accessible way. Clear and accessible communication of climate information helps stakeholders understand complex climate-related water resources risks, supports informed decision-making, and enables timely adaptation planning. It also facilitates dialogue between scientists, policymakers, water managers, and other stakeholders by providing an evidence base and a shared understanding of future challenges and opportunities.

Therefore, STARS4Water results generated with the data sets and model suites will be summarised, narrated (results from Task 1.5 and the quantitative risk assessment in Task 4.2), and placed in a wider perspective to provide the main message on climate risks and potential societal adaptation. Presenting the results in a coherent narrative and broader societal context is essential to translate scientific findings into actionable insights, increase awareness of climate impacts, and support the development of robust and effective adaptation strategies across sectors and scales.

2.2. General appearance of the Story Maps

Together with river basin stakeholders, we defined a set of guidelines on the overall look and feel, resulting in an accessible presentation that relies on visuals rather than dense technical text:

- Aim for the look and feel of an engaging newspaper article.

- Prefer visualisations over long text.
- Avoid formulas and complicated graphs that may be off-putting for non-scientists.

The titles and subheadings should be clear and compelling, capturing attention and communicate the main message at a glance.

2.3. Structure of the Story Maps

This section describes the recommended narrative flow and interactive elements to help readers navigate from a simple introduction to deeper, optional content. Basic characteristics are:

- Begin with a concise, readable introduction to the topic.
- Provide additional information that can be accessed by sector via buttons or similar interactive elements.
- Offer links to reports or other web pages for readers who wish to explore further.
- Consider structuring content around guiding questions, such as:
    - What is our purpose?
    - What are our challenges?
    - What are we looking for?
    - What did we find?
- Keep the Story Map itself concise. Avoid long texts.
- If needed, provide more detailed information in a second layer or via links to external pages and reports, where longer explanations and detailed results can be accessed.

2.4. Target Groups

The following points define the primary audiences and the appropriate level of language and detail to make the Story Maps accessible and useful to non-scientists and interested stakeholders.

- The primary audiences are the wider public and sector stakeholders seeking accessible information.
- Start with an introduction understandable to the general public followed by sufficient detail to engage stakeholders with relevant expertise.
- Highlight how communities are preparing for change.
- Avoid overly technical terminology.

2.5. Language

This section sets the default language policy and offers guidance on when and how to provide translations for different contexts.

- The default language is English.
- Translation into additional languages should be considered based on local conditions (e.g., for transboundary basins such as the Danube, Rhine, and Duero).
- Images can remain in English, as they are more difficult to translate.
- Plain text may be offered in multiple languages where feasible.

2.6. Use of Examples

We encouraged the use of concrete examples to illustrate key points as well as simple schematics to make complex ideas easier to grasp:

- Prefer examples and concise explanations over lengthy descriptions.
- Use schematic drawings to illustrate relationships and interdependencies.

2.7. Visualisation Options

This section introduces available ArcGIS Online tools and how to use them effectively to communicate content clearly and intuitively. For example, ArcGIS Online offers a range of tools suitable for these Story Maps, including:

- Images and Videos.
- Swipe Screen to compare different states of the same location on maps or photos. Recommendation: place explanatory text directly on the screen for both left and right views, rather than using figure captions.
- Maps: if metadata is made available to visitors, ensure it is relevant and understandable; otherwise, deactivate this function.
- Map Tours, where scrolling progresses from one location to another with pop-up windows showing location-specific information.

2.8. Clarity and Self-Explanatory Design

All materials should be as self-explanatory as possible, avoiding the need for complex legends, symbols, abbreviations, or extensive explanatory text.

3. Story Maps overview

Table 1 compiles basic information on the individual Story Maps, containing key message, authorship, maintainer contact and web access.

Table 1. Overview on the STARS4Water story maps

River basin	Key message	Authors	Maintainer contact	Weblink to Story Map
Danube	Danube Drought Water Conditions under Climate Change	Klösch, M., Graf, T., Monji, F., Glas, M., Preiml M., Toma, A., Scrieciu, A., Habersack, H.	Mario Klösch (BOKU University)	https://arcg.is/CLfyq0
Drammen	Balancing future water, energy, and ecosystems in the Drammen basin - Using integrated modelling and stakeholder insights to support sustainable water management	Trine J. Hegdahl, Kolbjørn Engeland, Shaochun Huang, CA Veie, E. Gelati, H. Hisdal	Trine J Hegdahl (NVE)	Balancing water, energy and ecosystems in the Drammen Basin
Duero	Duero River Basin: Groundwater beneath your fields: Smarter decisions in the Duero River Basin	Prieto, A.; De la Hera-Portillo, A.; Aguilera, H.; Moreno, L.; García, O.; Martínez-Santos, P.; Gómez-Escalonilla, V.; Rodríguez del Rosario, M.	Africa de la Hera-Portillo (IGME-CSIC)	https://arcg.is/1DDifT1
East Anglia	Drier future for East Anglia's wildlife, but action can help	Crapper, Z.; Rickards, N.; Laize, C.; Read, T.; Darch, G. and Keller, V.	Zara Crapper (UK-CEH)	https://arcg.is/0aLTHq0

Messara	Messara basin under water pressure *Understanding water deficits, groundwater dependence and future resilience in Crete's largest agricultural plain*	Kossida, M.; Fotopoulos, F.	Maggie Kossida (SEVEN)	https://arcg.is/1XfWGy3
Meuse*	The Meuse River Basin in a changing climate: Towards sustainable and balanced water availability	Correa, D., Werner, M. & Cremers, N.	Deborah Dotta Correa (IHE Delft)	https://arcg.is/v40Sn1
Rhine	The Rhine under Pressure: Navigating Water Scarcity in a Changing Climate	Edler, T., Ter Maat, J.	Tatjana Edler (Deltares)	https://arcg.is/0Dy4f44
Seine	The Seine River Basin - The future of low flow management	Collignan, J., Ramos, M.-H.	Maria-Helena Ramos (INRAE)	https://arcg.is/1HDKzn0

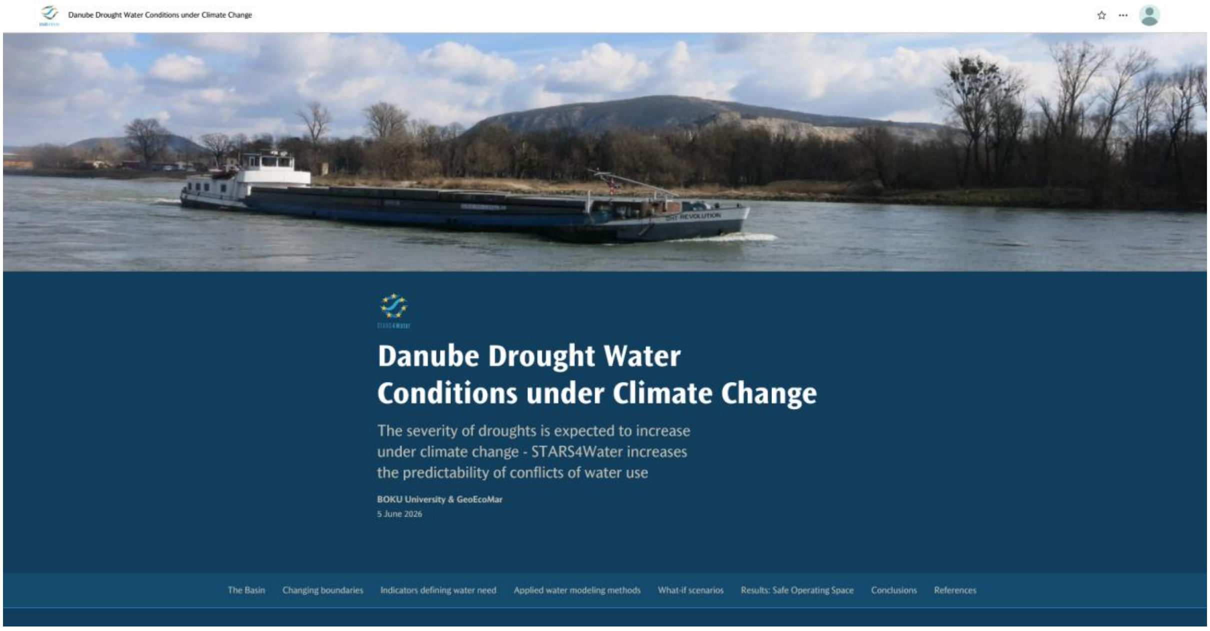
* The Meuse River study was carried out concurrently with STARS4Water, employing the STARS4Water methodology.

4. Individual Story Map summaries

4.1. Danube Drought Water Conditions under Climate Change

Authors: Martin Glas, Tamara Graf, Fatima Monji, Mario Klösch, Max Preiml, Andrei Toma, Albert Scrieciu, Judith Ter Maat, Helmut Habersack

This story map links basin wide flows to local operations to see how low-flow futures could reshape the Danube's safe operating space. Under drier scenarios and glacier retreat, more days fall below navigation thresholds at key bottlenecks, and the usable fairway narrows. Side channels disconnect from the river more often, but a planned reconnection measure greatly reduces disconnection days; ongoing bed lowering can undo these gains without sediment management. Run of river hydropower loses annual output (largest downstream) and shifts from summer losses to some winter gains. For the cities assessed, drinking water quantities stay far below low flow availability, while one lower Danube power plant on a residual branch can face short cooling water periods in very dry years. Even small upstream abstractions show downstream effects. Targeted actions – reconnection, sediment management, and careful allocation – can help keep ships moving, habitats connected, and energy and water services more reliable in a changing climate.



Weblink: https://arcg.is/CLfyq0

4.2. Balancing future water, energy, and ecosystems in the Drammen basin

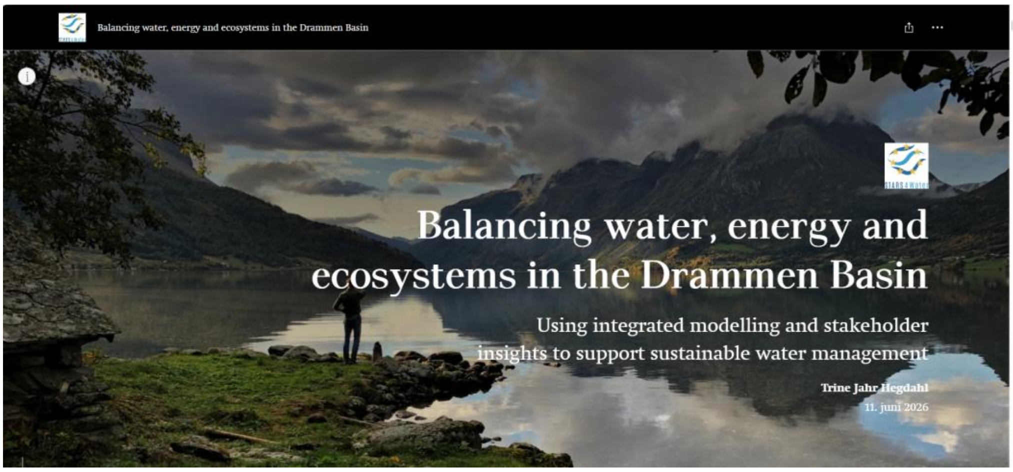
Authors: Trine J Hegdahl, Kolbjørn Engeland, Shaochun Huang, CA Veie, E. Gelati, H Hisdal

The Story Map of the Drammen River basin highlights how climate change is expected to reshape water availability, hydropower production, and ecological conditions over the coming decades. Climate projections indicate an overall increase in annual runoff, combined with pronounced shifts in seasonality. In particular, reduced snow storage and a transition from snowfall to rainfall will lead to higher winter flows, earlier snowmelt, and reduced summer runoff in many parts of the basin. These changes increase total water availability but also introduce greater temporal variability, with important implications for water management.

Increased inflow raises hydropower potential, but realised production grows more modestly due to operational constraints, reservoir capacity, and market-driven operation. In wetter scenarios, higher inflow also leads to increased spillage and bypass flows, reducing efficiency, and causing energy losses.

Ecologically, altered flow regimes pose important risks, particularly for low-flow conditions. Ecological assessments indicate moderate overall risk, with locally higher impacts where low flows are reduced. Maintaining minimum ecological flows may therefore become more challenging under future droughts.

Overall, the results highlight increasing trade-offs between hydropower production, ecological requirements, and water management, emphasising the need to operate within a climate-adapted "safe operating space."



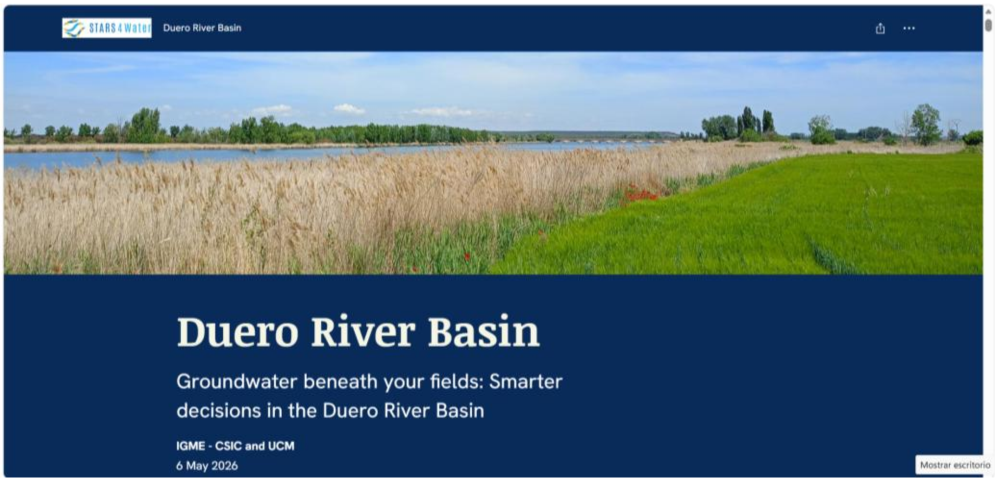
Weblink: Balancing water, energy and ecosystems in the Drammen Basin

4.3. Duero River Basin: Groundwater beneath your fields

Authors: A. Prieto Martín, A. de la Hera-Portillo, H. Aguilera, L. Moreno, O. García, P. Martínez-Santos, V. Gómez-Escalonilla, M. Rodríguez del Rosario.

The Story Map of the Duero River Basin focuses on the critical role of groundwater resources in one of Spain's most agriculturally intensive regions. The Duero Basin — the largest river basin on the Iberian Peninsula — faces growing pressures from prolonged drought cycles, intensified irrigation demand, and accelerating climate change, all of which threaten the long-term sustainability of its groundwater bodies. The Story Map presents, in an accessible format aimed at non-specialist audiences including farmers, water managers, and local communities, the key findings emerging from STARS4Water's integrated assessment activities in this hub. It illustrates how groundwater levels have evolved in recent decades under combined climatic and anthropogenic pressures, and how next-generation data services and modelling tools developed within the project can improve the understanding and management of these resources.

Particular attention is given to the Medina del Campo Groundwater Body, a heavily exploited aquifer system where declining piezometric levels threaten both agricultural water supply and associated wetland ecosystems. The Story Map highlights the value of multi-source data integration — combining in-situ monitoring, AI derived tools and hydrogeochemical indicators — to support more informed and adaptive decision-making at the basin scale. Interactive maps and visualizations allow users to explore spatial variability in groundwater availability and vulnerability across the basin under different future climate scenarios. The Story Map concludes with a forward-looking perspective on adaptation pathways, emphasizing the need for coordinated governance and stakeholder engagement to ensure the resilience of water resources in the Duero Basin under a changing climate.



Weblink: https://arcg.is/1DDifT1

4.4. Drier future for East Anglia's wildlife, but action can help

Authors: Crapper, Z.; Rickards, N.; Laize, C.; Read, T.; Darch, G. and Keller, V.

This Story Map considers the factors affecting water resources for the environment in East Anglia and how these will change in the future. Water sources such as groundwater and rivers are key for maintaining the environmental water requirements for wetlands and chalk streams. Human water demand (such as irrigation, domestic use and navigation) can reduce the water available for these requirements, and pressures are expected to increase into the future, for example through climate change, population growth and agricultural expansion. These pressures can be mitigated by reducing human abstractions (especially during periods of low flow) and making domestic and agricultural water systems more efficient. The STARS4Water Ecological Risk due to Flow Alteration (ERFA) results conclude that East Anglian rivers will face a medium risk of change to all flow indicators and a medium to high risk of change for low flows, suggesting that droughts will likely worsen into the future, and measures are needed to ensure sufficient water is available for environmental requirements.

Weblink: [Drier future for East Anglia's wildlife, but action can help,]()

4.5. Messara basin under water pressure

Authors: Maggie Kossida, Fotis Fotopoulos

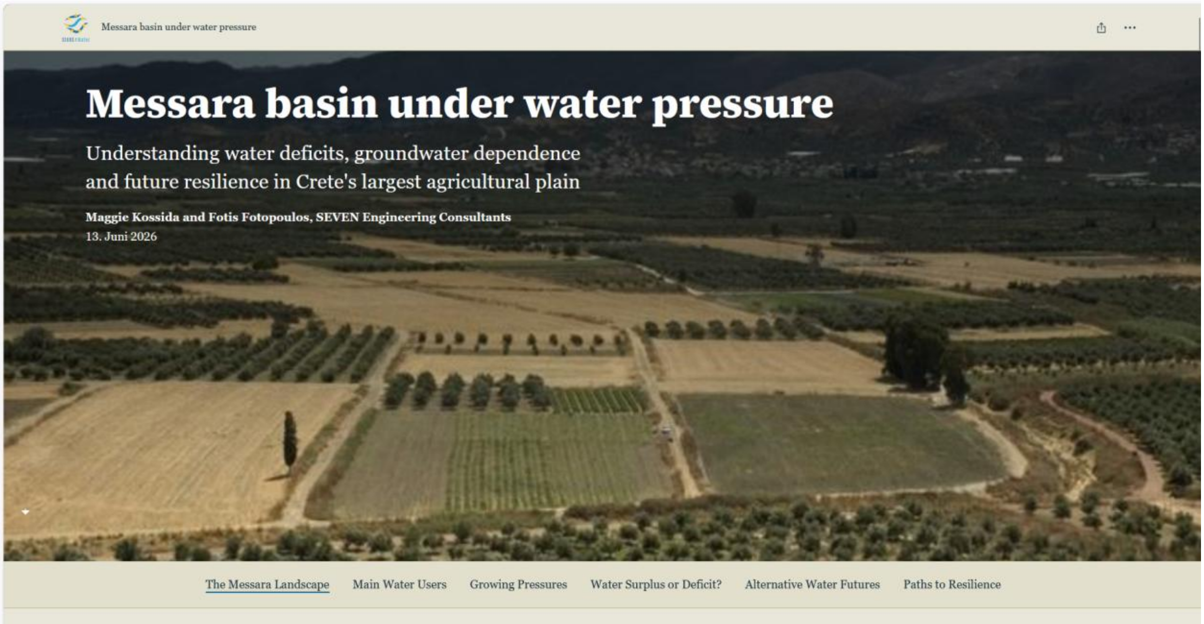
The Messara Plain is the largest and most productive agricultural region in Crete, supporting thousands of farmers and communities. Yet beneath its olive groves, vineyards and cultivated fields lies a growing challenge: the basin depends heavily on groundwater resources that are being used faster than they can be replenished.

Using the RIBASIM water resources model, developed within the STARS4Water project, this Story Map explores how water moves through the basin, who uses it, and where the greatest pressures occur. The analysis reveals that irrigation dominates water demand, accounting for almost thirty times more water use than domestic and industrial activities combined. Demand is concentrated in two central sub-basins that also host the basin's most productive aquifers.

The story shows how three forces are converging to increase water stress: decades of groundwater over-abstraction, persistently high irrigation demand, and a changing climate that is projected to bring hotter temperatures, less rainfall and longer drought periods. As a result, several parts of the basin experience chronic water deficits and very low water-supply reliability. More than half of Messara's agricultural land lies in areas where water shortages are the norm rather than the exception.

To explore possible futures, the Story Map evaluates alternative management scenarios developed with local stakeholders. The results demonstrate that improving irrigation efficiency, adapting agricultural practices, increasing surface-water availability, enhancing aquifer recharge, and strengthening water governance can significantly reduce pressure on groundwater resources and improve resilience to future droughts.

Ultimately, the Messara case illustrates how detailed modelling and stakeholder engagement can support better water management decisions. It highlights both the risks of continuing current practices and the opportunities available to secure a more sustainable and resilient water future for Crete's most important agricultural plain.



Weblink: https://arcg.is/1XfWGy3

4.6. The Meuse River Basin in a changing climate

Authors: Correa, D., Werner, M. & Cremers, N.

This Story Map combines results from the LoFloMeuse project and the Deltares study on socio-economic scenarios and future Meuse discharge. The scenario study shows that climate change and socio-economic developments may make low flows more frequent and severe, highlighting the need for coordinated adaptation across the transboundary basin. The LoFloMeuse project assessed the potential of Nature-based Solutions (NbS) and selected technical measures to mitigate these impacts. Streamflow analysis, hydrological modelling and stakeholder engagement were combined to evaluate measures such as reforestation, wetland restoration and improved agricultural management. Using the distributed wflow_sbm model, the effects of individual measures and basin-scale strategies were assessed during the critical low-flow period from July to September.

The highest-potential NbS strategy increased average discharge at Monsin by 9.23 m^3/s, although it would require extensive land-use changes. A stakeholder-informed strategy produced a smaller but positive increase of 0.57 m^3/s. Technical measures, including improved reservoir operation and additional storage in lock reaches, were estimated to contribute approximately 15 m^3/s.

The results show that NbS can support low-flow mitigation, but their effectiveness depends on where and how they are implemented. More resilient low-flow management will therefore require integrated strategies combining NbS, technical measures and water-demand management across the Meuse Basin.

Weblink: https://arcg.is/v40Sn1

4.7. Navigating Rhine water scarcity in a changing climate

Authors: Tatjana Edler, Judith ter Maat

This story map presents how climate and socio-economic change intensify water scarcity across the Rhine basin. It contains the following chapters:

- The Rhine under Pressure, explaining rising temperatures, shifting precipitation, and growing demand.
- Where the Rhine Flows profiles nine reaches - from the Alpine Rhine to the Delta - highlighting key characteristics and water users.
- Socio-Economic Scenarios introduces three futures (Rhine Sustainable Community, Middle of the Road, Economic Growth) co-designed with CHR, CCNR, and ICPR.
- How We Model the Future describes the integrated Wflow-RIBASIM setup and datasets, translating narratives into quantitative inputs.
- Maps show modelled availability, allocation, and sectoral demands, with increasing summer low-flow stress, highest under Economic Growth.
- Steps in the Project outlines the workflow.
- What Are the Challenges details trade-offs among domestic, industrial, and agricultural uses.
- Communities Prepare highlights adaptations.
- What's Next offers recommendations to update the ICPR Climate Adaptation Strategy and strengthen coordination.
- Dive Deeper links to SES report and project site.

Weblink: https://arcg.is/0Dy4f44

4.8. The Seine river basin: the future of low flow management

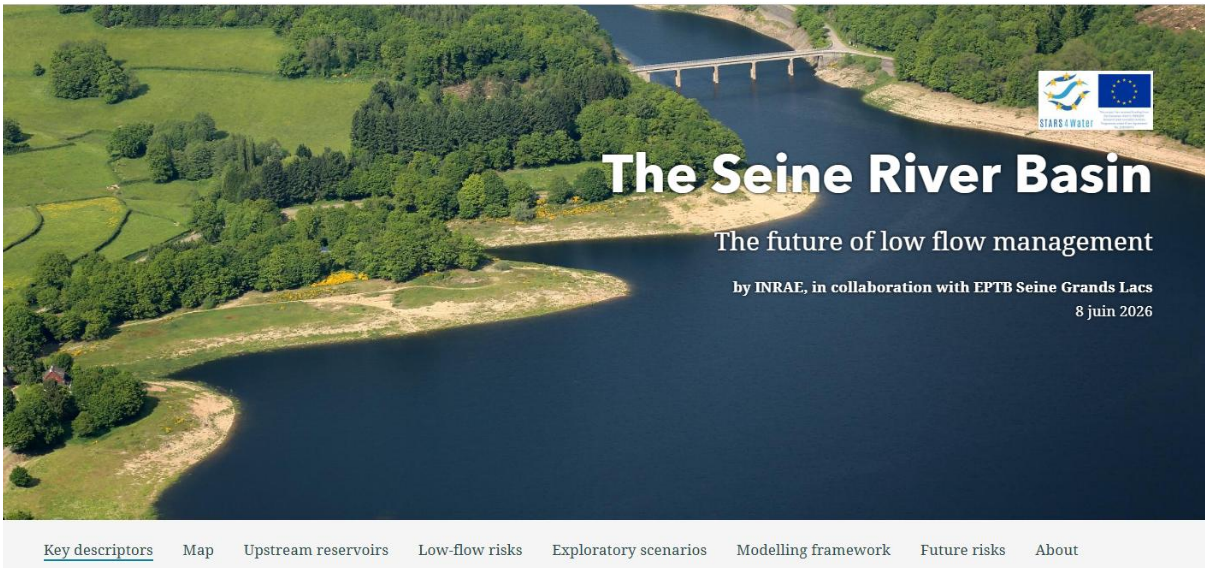
Authors: Julie Collignan, Maria-Helena Ramos

The Story Map of the Seine River basin highlights low flow management in the basin, with a focus on how future climate projections and upstream storage reservoir management strategies can have an impact on river flows, up to the Seine River in Paris. It first introduces the river basin with some key numbers and presents a map with the location of the hydrologic station in Paris and the four storage reservoirs managed by the stakeholder in the STARS4Water project – EPTB Seine Grands Lacs (EPTB SGL). The reader can navigate to external webpages to learn more about these locations. The EPTB SGL is also introduced, highlighting its main role in the design and management of water-related infrastructures to improve integrated water resources management in the river basin. Its three main missions are listed: the protection and prevention against flooding, the maintenance of a minimum flow in the Seine River and its main tributaries during the dry season, the adaptation to climate change, and ecological protection.

Before presenting STARS4Water achievements, it was considered important to guarantee a general understanding of how reservoirs are managed throughout the year. For this purpose, the Story Map presents an example of management for the Marne reservoir for the year 2012-2013. It also offers a link to EPTB SGL communication material on water management operations (YouTube video, in French). The Story Map also illustrates our quantitative evaluation of how the four upstream reservoirs influence the discharges downstream, reducing the average discharge during the reservoir filling period (November to June) and supporting low flows during the release period (July to October).

To present the STARS4Water outcomes on the Safe-Operating-Space, the Story Map introduces the regulatory framework of low flow thresholds, the climate projections (with link to the national project Explore2) and the what-if question co-defined with the stakeholders. The modelling framework is presented, as well as an illustration of the results for the Marne reservoir. Main lessons learned are highlighted at the end. The Story Map was designed by INRAE and contributed/validated by EPTB SGL.

The maintenance of the Story Map will be facilitated by future collaborations envisaged to continue after the end of the STARS4Water project.



Weblink: https://arcg.is/1HDKzn0

5. Story Maps maintenance

The STARS4Water consortium, in agreement with the individual Story Map maintainers, has committed to maintaining the Story Maps for at least for five years beyond the end of the project. During this period, maintainers will ensure that the Story Maps remain accessible and fully functional, resolve technical issues where feasible, and update content when significant new information, datasets, or developments become available. While comprehensive revisions are not anticipated, the Story Maps are intended to remain a reliable and accessible resource beyond the lifetime of the project.