

MARS fact sheet #13

The MARS Diagnostic Analysis Tool (DAT)

An approach to diagnose the causes of ecological degradation of water bodies

What is it about?

Water bodies are subject to multiple man-made stressors with individual or combined adverse effects on the ecological status. This results in a loss of biodiversity – sensitive species disappear and tolerant species, such as neobiota, thrive. In consequence, many water bodies are of poor ecological status.

To improve ecological status and to derive appropriate management and restoration options, it is necessary to know the causes of ecological degradation. Yet, often the ecological assessment does not identify the causes itself. Here, the MARS DAT provides a tool to fill this gap. It is a diagnostic tool that aims to help water body managers identify and rank potential causes of ecological degradation at the scale of individual water bodies.

What is the DAT?

The DAT is a statistical approach that combines probabilities and knowledge rules of cause-effect relationships. A knowledge rule might be: “it is impossible to achieve good status for this stream water body, if riparian shading is completely absent”. The probability then comes in to better account for the strength of this knowledge rule, as there might exist exceptional cases where good status is achievable even without riparian shading: “it is 95% impossible to achieve good status for this stream water body, if riparian shading is completely absent”. The knowledge rules and probabilities are then combined using a Bayesian network. The network statistically combines all probabilities and allows of a backward diagnosis from ecological status to the potential causes of degradation.

The DAT also provides a prognostic tool that allows of estimating probabilities of ecological status effects conditional on the user’s indication of the status of selected causes of deterioration.

How does DAT work?

The DAT is accessible through the [Freshwater Information Platform](#) (FIP) via a graphical user interface. The user is asked to indicate values or ranges of selected biological diagnostic metrics, which represent ecological status. The underlying Bayesian network then calculates the probabilities of selected causes of degradation and provides both a graphical and tabular representation of the results. Additional textual information is provided to help identify the causes and derive appropriate management options.

MARS has developed several prototypes including phytoplankton, benthic invertebrates and fish and representing lowland and alpine rivers. The prototypes are applicable only to the respective water body types, for which they have been developed. The application beyond these types is not recommended without verification and adaptation of the underlying knowledge rules.

The methodology is described in the MARS Deliverable 7.1, available for download here: http://www.mars-project.eu/files/download/deliverables/MARS_D7.1_suite_of_tools_1.pdf.

You can access the MARS DAT here:

<http://www.freshwaterplatform.eu/index.php/mars-diagnostic-tools.html>

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Three steps to diagnose using the DAT

- 1 Answer to the diagnostic questions one by one. Unknown answers can be left *unknown*.
- 2 Read of the probabilities of the potential causes of deterioration.
- 3 Adjust the display of probabilities to allow for best representation of the potential causes.

Info buttons explaining the diagnostic metrics

Tabular display of causes in descending order of probability

Further information and useful links

The screenshot shows a web browser window with the URL `https://simplyshiny.shinyapps.io/catch_2_spider_plot/#%23`. The interface is divided into three main sections:

- Query section (left):** Contains five diagnostic questions with dropdown menus set to "Unknown":
 - What is the proportion of EPT specimens in the community (%) ?
 - What is the proportion of grazers (%) ?
 - What is the saprobic st... ?
 - What is the Average Score per person ?
 - What is the proportion of shredders (%) ?
- Abstract (middle):** Titled "Benthic invertebrates in mid-sized sand-bottom lowland rivers of Central Europe". It explains that users can diagnose potential causes of deterioration by choosing metric states. It mentions that clicking on a cause provides more details, and that a "Causal hierarchy" tabular output is available. A "Read more" link is present.
- Results section (right):** Titled "You are in the diagnostic analysis" and "Potential causes of deterioration". It features a radar plot with six axes: Arable land use, Urban land use, Fine sediment pollution, Flow reduction/impounding, Straightening, and Riparian degradation. A large blue circle with the number "2" is overlaid on the plot.

Callouts from the three steps point to specific features:

- Step 1:** Points to the "Info buttons" (question marks) next to the diagnostic questions.
- Step 2:** Points to the "Read more" link and the "Causal hierarchy" tabular display.
- Step 3:** Points to the "Change the %-scale of the radar plot here" slider, which is currently set to 30%.

Query section with questions relevant for the diagnosis

Abstract characterizing the model features and applicability

Results section displays the probabilities of individual causes in a radar plot

Probability trimming adjusts the results display in the radar plot

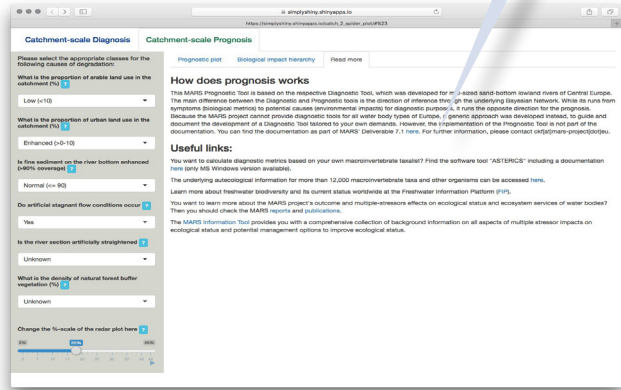
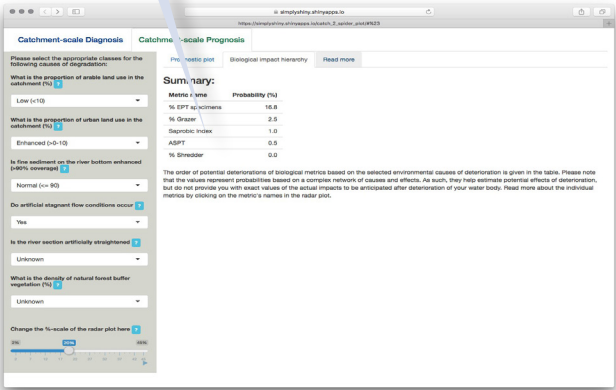
Click on a cause to get more information

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Besides the graphical display of the probabilities of the causes, there is a tabular output showing the causes in hierarchical order. Under "Read more", the user is provided with useful links that may help diagnose the causes of deterioration, for instance, at the broader catchment scale, and calculate the diagnostic metrics based on a list of species.

Hierarchical order of causes

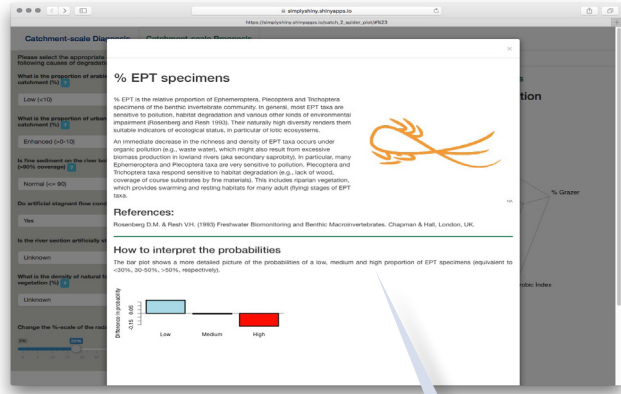
Background information about diagnosis and prognosis



A click on a cause name in the diagnostic part (or a metric name in the prognostic part) of the DAT will open a window with useful background information and potential management options.



Background information about stressors



Background information about used metrics

Interested users, who wish to tailor existing prototypes or develop new diagnostic tools may wish to consult the "cookbook" at http://www.mars-project.eu/files/download/deliverables/MARS_D7.1_suite_of_tools_1.pdf. The cookbook provides a stepwise methodology of the development and implementation of a Bayesian diagnostic network. For further information, please contact christian.feld@mars-project.eu.