User Manual

Decision Support System for Roadside Spring Protection (RoSPro)



CLIENT **Partners for Water**

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Summary

This report documents the technical work conducted by FutureWater, MetaMeta and ICIMOD under the Roadside Spring Protection (RoSPro) project, with a focus on the development of a DSS (Decision Support System) toolkit to visualize and assess digital twin results at sub-basin and basin levels. The aim of this DSS is to inform stakeholders with evidence-based, scalable water management strategies. Apart from results of the digital twin, the DSS contains socio-economic data gathered within the project, and a simple cost-benefit calculator. This User Manual explains in detail the content of the DSS and how to interact with it to get insightful data.

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1 DSS definition, importance and structure

1.1 Definition and importance

A **Decision Support System (DSS)** is a set of tools and processes designed to assist in decision-making by providing relevant data, models, and analytical tools. It helps stakeholders-such as local governments, communities, and project managers-analyse complex situations, assess different intervention options, and make informed decisions based on evidence.

The RoSPro DSS provides a structured and efficient way to facilitate informed decision-making for stakeholders involved in spring protection and related socioeconomic development.

Advantages of setting up a DSS:

- **Data Integration**: Combines multiple data sources (hydrological, socioeconomic, geospatial) into a single platform for easy and comprehensive analysis, ensuring that all relevant data is available in one place.
- **Informed Decision-Making**: Delivers data-driven insights, enabling stakeholders to make well-informed decisions regarding spring protection, resource allocation, and the implementation of interventions. This ensures that decisions are based on accurate and up-to-date information.
- **Stakeholder Collaboration**: Promotes collaboration among various stakeholders by offering a transparent, accessible platform. This facilitates effective communication, collective decision-making, and a shared understanding of priorities and goals.
- **Upscaling the Approach**: The DSS can be replicated in new spring interventions, both within the same region or in other areas facing similar challenges. This scalability allows for broader application and extension of the RoSPro approach to other vulnerable regions.

By setting up the DSS, RoSPro enhances the decision-making process, making it more structured, data-informed, and collaborative, ultimately contributing to the success and sustainability of spring protection efforts.

1.2 DSS data structure

The RoSPro DSS serves as a comprehensive tool for stakeholders, offering a structured and user-friendly platform to manage and assess the progress of the project. It provides a wide range of features designed to facilitate decision-making and strategic planning. The information included on the DSS covers:

- **Project Summary**: The DSS summarizes the entire RoSPro project, offering a clear overview of the encountered challenges, solutions implemented, project phases, and the methodology used throughout the project. This helps stakeholders easily understand the project's progression, objectives, and key actions taken.
- **Socioeconomic Context**: It presents detailed insights into the socioeconomic context of the area, helping users understand the demographics, livelihoods, and economic activities of the local population. This information is essential for assessing how the interventions have impacted the community and its economic development.
- **Overview of Selected Springs**: The DSS offers a detailed account of the four selected springs, providing baseline data on their water availability, quality, and usage before the intervention. It also highlights the improvements observed after the RoSPro interventions, including changes in water supply, accessibility, and overall functionality of the spring systems.

- **Dashboard for Upscaling Potential:** The DSS outlines the upscaling possibilities for replicating the RoSPro approach in other areas, both within the same basin and in different regions. Based on hydrological analysis, the DSS helps identify regions that could benefit from similar interventions, extending the project's impact to vulnerable areas facing similar challenges.
- **Cost & Benefit Calculator:** The DSS includes a simple yet effective cost and benefit calculator, which allows users to compute the costs of potential interventions. This tool helps in evaluating the financial feasibility of different interventions and provides insights into the expected benefits, such as improved water availability, agricultural productivity, and reduced infrastructure maintenance costs.

Overall, the RoSPro DSS is a powerful tool that integrates a wide range of data, provides insights into the project's impact, and supports future planning and decision-making, making it an invaluable resource for managing sustainable water resources and infrastructure.

The DSS is available at the following link: **https://futurewater.eu/rosprodss/**

At the top left corner of the main page, you can find a navigation pane, which allows you to move directly to certain sections of the DSS content. Otherwise, for the sequential visualization of the whole story, you just need to scroll down, and content will appear in an immersive way.



Figure 1. DSS cover picture

The aim of this manual is to cover in detail the **interactive dashboard section** only, which visualizes and assesses digital twin results at sub-basin and basin levels. The RoSPro project has implemented the SPHY (Spatial Processes in Hydrology) hydrological model to make a digital twin at the basin scale. For more technical details, please refer to the specific manual on SPHY modelling for Roadside Spring Protection.

2 Dashboard

2.1 Content

2.1.1 Default view

By clicking on ‘Dashboard’, at the Navigation Pane located in the top left corner of the screen, you will be directed to the interactive dashboard section of the DSS.
The screenshot below shows the default view. The left part shows the canvas, in which multiple geospatial layers can be activated and deactivated for visualization. The right part is reserved for interactive graphs. Both the canvas and the graphs can be modified by the user, as the dashboard is highly customizable. More details are explained in sections below of this manual.

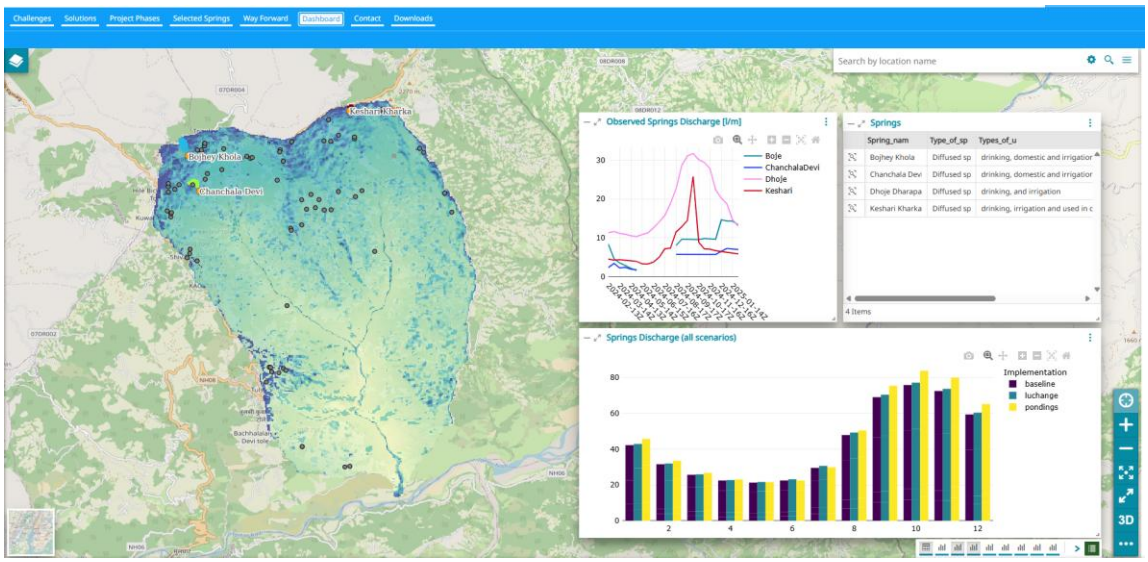
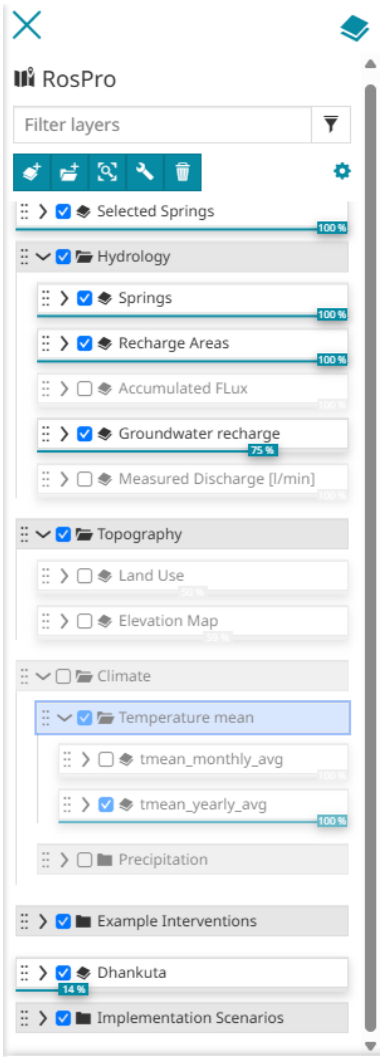


Figure 2. Default view of the interactive dashboard

2.1.2 Layers

To display the set of geospatial layers available, you have to click on the button at the top left corner of the dashboard. The whole dropdown will appear, containing all layers available:



Layers are organized according to its type:

Selected Springs:

This layer displays the locations of the springs selected for the RoSPro project, allowing users to view the specific spring sites being monitored and managed.

Hydrology:

This category contains multiple layers focused on the water dynamics in the area:

Springs: Shows the locations and conditions of spring sources in the region.

Recharge Areas: Areas where groundwater is replenished.

Accumulated Flux: Represents the net movement of water (inflow and outflow) over a period of time, which could indicate water availability or shifts in the hydrological conditions.

Groundwater Recharge: Indicates the amount of groundwater replenishment in the region, crucial for understanding how the springs' water supply is sustained.

Measured Discharge [l/min]: This layer shows the actual flow of water from the springs, measured in liters per minute (l/min), providing insight into water availability and how it changes over time.

Topography:

Includes layers related to the physical features of the landscape:

Land Use: Displays how land is used in the area, such as agricultural, residential, or forested land. This helps to assess the potential impacts of land-use changes on water availability and quality.

Elevation Map: Shows altitude variations in the region, useful for understanding how elevation influences precipitation and water flow.

Climate: This category focuses on climatic data, with several layers:

Temperature Mean: Represents the average temperature in the region over the simulation period, essential for understanding temperature-related trends and their impact on the environment.

- **tmean_monthly_avg**: The **monthly average temperature**, giving insights into seasonal variations in temperature.
- **tmean_yearly_avg**: The **annual average temperature**, showing long-term trends in temperature.

Precipitation: Shows rainfall patterns in the region, both monthly and annual average, crucial for understanding water availability and spring recharge rates.

Example Interventions:

This layer displays visual examples or proposed interventions aimed at improving spring protection, water management, and infrastructure development in the four selected springs.

Implementation Scenarios:

Shows different intervention scenarios that were tested in the project (baseline, land use change, ponding), in terms of spring discharge.

2.2 Functionalities

2.2.1 Raster layers

A raster layer is a type of data representation used in Geographic Information Systems (GIS) to represent geographic phenomena in a grid format. It consists of a matrix of cells (also known as pixels), where each cell contains a value that represents information such as elevation, temperature, land cover, or any other spatial variable. These values can be integers, floating-point numbers, or categories, depending on the type of data being represented.

These layers allow to visualize spatially distributed data. Raster layers can be managed from the dropdown menu, by clicking and unclicking them.
For example, to visualize the Elevation Map, we can unclick the category 'Hydrology' and click on 'Topography' and 'Elevation Map' buttons. Then we will see the elevation map on the canvas:

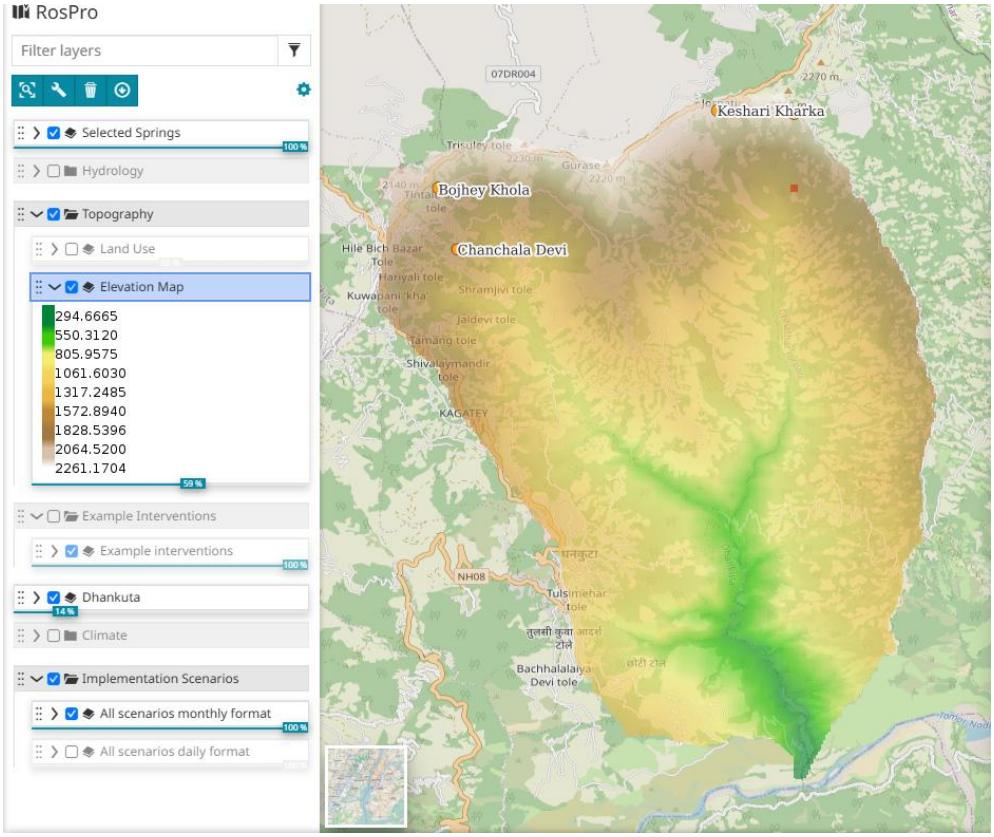


Figure 3. Canvas showing the elevation map

We can also play with transparency, if we still want to see underlaying layers. This can be done by modifying the transparency value that is below each layer's legend:



Note that multiple layers can be activated at the same time, but only the one that is most in the top of the dropdown menu will be visible. So to be able to visualize elevation, we have to unclick the above categories.

Raster layers can be queried at the pixel level, meaning that we can click on one location and the value of the selected map for the specific location will show up in the right part of the screen:

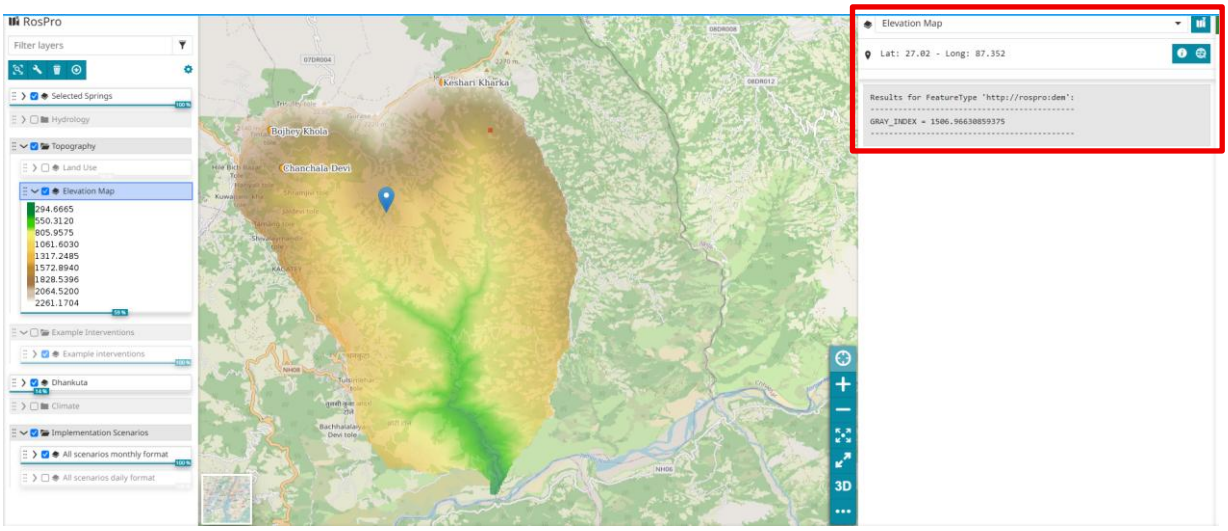


Figure 4. Query for a specific pixel value

2.2.2 Vector layers

A vector layer is another type of spatial data representation used in Geographic Information Systems (GIS), but it differs from a raster layer in how it represents geographic features. Instead of using a grid of cells like a raster, a vector layer uses points, lines, and polygons to represent geographical objects and their relationships.

Vector layers are, in the specific case of RoSPro, point-based layers showing characteristics of springs. These layers don't have values for the entire basin, but just at the locations that they are representing. Each point feature (springs in this case) can have associated attributes (or data) stored in a table. This table can be shown by clicking on a vector layer and on the 'Open attribute table' button. Let's try this by clicking on the 'Selected springs' layer:

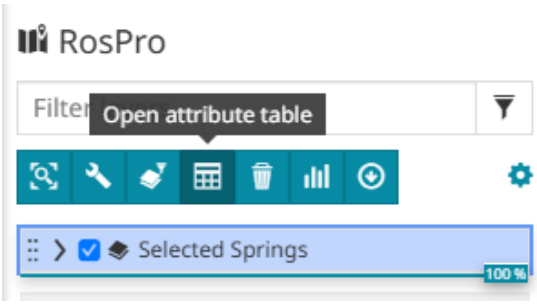


Figure 5. Open attribute table button

A new table will appear at the bottom of the screen, showing the attribute table of this layer:

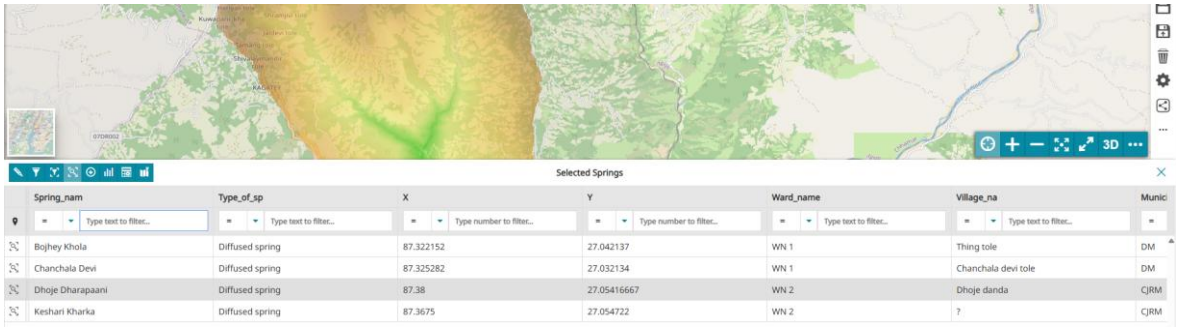
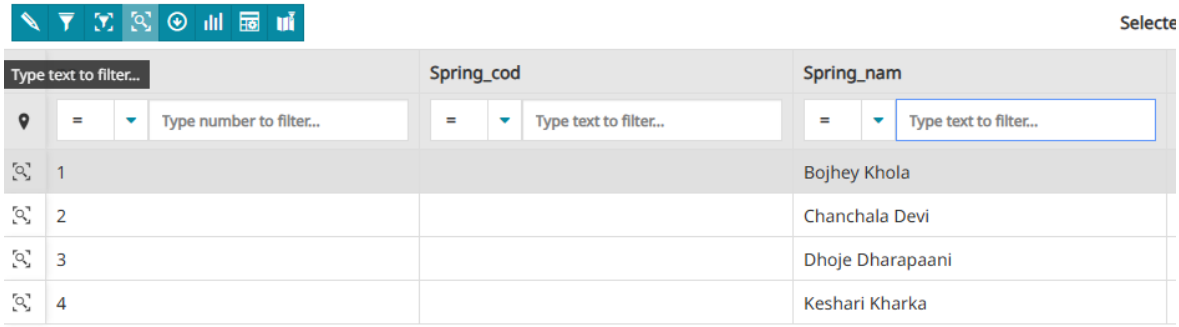


Figure 6. Attribute table of the Selected Springs Layer

Many characteristics are shown per spring: type, coordinates, village, municipality, types of use, among others.

In this case, we have four features, corresponding to the four selected springs:



If we click on the 'Zoom to feature' button, the map will automatically zoom to the selected feature (in this case the Bojhey Khola Spring)

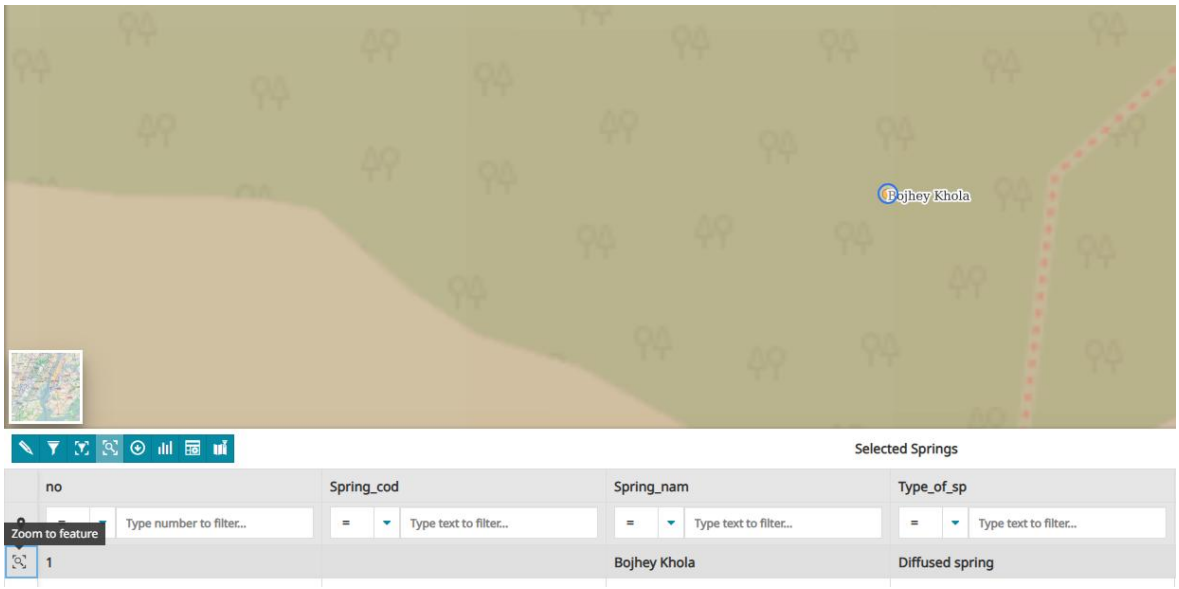


Figure 7. Zoom to feature functionality

We could also click the 'Download grid data' button, that allows you to download this data in multiple formats (shapefile, csv, GeoJSON,).

As well as for raster layers, by clicking one feature we will get its information on the right part of the screen:

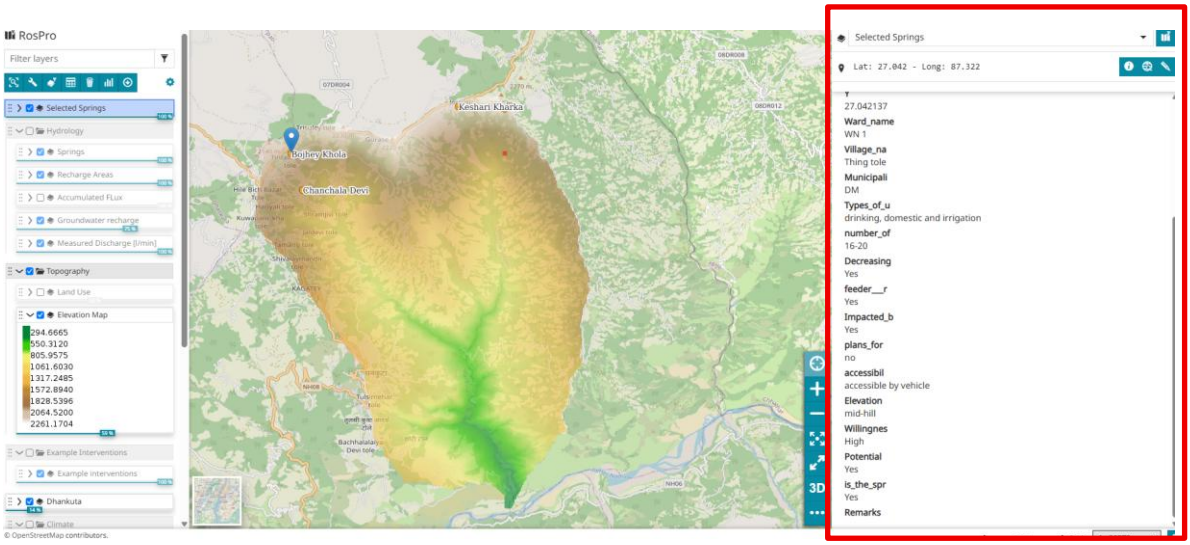


Figure 8. Query for one location

The most useful button is 'Create chart for the selected layer'. This button allows you to create different types of graphs for representing your vector layer data.

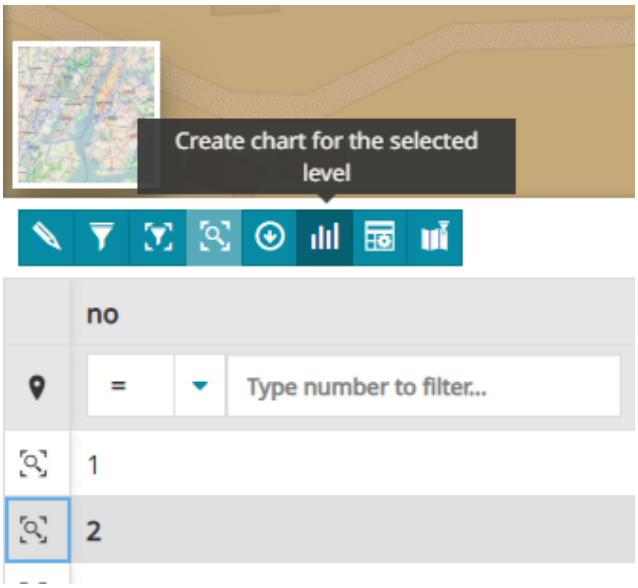


Figure 9. Create chart button

For example, let's select the 'All scenarios monthly format' layer, under the 'Implementation Scenarios' category. If we open the attribute table, we can see the data associated with this layer:

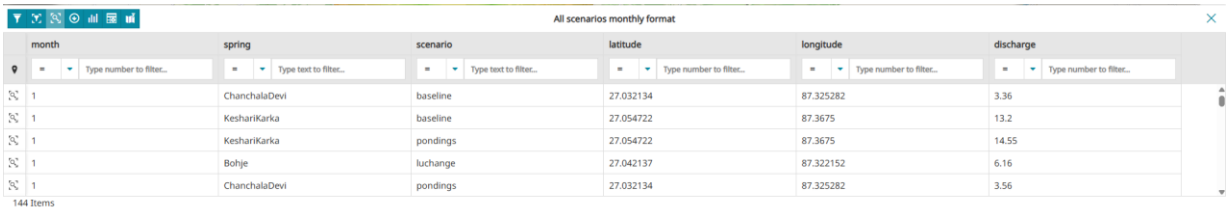


Figure 10. Attribute table of implementation scenarios

Per spring and per scenario, the simulated monthly discharge is showed. By clicking on the 'Create chart for the selected layer' button, the following menu will appear:

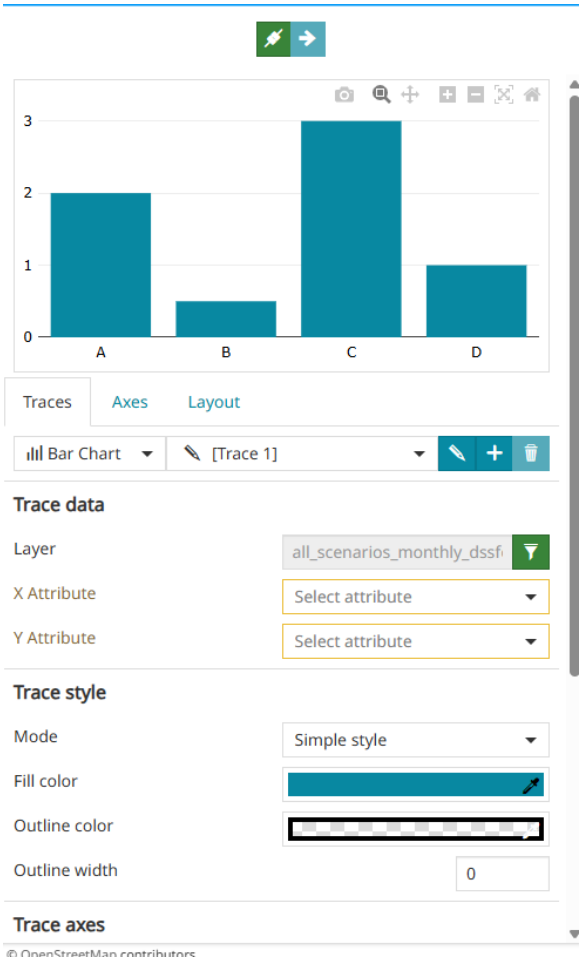


Figure 11. Menu for creating chart

We can select one option between bar chart, pie chart or line chart. Then, we will have to fill all the required fills to build our graph. Multiple options are available. For this example, we will represent the monthly discharge per type of implementation, for all springs, replicating the graph that is shown in the default view of the dashboard:

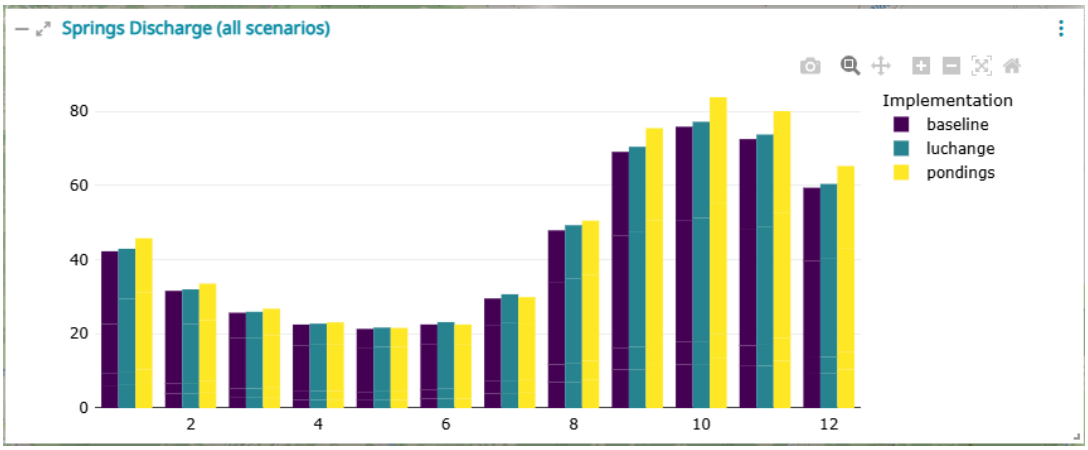
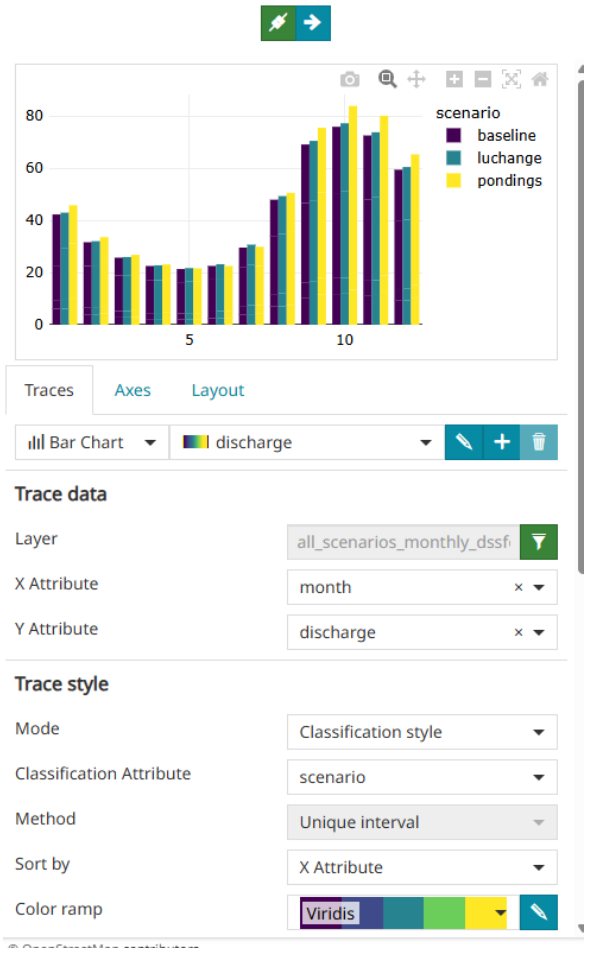
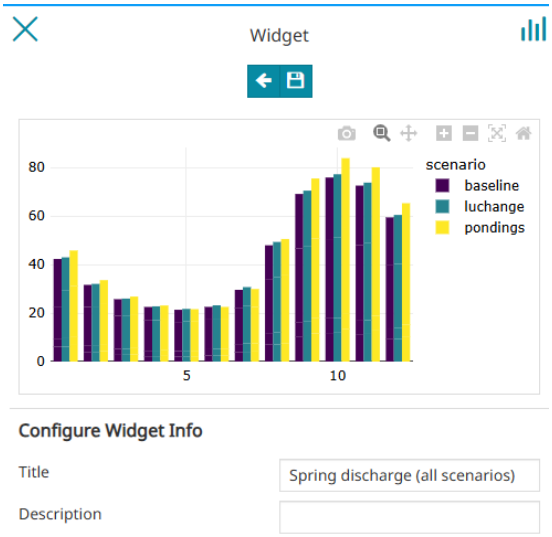


Figure 12. Monthly spring discharge per implementation

For getting this graph, we have to fill in the menu as follows:



The X axis represents the month column of the attribute table, and the Y axis represents the discharge column. The classification attribute is the scenario (baseline, ponding or land use change) and this graph shows the discharge for all springs (sum). By clicking on the → button, we can add the title to the graph and save it:



The new graph will be added to the canvas, and we can drag and drop it in the desired position:

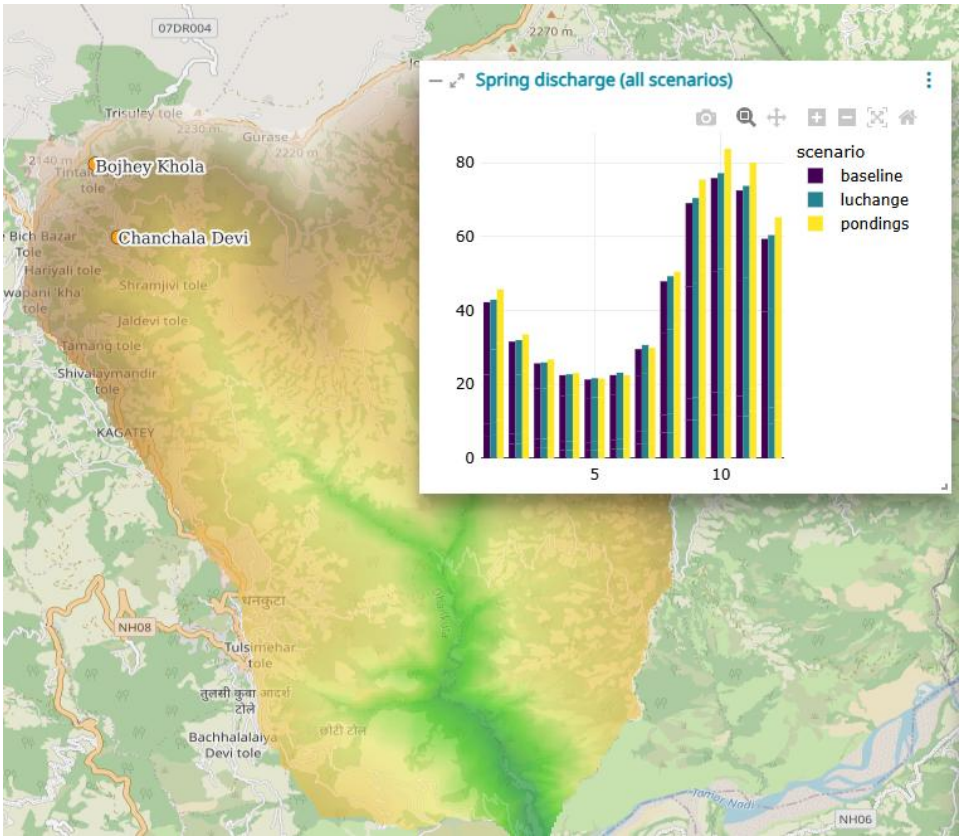


Figure 13. New graph generated on the canvas

The rest of the existing graphs by default can be minimized or moved to other positions, in order to organize the dashboard per the user convenience.

Data from the graphs can also be downloaded:

