GALAPAGOS TUTORIAL

Marxan Planning Platform

The Nature Conservancy

Microsoft

MARXAN
conservation solutions

The University Of Queensland
AUSTRALIA

BIOPAMA
From Knowledge to Action for a Protected Planet

With additional support from:

vizzuality.

mapbox

UN environment programme WCMC

PacMARA
Pacific Marine Analysis & Research Association

Through an initiative of:

European Commission

This tutorial was updated in October 2024 by:
Fernanda Thiesen Brum, Jorge G. Álvarez-Romero, Jennifer McGowan, Alex, Hearn, Brooke Williams and David Albert.

To contact the Marxan team, please write us to marxancloud@gmail.com

To contact MaPP support, write to marxanadmin@tnc.org

Citation

TNC. 2024. The Marxan Planning Platform: Galapagos Tutorial. Global Science, The Nature Conservancy (TNC), Arlington, Virginia, USA. https://marxanplanning.org

Data used in this tutorial:

Acuña-Marrero, D., Smith, A.N.H., Hammerschlag, N., Hearn, A., Anderson, M.J., Calich, H., Pawley, M.D.M., Fischer, C., Salinas-de-León, P., 2017. Residency and movement patterns of an apex predatory shark (*Galeocerdo cuvier*) at the Galápagos Marine Reserve. PLoS One 12, e0183669.

Galapagos Movement Consortium, Movebank Data Repository https://www.movebank.org/cms/movebank-main

Harris, P.T., Macmillan-Lawler, M., Rupp, J. and Baker, E.K., 2014. Geomorphology of the oceans. *Marine Geology*, *352*, pp.4-24.

Hearn, A.R., Acuña, D., Ketchum, J.T., Peñaherrera, C., Green, J., Marshall, A., Guerrero, M., Shillinger, G., 2014. Elasmobranchs of the Galápagos Marine Reserve, In (J. Denkinger, L. Vinueza, eds.) Galápagos Marine Reserve: a dynamic socio-ecological system., pp. 23-59. Springer.

Hearn, A.R., Green, J., Román, M.H., Acuña-Marrero, D., Espinoza, E., Klimley, A.P., 2016. Adult female whale sharks make long-distance movements past Darwin Island (Galápagos, Ecuador) in the Eastern Tropical Pacific. Marine Biology 163, 214.

Hearn, A.R., Espinoza, E., Ketchum, J., Green, J., Peñaherrera, C., Arauz, R., Fischer, C., Steiner, T., Shillinger, G., Henderson, S., Bessudo, S., Soler, G., Klimley, P., 2017. Una década de seguimiento de los movimientos de tiburones resalta la importancia ecológica de las islas del norte: Darwin y Wolf, In (L. Cayot, D. Cruz, eds.) Informe Galápagos 2015-2016. pp. 132-142. DPNG, CGREG, FCD & GC, Puerto Ayora, Galápagos, Ecuador.

Hearn A, Cárdenas S, Allen H, Zurita L, Gabela-Flores MV, Peñaherrera-Palma CR, Castrejón M, Cruz S, Kelley D, Jeglinski J, Bruno J, Jones J, Naveira-Garabato A, Forryan A, Viteri C, Picho J, Donnelly A, Tudhope A, Wilson M & G Reck G (2022). A Blueprint for Marine Spatial Planning of Ecuador's Exclusive Economic Zone around the Galápagos Marine Reserve. Universidad San Francisco de Quito / PEW Bertarelli Ocean Legacy, Quito, Ecuador, 361 p.

Parra, D.M., Andrés, M., Jiménez, J., Banks, S., Muñoz, J.P., 2013. Evaluación de la incidencia de impacto de embarcaciones y distribución de la tortuga verde (*Chelonia mydas)* en Galápagos. Retrieved from Puerto Ayora, Galapagos, Ecuador

Seminoff, J.A., Zárate, P., Coyne, M., Foley, D.G., Parker, D., Lyon, B.N., Dutton, P.H., 2008. Post-nesting migrations of Galápagos green turtles *Chelonia mydas* in relation to oceanographic conditions: integrating satellite telemetry with remotely sensed ocean data. Endangered Species Research 4, 57-72

Shillinger, G.L., Swithenbank, A.M., Bailey, H., Bograd, S.J., Castelton, M.R., Wallace, B.P., Spotila, J.R., Paladino, F.V., Piedra, R., Block, B.A., 2011. Vertical and horizontal habitat preferences of post-nesting leatherback turtles in the South Pacific Ocean. Marine Ecology Progress Series 422, 275-289.

Objectives of this tutorial

The purpose of this Marxan Planning Platform tutorial (MaPP) is to walk users through the development of several simple Marxan scenarios speaking to the foundations of spatial prioritization and Marxan concepts. It is targeted at users who are new to Marxan but may have some basic knowledge of core conservation spatial planning concepts. The narratives and scenarios used throughout this tutorial are fictional.

Additional resources

To find out more about Marxan visit: https://marxansolutions.org/

What is Marxan? https://marxansolutions.org/what-is-marxan/

What is Conservation Planning? https://marxansolutions.org/whatisconservationplanning/

Resources on systematic conservation planning:

https://marxansolutions.org/learn/

https://www.youtube.com/watch?v=1IDeKJJO7s8&t=52s

https://onlinelibrary.wiley.com/doi/10.1111/brv.12008

Activities

Welcome! You are about to embark on an exciting journey. By the end of this tutorial, you will be able to run your own Marxan analysis, an important step towards designing better conservation plans to conserve nature more efficiently and cost-effectively. Let's get started!

Today you are a conservation officer helping plan the Galapagos Marine Reserve. The Galapagos Islands and surrounding waters are recognized globally for their unique species and biodiversity, such as the endemic giant tortoises, Galapagos penguins and marine iguanas. In 1998, the Ecuadorian Government created a marine reserve, covering 138,000 km2 around the islands, which at the time, made it the second-largest marine reserve in the world. However, many of the species inhabiting the Galapagos, such as the blue-footed booby (*Sula nebouxii)* and silky shark (*Carcharhinus falciformis*), utilise the open ocean, and range outside the borders of the reserve. Thanks to tracking studies carried out over the quarter century since the creation of the reserve, we know much more about the movements of many of the species in and around the reserve and can begin to assess whether the current reserve provides adequate protection for them. We also know much more about the distribution of key ocean habitats in our region. Given that industrial and semi-industrial fishing pressure in Ecuador's waters outside the reserve increased dramatically at the turn of the century, and that in recent years, large distant water fishing fleets have been reported in the high seas surrounding Ecuador's Exclusive Economic Zone, the residents of Galapagos are concerned that the existing reserve may not provide sufficient protection to the ocean and wildlife that their livelihoods depend on. They are campaigning for an expansion of the reserve and have asked us to identify key areas that should be included in their proposed new design. However, the fleets operating around the reserve are concerned that increasing the size of the reserve may affect their livelihoods. In addition to information on key habitats and species movements, we have obtained spatially explicit catch data from the two main fleets - the industrial tuna purse seine fleet and the national longline fleet for large pelagic species.

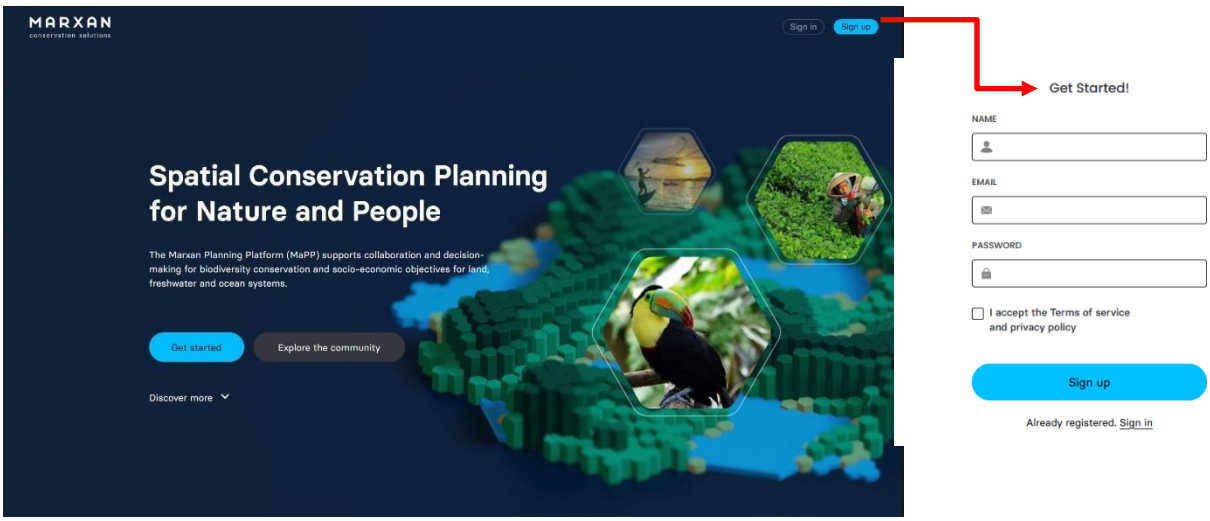
We will explore a few example scenarios to better understand the foundations of planning with Marxan. First, we will explore a scenario based only on conservation features (species

and habitats). Next, we will assess Galapagos' current protected area network and see how far away we are from meeting our targets and prioritizing places to close the gap. Finally, we will explore a scenario where we try to meet targets and minimize impacts of fisheries.

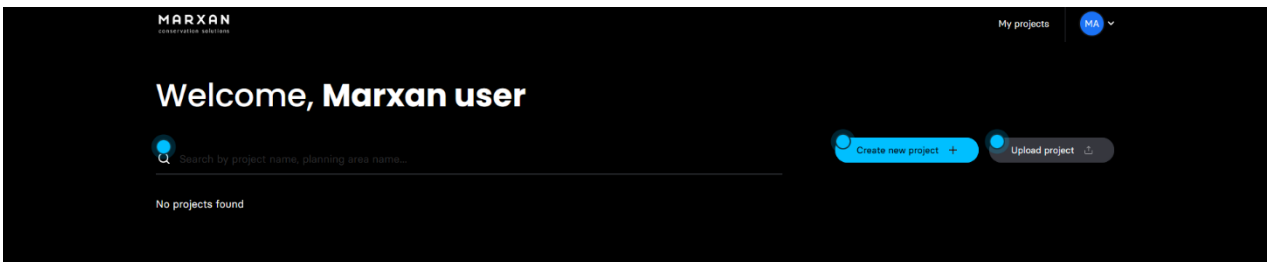
Getting started

1. Registering an account in the Marxan Planning Platform

Go to marxanplanning.org .Register to use the Marxan Planning Platform (MaPP), and sign in. You will get a message from MaPP in your inbox (please check your - junk folder!).



Access your account by following the instructions in the email. Once logged in, you will be welcomed by your username in your personal dashboard.



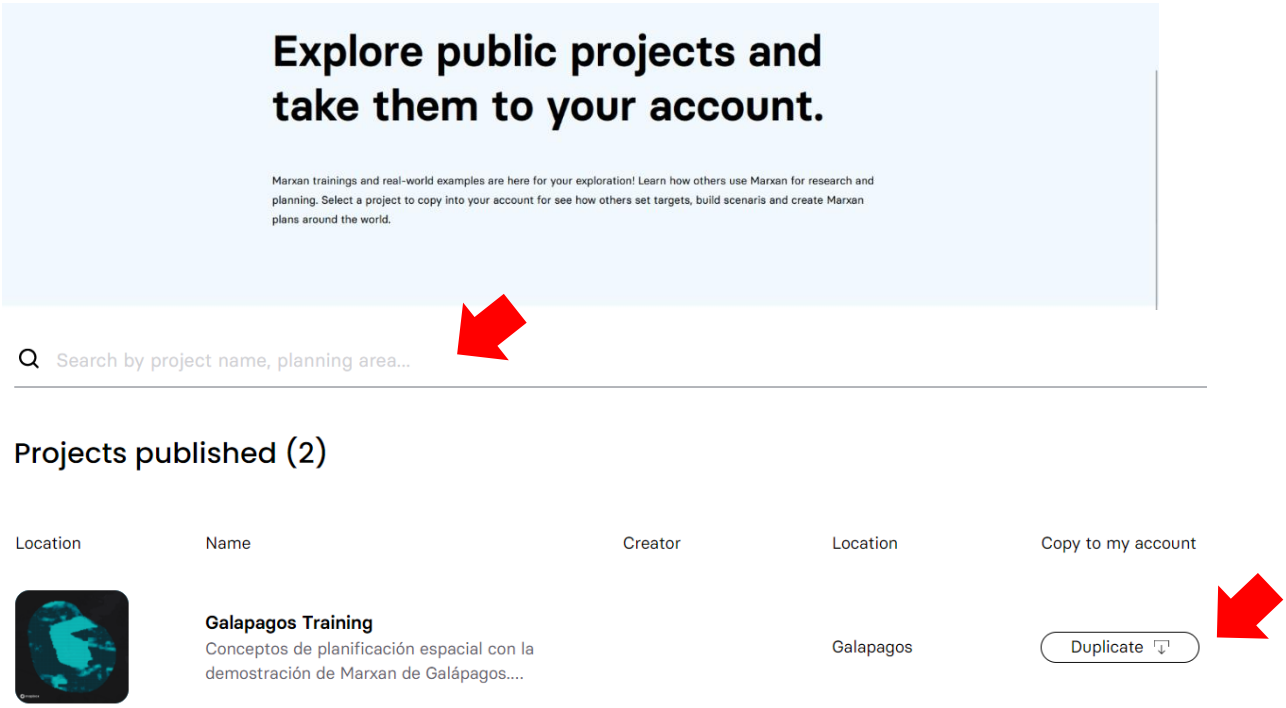
2. Select the project for this tutorial

In Marxan MaPP you may upload your own data securely to create your planning projects and develop scenarios. In this tutorial we are going to use an existing project that has been publicly shared on the community page of MaPP. This project will already have preloaded planning units, conservation features, costs, protected areas, and main parameters defined. During this tutorial, you will explore and modify the parameters of these scenarios to understand how Marxan works and the key functionalities of MaPP.

Clicking on the *Explore the community* in the landing page of MaPP.

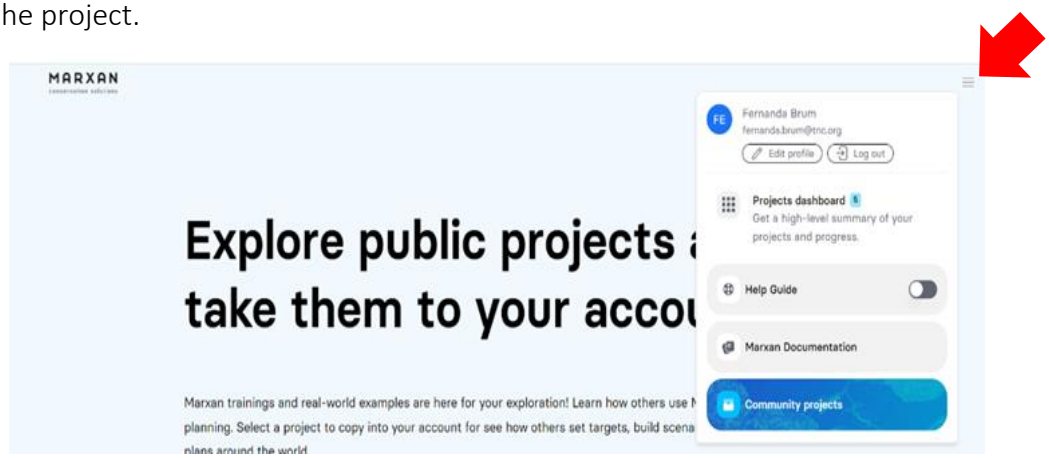
In the Community page you will see all MaPP projects that have been published as "Public".

2.1. Find the project called *'Galapagos Training'* and click on *Duplicate*. You can search by typing 'Galapagos' or scroll down to find it.

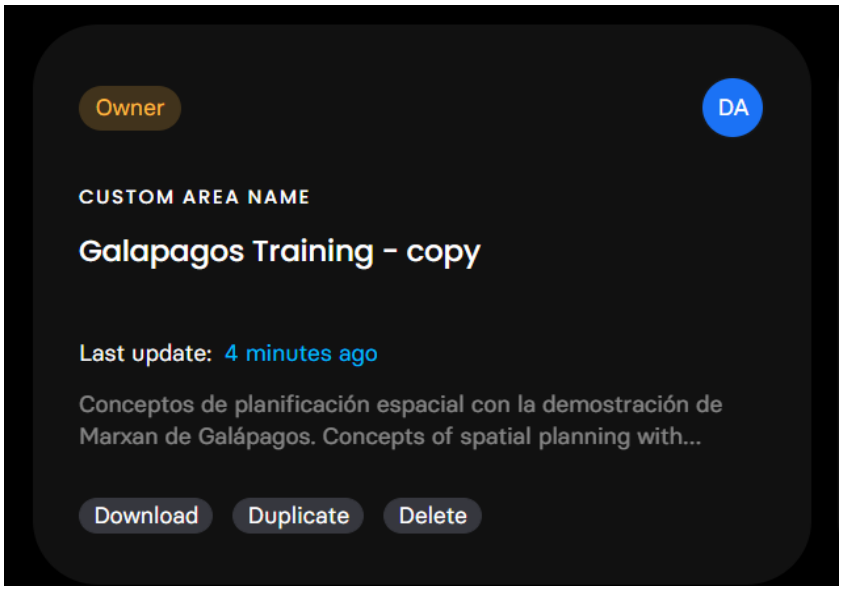


The project will be copied into your dashboard.

2.2. Click on *My Projects* on the top right side of the screen, by the icon with your initials to see your list of projects. Please allow a few minutes for the platform to duplicate the project.



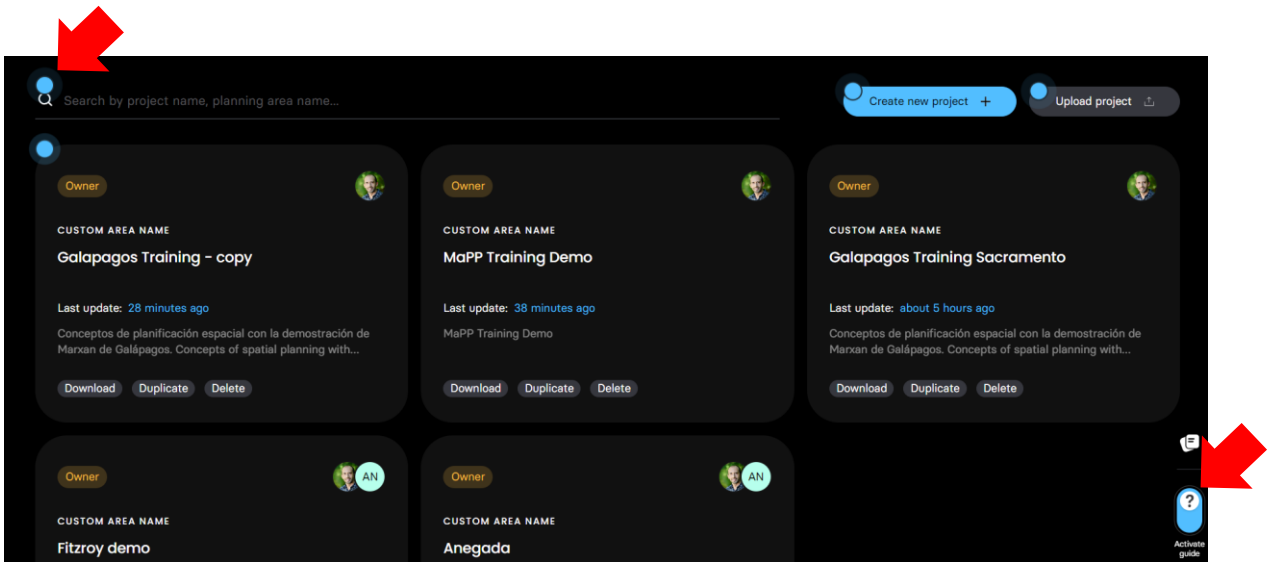
You will see the newly duplicated project “Galapagos Training - copy” in your workspace

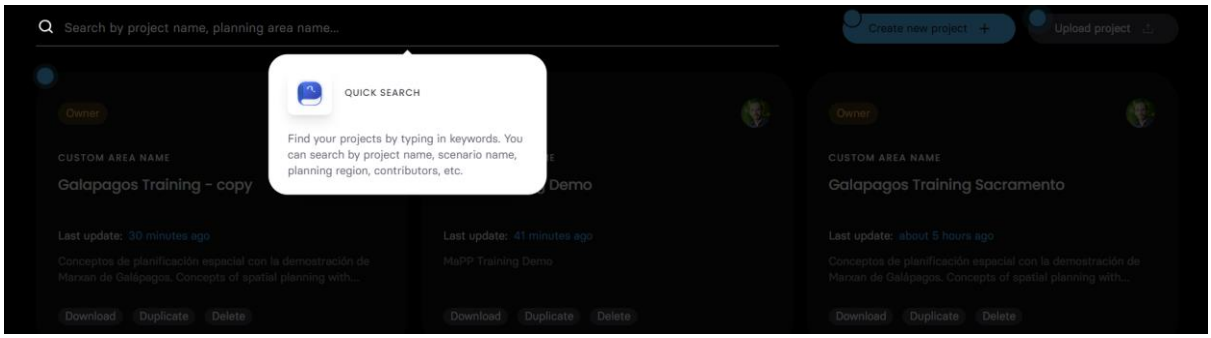


To learn how to create a new project, go to page 30.

Getting help

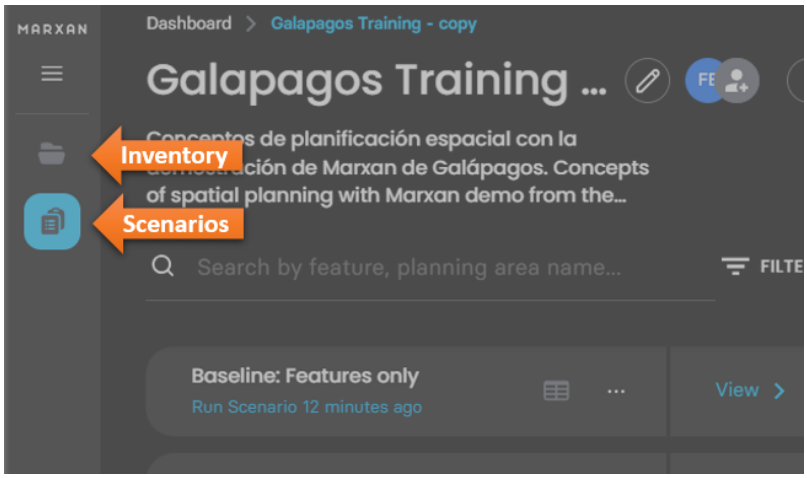
Before creating your first scenario, you will turn on the help pop-up messages by clicking on the bottom right question mark icon marked (*Activate guide*). You will note some blue circles on the screen; this identifies key /steps/functions on each page or step that will provide key information about functions and workflow. Throughout this tutorial, click on all the blue dots to learn about the platform and creating and running Marxan in MaPP.





Opening the project

Now we´re going to open the project by clicking in the project name. This is going to direct you to the scenario's dashboard. You´ll notice the menu in the left bar, where you can find two major options "Inventory Panel" and "Scenarios".

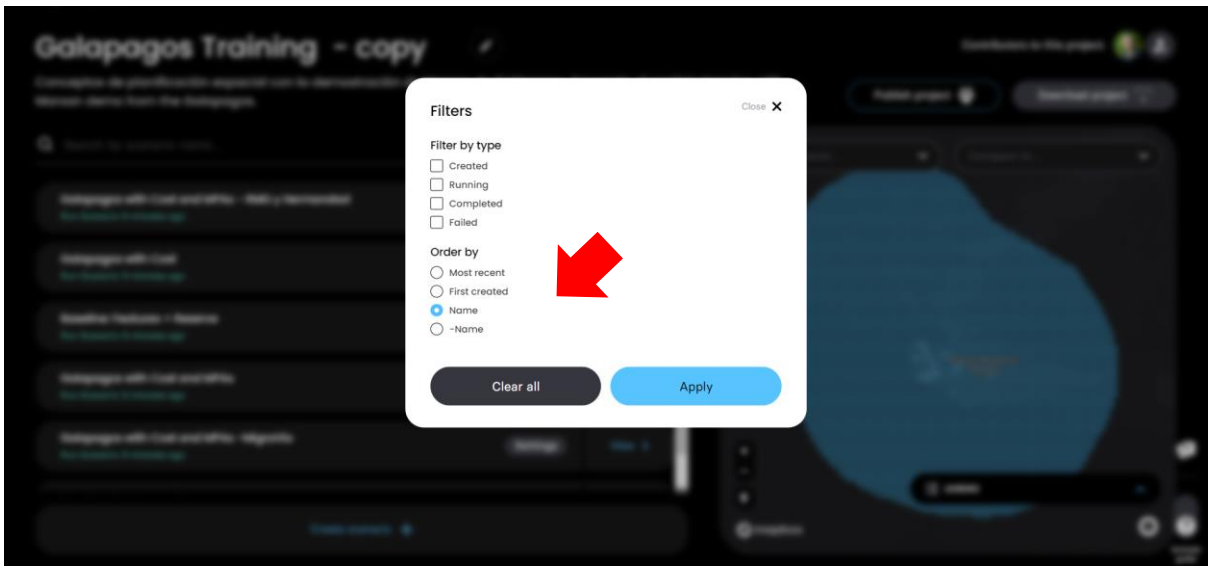


The Inventory Panel is designed to centralize and manage all crucial information required for effective scenario building. This includes features, protected areas, and cost layers. The Inventory Panel provides tools for efficient file management, allowing for uploading, viewing, editing, and deleting files and adding/filtering/bulk editing using the *feature tagging system*. For more details on how to upload/handle information in the inventory panel, go to page 39. For now, we´ll be using the pre-existing scenarios in the project using the Scenario´s dashboard. For more details on new scenarios creation, go to page 45.

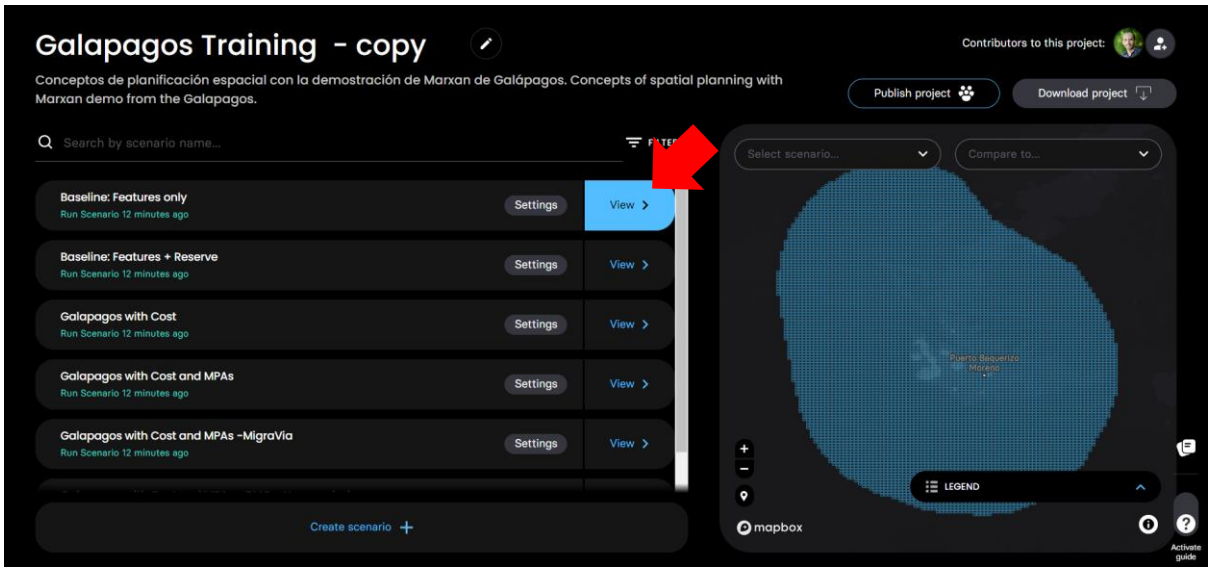
Scenario 1 – Baseline Features only

Open an existing scenario

1. First, we will open your fist scenario; to do this click on FILTERS and Order by ‘Name’; you will note that when you have many scenarios you will be able to filter and sort scenarios based on different criteria.



2. For this part, please click on *View* to access ‘Scenario Baseline: Features only’.



When you access this scenario, you will find a left bar menu with three functionalities: (1) Grid setup  , (2) Marxan settings, and (3) Solutions. These are the three stages in the MaPP workflow; you will follow them whenever you create a scenario.

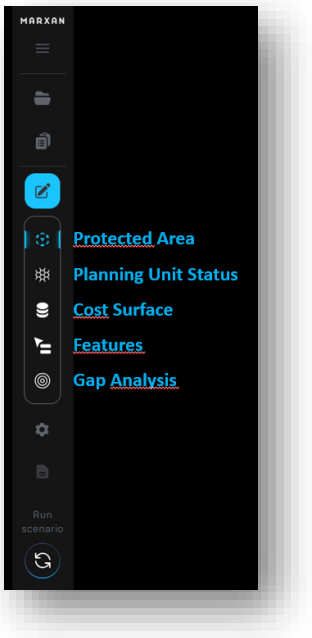
In this scenario, our target is to protect 30% of each feature. For now, we want to consider only the features and not the existing protected area network.

1. Working with the Grid Setup panel

Often conservation and management actions are restricted by costs, therefore Marxan seeks to meet targets, while minimizing costs and other impacts of industries, communities or other stakeholders. For this scenario, we will use the default planning unit area as our cost surface under the assumption that the less area we need to acquire or manage to meet our targets, the more cost-efficient the plan will be. The MaPP platform uses “equal area” as a default cost, but you can define costs from this panel and we will look at how cost influences the outcomes in the next scenario.

Click on *Grid setup*  to navigate the left bar menu through the different options regarding the planning unit grid settings. Here you can incorporate protected areas into the scenario analysis, edit planning unit status, select a customized cost surface, select features

and set targets and penalties, and assess how much of your features are already under protection based on protected area location.

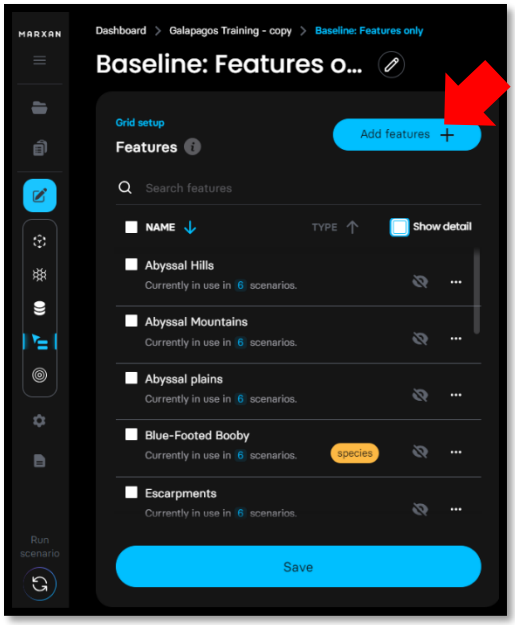


Because we do not want to add any protected areas at this point in time, nor do we want to customize the planning unit grid by adjusting planning unit status, we will jump straight into the tab **"Features"** to explore conservation features and set targets.

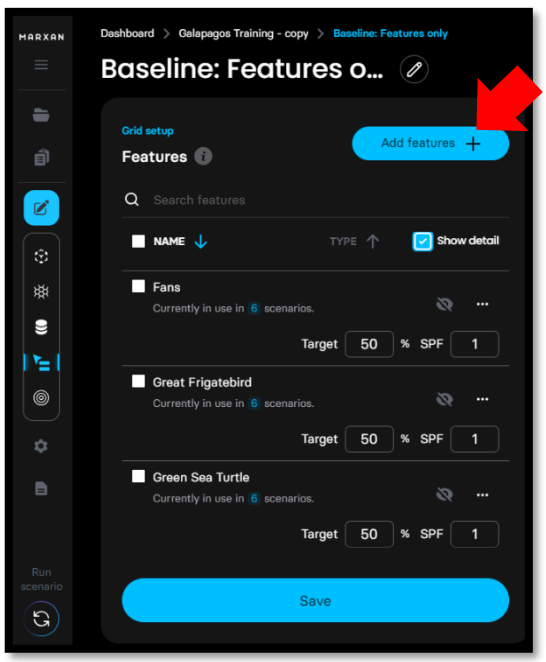
1. Setting targets

a. Click on the **"Features"** tab to access the options in this section.

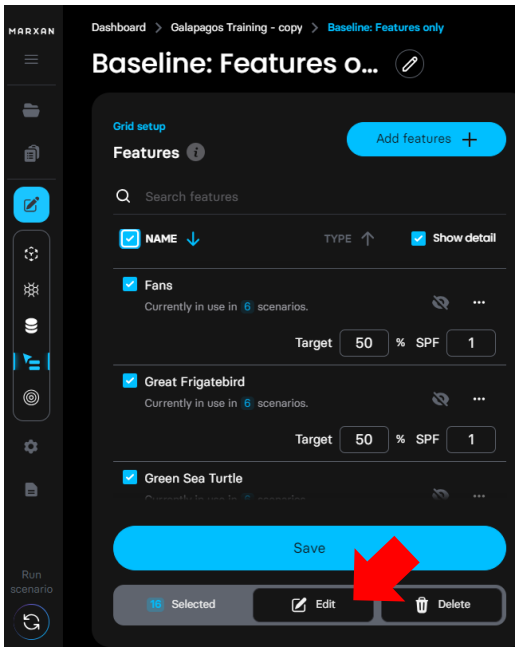
Here will be able to add, visualize, explore and your conservation features. In this case, we have already preloaded the features for you. You will be able to see the feature distribution selecting the "show on map" icon. The distribution will be highlighted in the map of the right panel of your screen. You may also use the map to zoom in and zoom out. You can remove or add features to the scenario but in this case, we will leave it as it is. Take a moment to get familiar with the features – which are made up of both geomorphological features like escarpments and seamounts, and species, such as Blue-Footed Booby and Green Sea turtles.

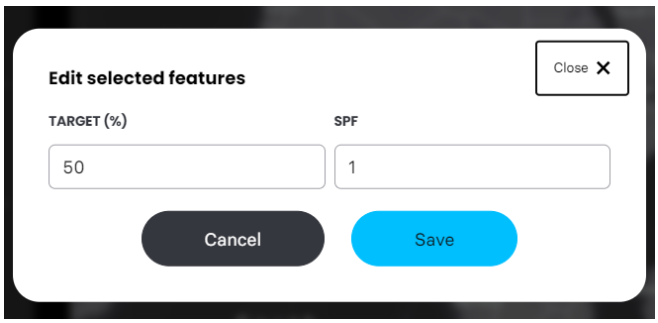


Click on ***Show detail*** to set the targets and penalty factors.



You may change all the feature targets at once by selecting all the features and clicking in "Edit". Then, use the "Target" and "SPF" fields to bulk edit the features all at once.

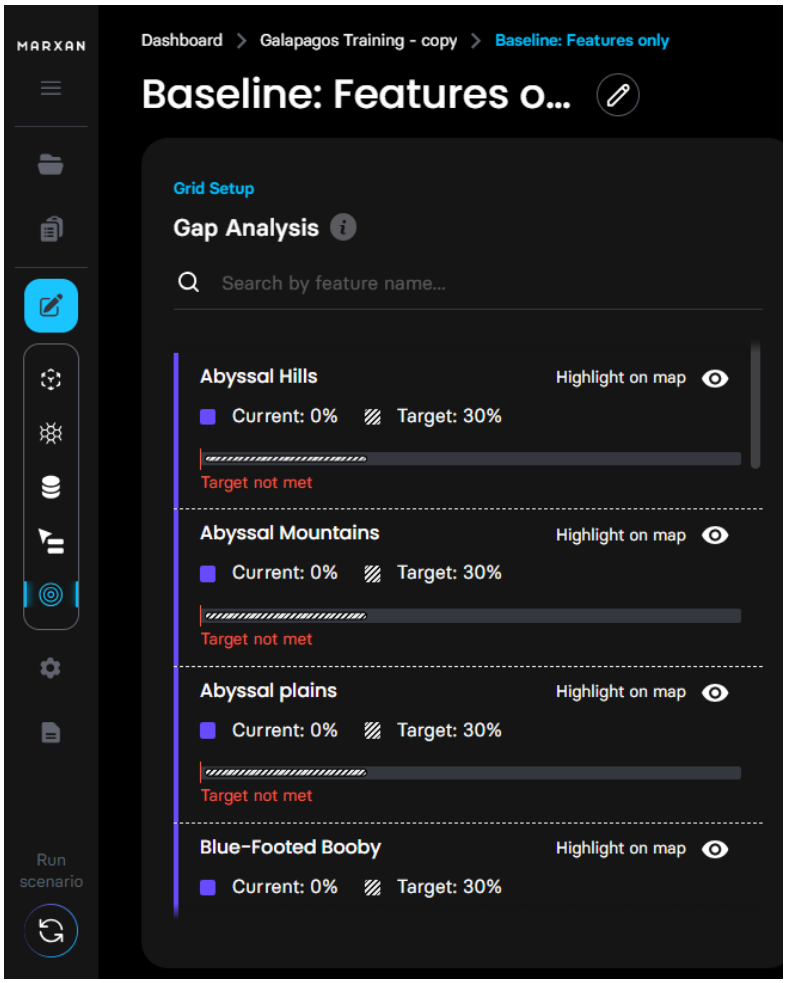




You may do this by clicking on the % number and typing the desired target or by moving the slider bar. You can also bulk edit features based on tag, by clicking on the desired tag and filtering the features. In this scenario we will set all features at 30%. For now, we will leave the Species Penalty Factor (SPF) as the default- which is 1. We will come back to the SPF later.

When you have set all your targets to 30%, click *Save*. The platform automatically processes these features and conducts a gap analysis. This might take a few minutes.

Click on the "Gap Analysis"  . Because we did not add any protected areas in this scenario, targets should appear as not met in red text below the progress bar because no planning units are allocated or selected to be in the network.



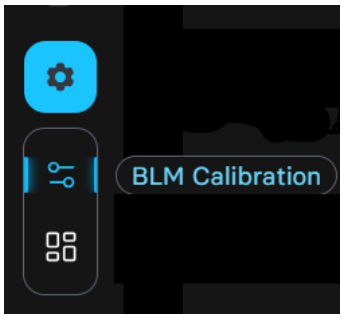
2. Setting up parameters to run Marxan

In this scenario, we will learn how to assign the level of clumping of planning units and leave the *Advanced settings* as the default.

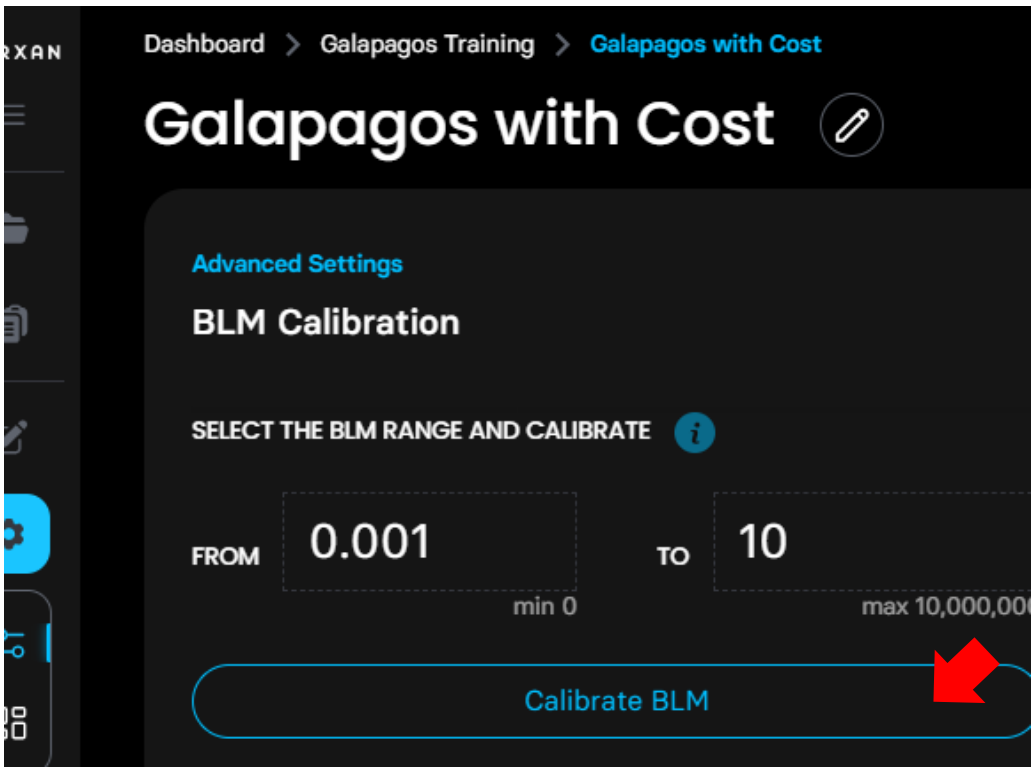
Clumping: BLM calibration

The boundary length modifier (BLM) helps the user decide how "clumped" the network should be. Often, it is not feasible to enforce a network of fragmented planning units (as usually happens when we optimize with no design constraints). For this reason, we need to adjust the BLM to ensure we can minimize fragmentation and aggregate solutions into patches via "clumping." There is no perfect value for the BLM, so we encourage users to explore different levels with calibration.

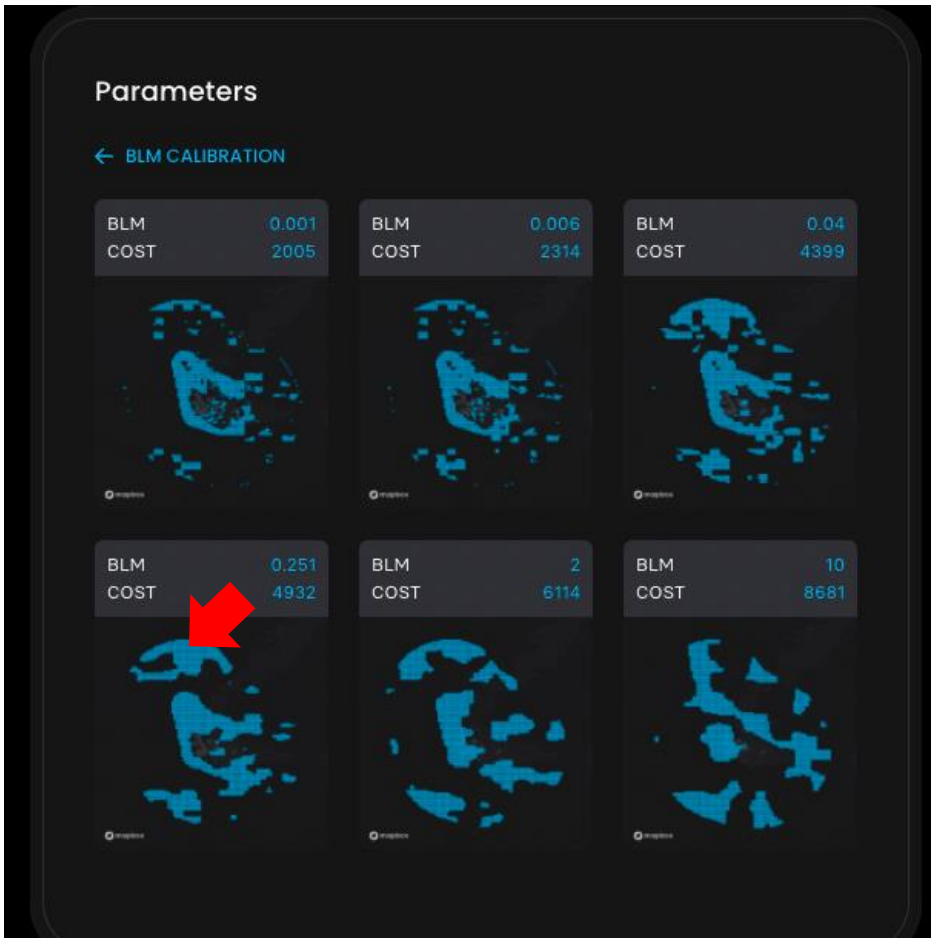
In the left bar, click on Marxan Settings → *BLM calibration*.



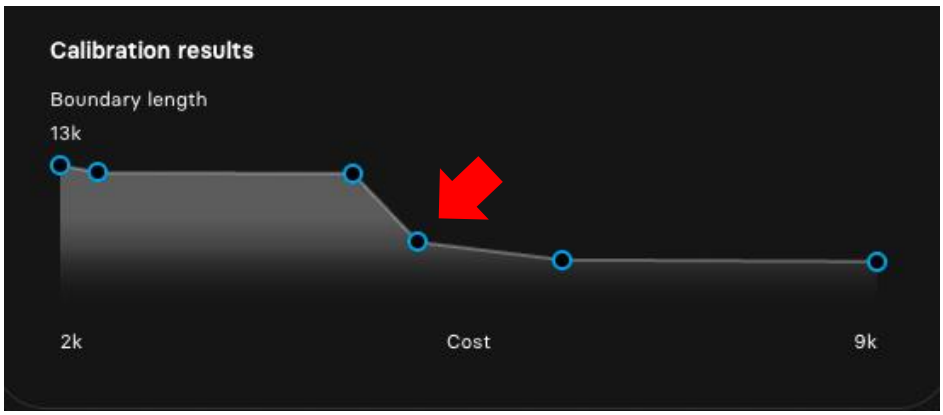
You will see that the BLM values 0.001 to 10 are selected by default. You can leave them as they are and click **"Calibrate BLM"** to run the calibration.



This might take several minutes. The platform is calculating all of the pairwise boundaries shared between planning units. Once complete, you will see a panel with the visual result of the clumping. It might take a sometime to load the following images.



At the bottom of the page, you will also see the relationship between the BLM value and the cost. This helps you understand the BLM value that will give you impact without just adding more cost to the solutions. We typically use the "elbow" of the curve to help us identify a good BLM. You can always reset the values of this calibration to a wider or smaller range for iterative calibration.

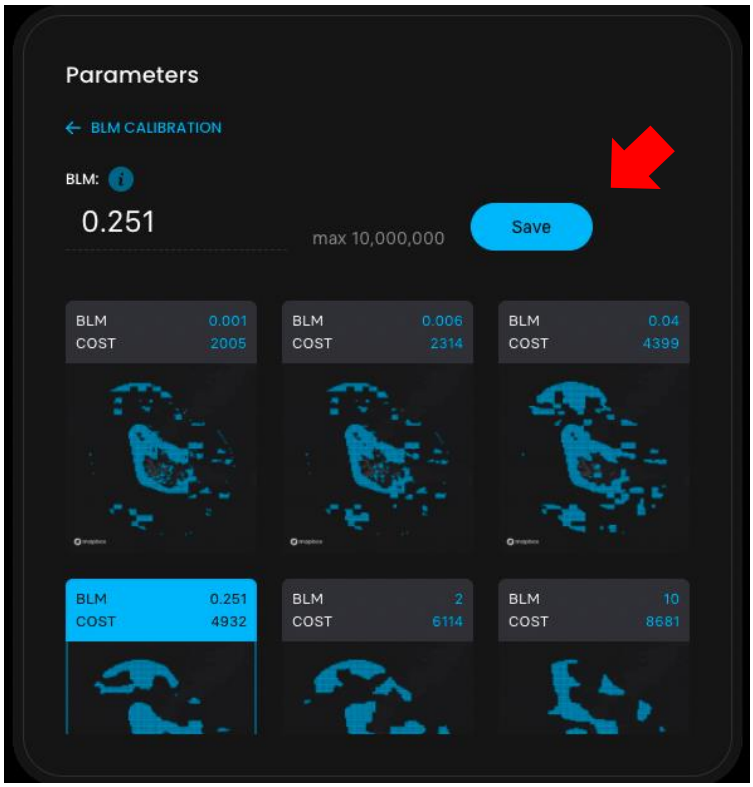


Note: Your calibration results may look different than this curve

Question: Which BLM value do you think we should use?

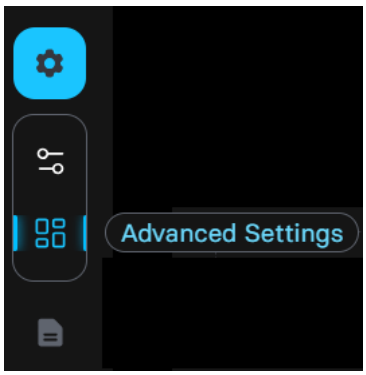
Answer: It is subjective and depends on the decision maker, but BLM ~1 looks appropriate.

Select the “elbow” BLM 0.value and click SAVE



Advanced settings

The advanced settings option allows you to manage the specific parameters under which Marxan will run. Click on *Advanced Settings* to view these settings.

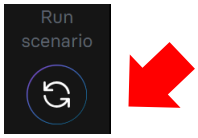


Here you will be able to select important parameter such as number of runs, BLM, or number of iterations. It is best practice to run Marxan 100 times but since we are just exploring, we will keep it to 10 runs. For now, we are not going to change any default settings.

3. Run Analysis

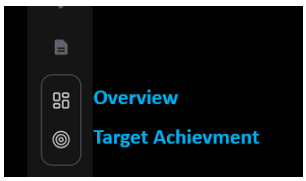
Congratulations you are now ready to run your Marxan analysis!

1. Hit RUN SCENARIO!

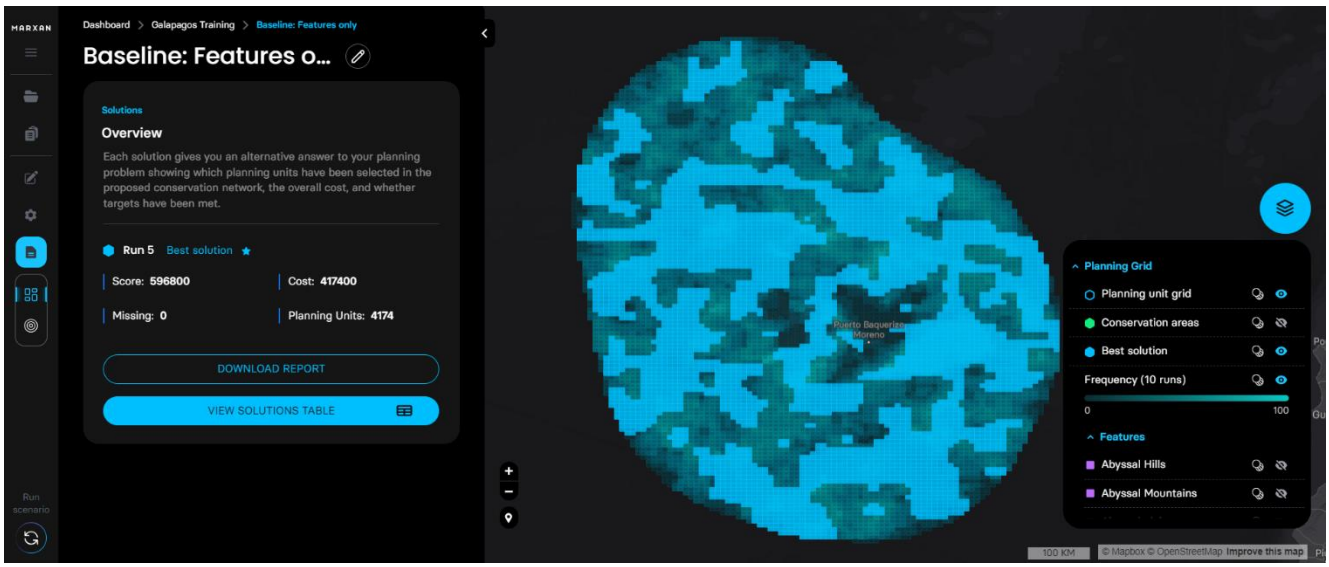


1. Exploring solutions

After a few minutes, you can open the **Solutions** tab on the left panel and the map with the spatial solutions and outputs.



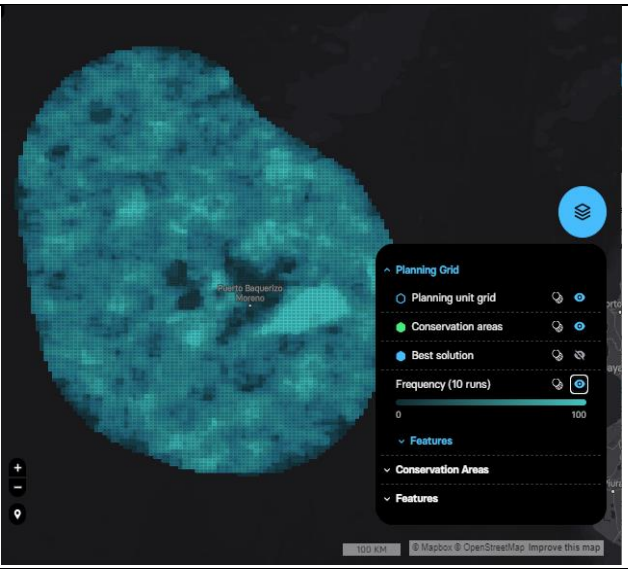
Go to **Solutions** → **Overview** to explore the main results. Marxan produces two kinds of outputs:



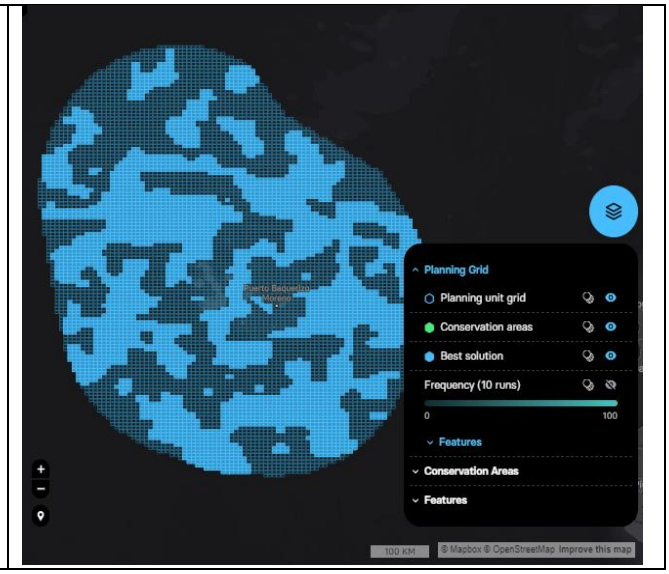
Selection Frequency Map - This shows the number of times a planning unit was selected for the final solution across all runs. This output shows the relative value of the planning units needed to meet the targets. For example, if you set the number of runs to 10, and after running Marxan, a planning unit has been selected in 8 solutions, and its selection frequency will be 8. The default for this example should have a max SF = 10, as we ran Marxan 10 times by default.

The **"Best solution"** is the lowest-scoring run and is often the preferred or baseline output of any solution. The platform shows the best solution by default in the map, but you can toggle all solutions from the dropdown menu.

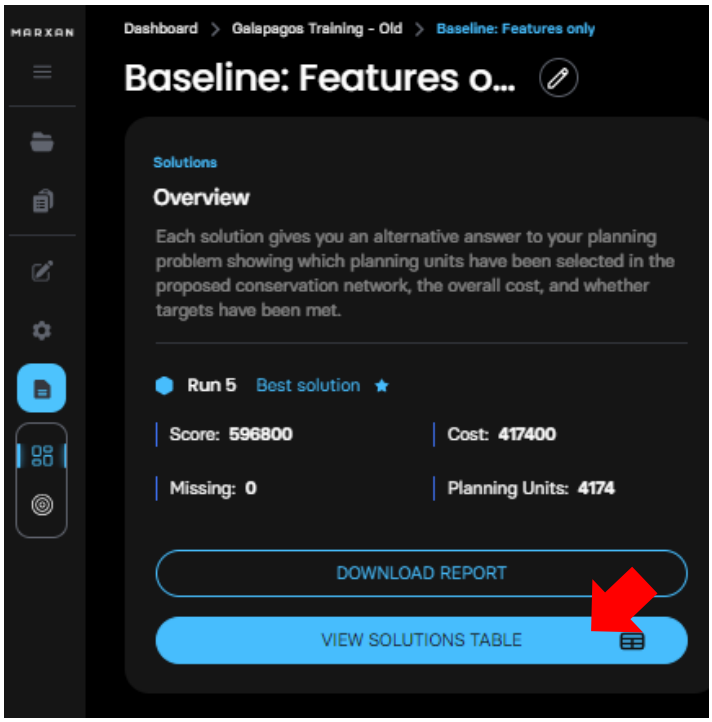
Selection Frequency output



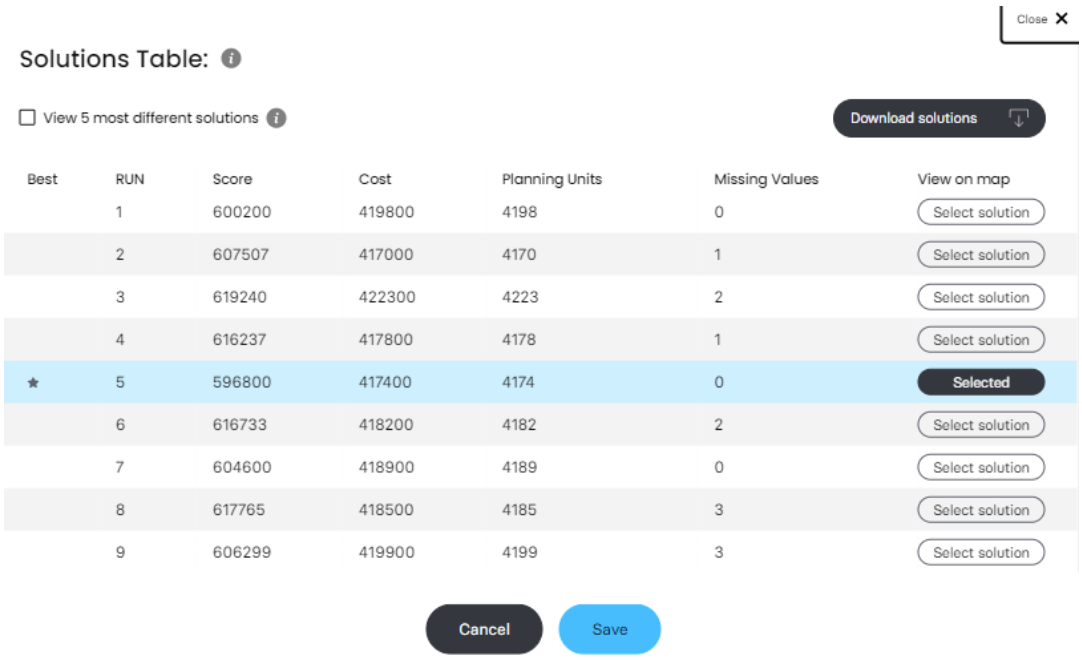
Best Solution output



In the left panel you can see some of the key values after running the analysis such as the overall score (the mathematical answer to Marxan's objective function), cost (the summed cost of all selected planning units), number of planning units and the number, if any, of targets that have been missed for each run. The summary of solutions as well as all Marxan output files can be accessed by clicking on *View Solutions Table.*



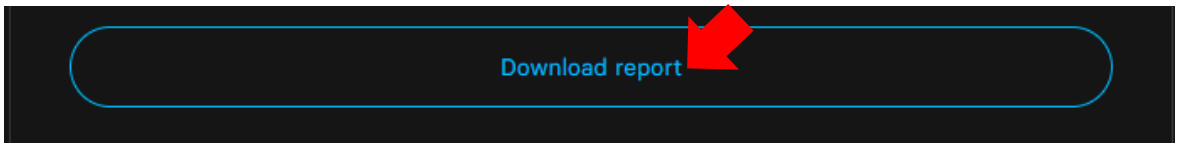
The table data can be sorted by clicking on the column header to sort in ascending or descending order. This allows you to rank the solutions in order of score. If you would like to download all Marxan output files, click on *Download solutions.*



To show an individual solution on the map that is different from the best solution, click *Select Solution* in the last column of the solutions tab. Also, a handy feature of MaPP is that it automatically does a multivariate classification of group solutions that are most dissimilar and identifies single solutions representative of these groups, called “View 5 most different

solutions". In this way, users can identify options that represent feasible but notably different solutions as the basis for ongoing discussions. You can also download the solutions for this subset of solutions to visualize or process outside of MaPP using any GIS software.

To get a report of your preferred run in PDF format, *Click on Download report.*

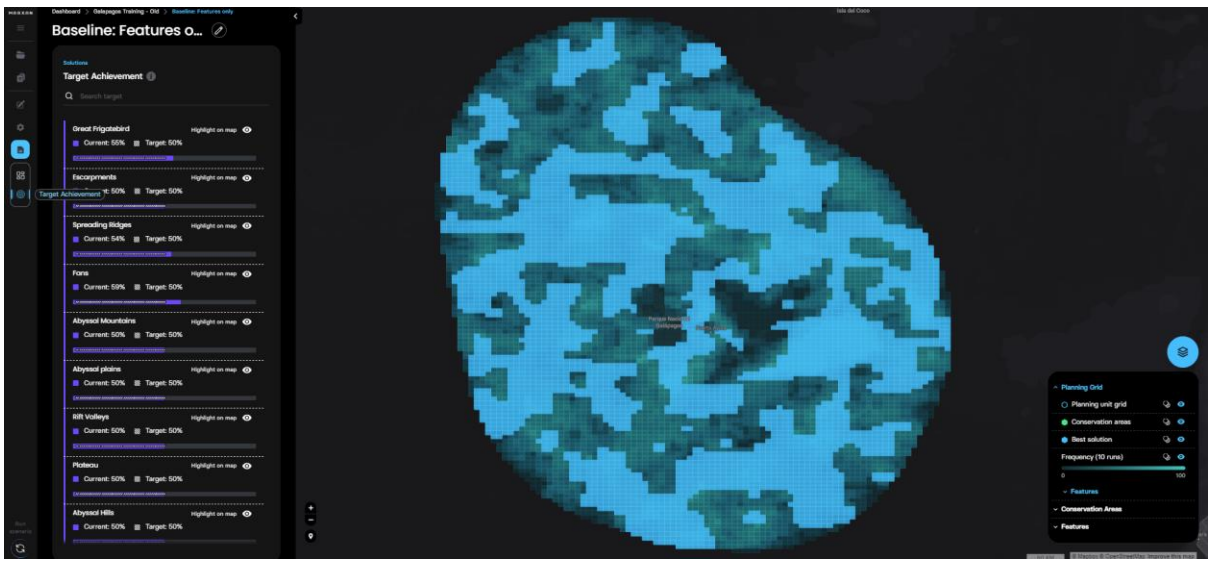


Evaluation: Target Achievement

We can check to see if any of our targets have not been met by simply looking at the Missing value in the Solutions panel.

Return to the *Solutions Table* and select a Run number that has not met more than one target. To learn which features have not met the target, click on **Target Achievement.**

The left panel shows the list of features and the map. Each species has a *Current* (the amount captured in this solution) and *a Target* (the target amount for that feature). If the *Current* is lower than the *Target*, the target has not been met

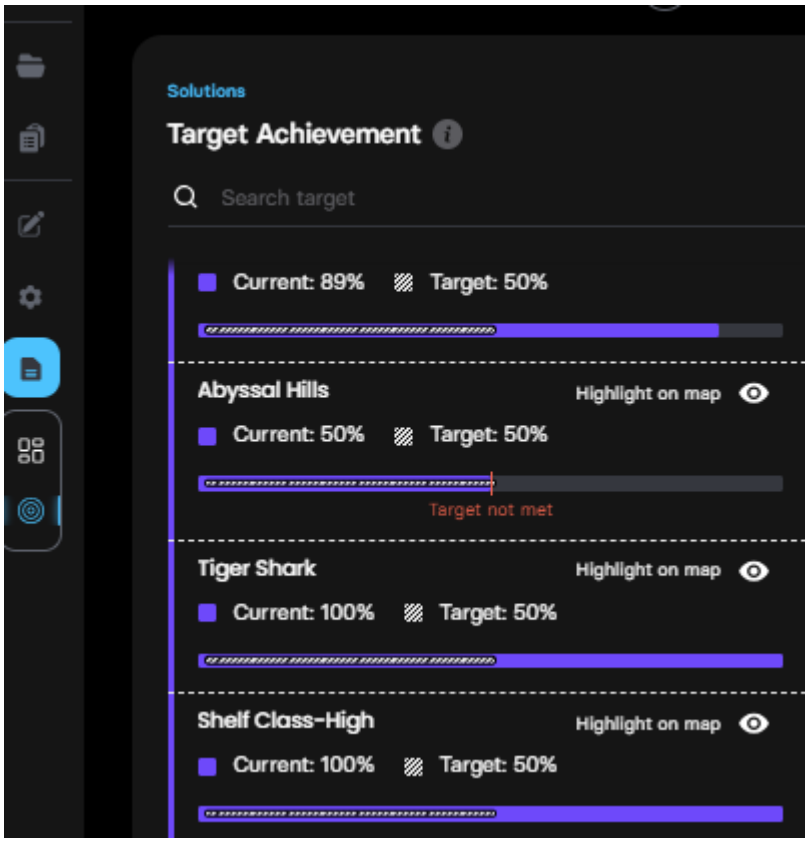


.

If a target has not been met, we can increase the *Species Penalty Factor* (SPF) for individual features. This can be found by returning to the *Features* tab and clicking *Set up Features*. Here, you can manually increase the SPF. By increasing the SPF, you are forcing Marxan to prioritize meeting the target for that feature over minimizing costs (the objective function). You will not incur the SPF penalty in the Marxan score if the target is met.

Species Penalty Factor

The Species Penalty Factor (SPF) is a scaling factor which determines the importance of meeting the target for each species. The Marxan Score incurs a "penalty" for not meeting a target, and therefore the higher the SPF or "penalty" the more advantageous it is for Marxan to meet the target, even if the feature occurs in a high-cost area. In some cases, you may want to change the proportion of target achievement that you are willing to consider as a "missed target". For example, in the **Advanced Settings Tab,** you can set the value for **"Conservation Feature Missing Proportion"** to 0.95, so that if your solution is within 95% of the target, Marxan will consider it met.



Question: Why might we miss our targets for features?

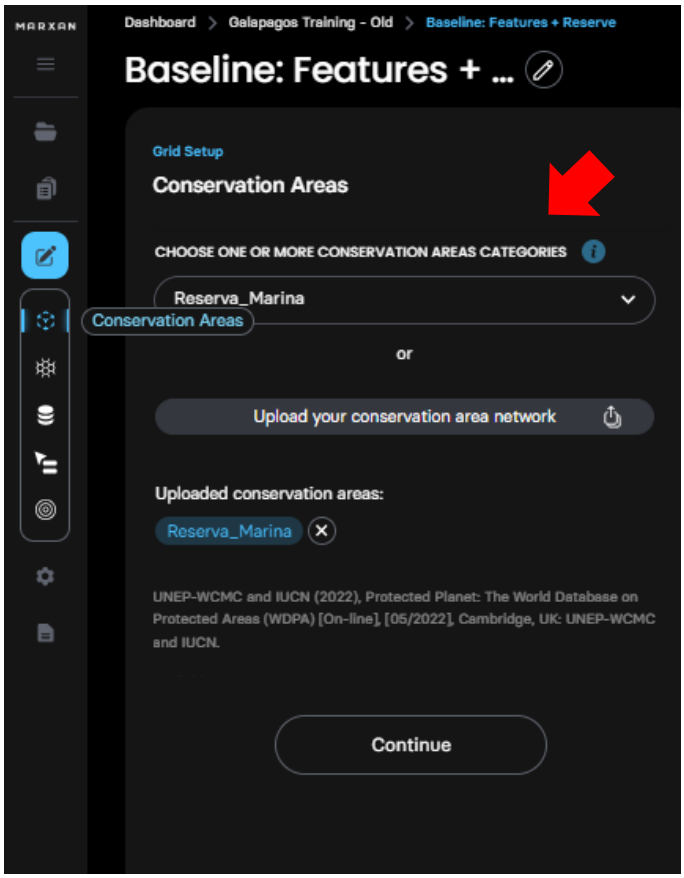
Answer: They might overlap with high cost areas, be locked-out or we have set our "Conservation Feature Missing Proportion" threshold really high so that even a fractional value shortfall will be considered "missed". It is up to you to understand the target achievement for your solutions.

Scenario 2 – Galapagos with Reserva Marina

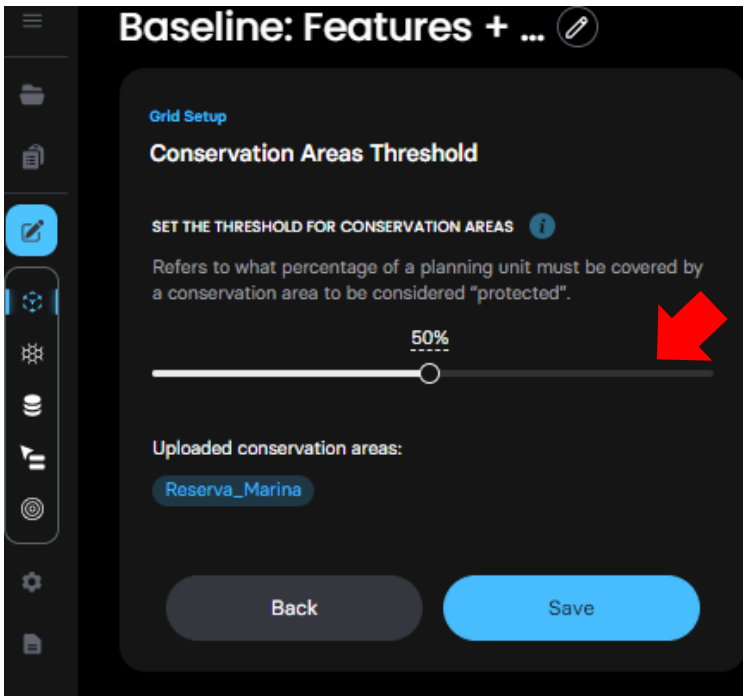
Because we are trying to protect 30% of each feature, we want to consider areas that are already protected as contributing to meeting our targets. Go to Scenario Baseline: Features + Reserva in the main project and click on *View.* In the Planning Unit tab

1. Locking in conservation areas

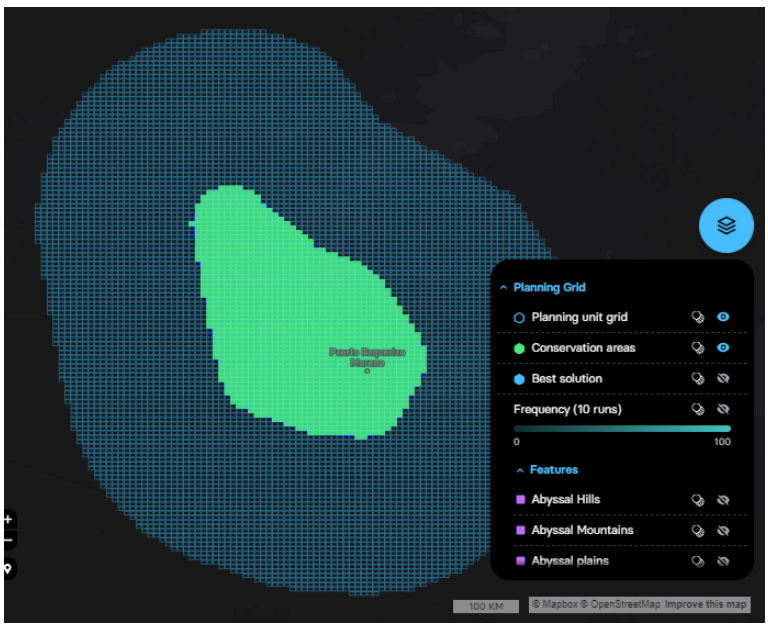
We have already added the Galapagos Marine Reserve to the scenario. Go to the "**Grid setup**" and select **Conservation Areas.** From the dropdown menu select "ReservaMarina." You will see the boundary appear on the map. Press **Continue.**



You can set a threshold for what planning units are considered “protected” by looking at their coverage from a Protected Area boundary. Use the slider to see how different values influence the boundary. Set a threshold of 50% and Save.



The areas locked in by using the threshold will appear in the right map as light green “Conservation areas”.



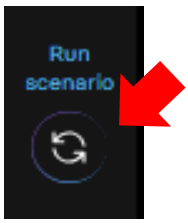
Then follow the same process as in Scenario 1:

1. In the Features Tab, select “Set Up Features” and then click “See details” to view and “Edit” adjust targets.
2. Set “All Targets” to 30% and “SAVE”
3. In the Features Tab, view **Gap Analysis** results.

Question: How well does the Marine Reserve protect all your features?

Are there features that are not adequately conserved with the existing reserve? Which ones?

Calibrate the BLM and **Hit RUN Scenario! Then view your results.**



Question: Do the results (selection frequency and best solution) differ compared to the solutions from Scenario 1? How about the costs?

Scenario 3 – Galapagos with Cost

Now we are going to introduce a different cost consideration into the plan. In the last two scenarios, we used the planning unit area as a cost with the intention of meeting targets in the smallest footprint possible.

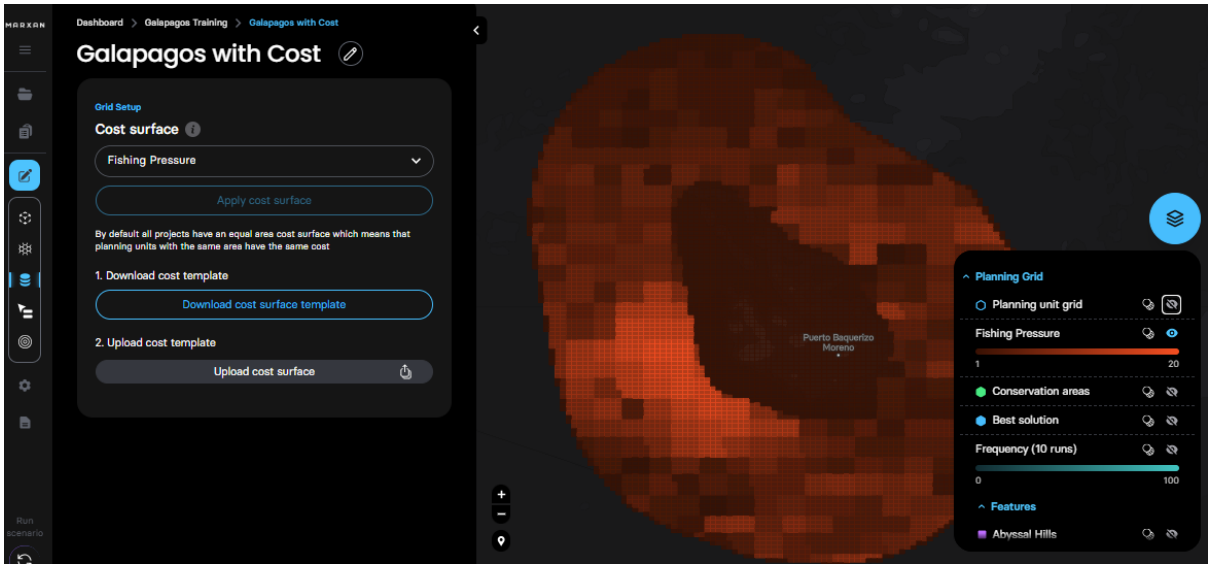
We are now going to introduce a new cost estimate – a cost to the fishing industry. This is a layer which reflects the economic value derived within a given cell for the two primary fishing fleets operating in the Galapagos: the artisanal long-line pelagic fleet, and the industrial tuna purse seine fleet.

Because there is no fishing allowed in the marine reserve, the cost is negligeable and so Marxan will preference meeting targets in these low-cost areas.

1. Go to Scenario 3- Galapagos with Cost

1. Selecting a cost surface

To view the cost surface, you can go to Grid setup → Cost surface. There you can find a preloaded customized cost surface, containing the fishing values per each planning unit. Go to the dropdown menu and select “Fishing Pressure.” Then click “Apply cost surface.” The cost surface chosen will appear on the map for visualization.



This is a duplicate scenario to the Baseline: Features only scenario with no MPAs locked in, 30% targets and a BLM of 0.251. We will now look at how adding a cost changes the solutions.

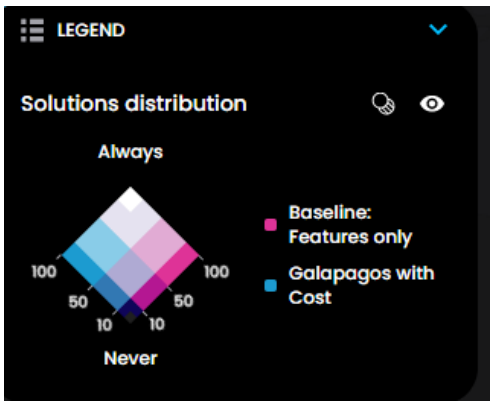
2. Run Marxan in the Parameters panel and view the results.

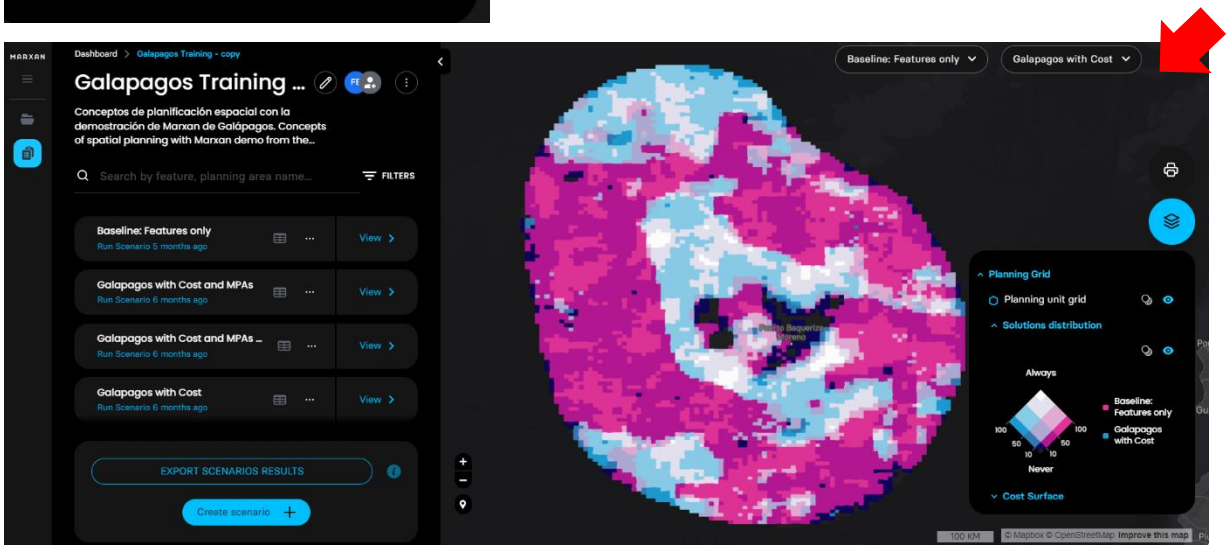
You can take screen shots of the Baseline: “Features Only” results and the “Galapagos with Costs” and view the difference. What impact does the cost surface have on the results? Feel free to also examine the solutions table.

3. Compare multiple scenarios

If you want to explore a visual comparison, you can return to the Scenario´s Dashboard. In the viewer panel on the right, you can create a **“Difference Map,”** which helps you

understand how Selection Frequencies change from scenario to scenario. Also, you can download a PDF with this map for further exploration.





Scenario 4: Galapagos with Cost and MPAs.

Now let's look at how the Features, Costs and the existing Marine Reserve all influence the solutions.

Go to **Galapagos with Cost and MPAs** from the scenario dashboard **and explore this scenario.** Here, we have ensured the Marine Reserve is locked into the solution, and will try to meet targets while minimizing impacts on the high value fishing grounds.

You be getting quite familiar now with how Marxan works. Feel free to explore other functions and parameters in this scenario. For example, try changing targets for species to be higher than 30%. What do you think is a sensible target for mobile species in the Galapagos?

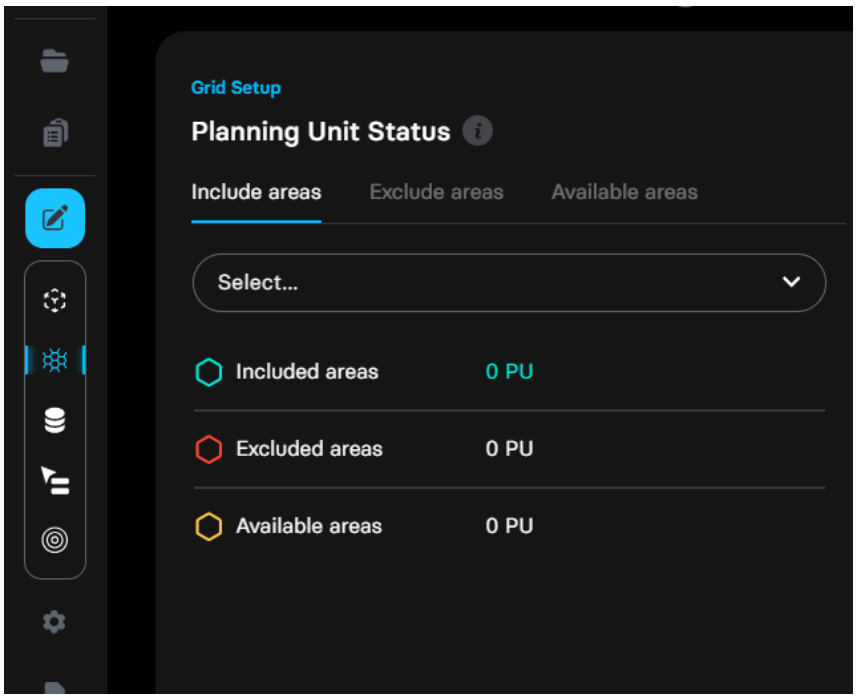
Sometimes, when planning a conservation network, some areas cannot/should not be protected or included in the solution. When planning units are excluded from the solution, they are "locked out" of the solution. You can manage the status of each planning unit, making them locked in/out or available in the **Grid setup → Planning Unit Status.**

Question: Can you think of some reasons why an area might not be included in a protected area network?

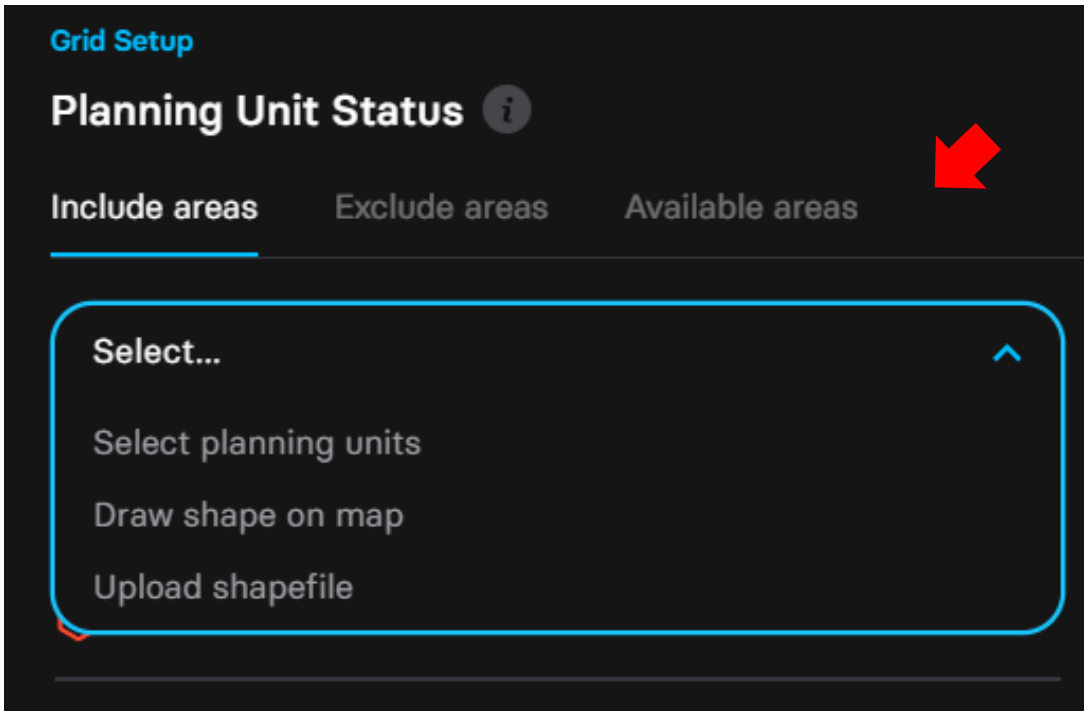
1. Adjusting planning unit status

How to lock in, lock out or make a planning unit available again in the Marxan Planning Platform

You can set statuses in the **Grid setup** -> **Planning Unit Status (optional).**



You will find three tabs, one for including areas, one for excluding and another for making areas available. Each of those tabs has three options: 1) *Select planning units* (you select manually which units you want to include or exclude); 2) *Draw a shape on map* (you manually draw a shape to set the areas you would like to exclude or include); and 3) *Upload shapefile* (you upload a vector polygon GIS file with the areas you would like to exclude or include).



Once you have selected your planning units to lock out/in/available, click the ***Save selection*** button.

Don't forget to go to the parameters panel and Hit RUN! Explore your results, compare solutions, etc.

BONUS Scenario: Galapagos with Cost and MPAs-Hermandad

We also added a scenario where we locked in the newly established Hermandad migration corridor - connecting the Galapagos with the Cocos Islands.

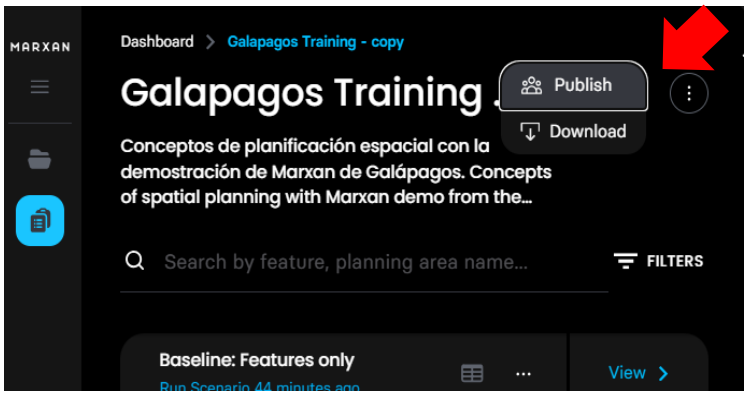
You can see this newly included area in the Conservation areas tab. Continue to explore changing targets and parameters and viewing the results. Ask yourself questions about missing targets, SPF, costs, and BLMs. These are all interacting to deliver good solutions.

Question: What important information can you derive from this exercise about feature representation and MPA coverage?

Making your project public

In MaPP, you can share your project by publishing it in the public domain. In this tutorial, we will show you how to make your project public so that anyone, anywhere, can see it and

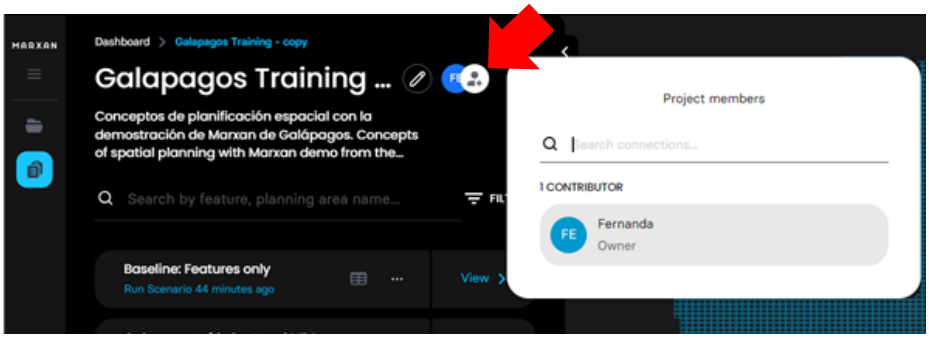
learn from you. Go to your main project page and click on *Publish.* Fill in the form and click *Publish*. You will find your project on the community page. As a project owner, you can delete the project from the community page if needed.



Sharing your project

In MaPP, you can privately share your project with your team, partners, or stakeholders. In this tutorial, we will show you how to share your project with selected people so you can engage more people in the planning process. For this, all the people to whom the project will be shared must be registered on MaPP. Go to your project page, click on the “add people” icon, and search for the user's email account to be added. The users can be added as owner, collaborator, or viewer, with different permissions as follows:

- Owner- Can create/edit/delete scenarios and edit/delete/publish/share the project.
- Contributor – Can create/edit/delete scenarios; it´s not allowed to edit/delete/publish/share the project.
- Viewer - Can only visualize content.

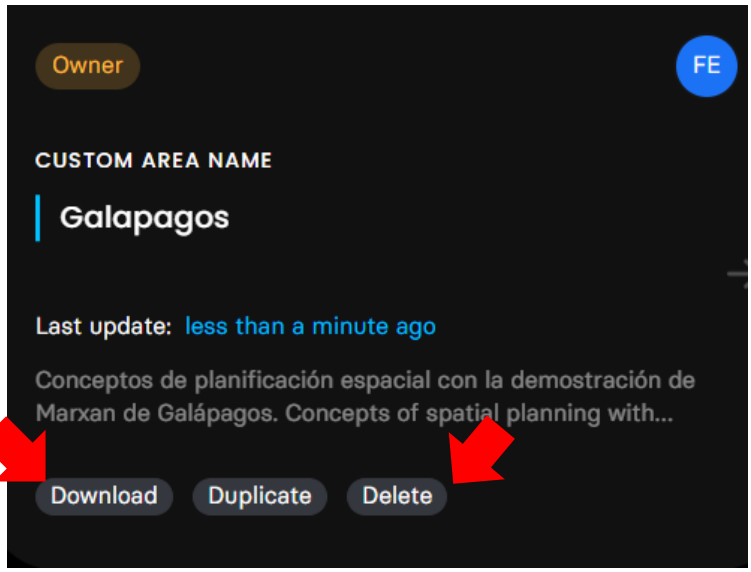


Creating a new Project

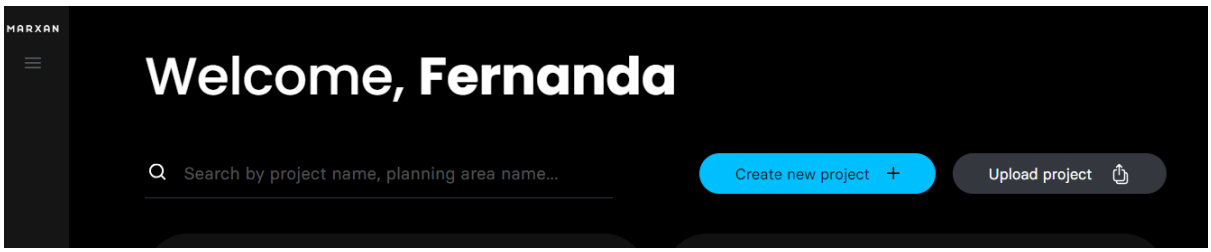
Unless you are using a project uploaded by a member of the Marxan community (as the one described above and used for this tutorial) or working with an existing project setup by someone else (for example, a member of your team working on the same project), the first step is to create a new project.

It is important to note that unless you share your projects with others or publish them publicly, the project and all the information you upload are private and only available to you. You can allow selected people (registered users only; you can find them by typing the email they used to register in MaPP) to view, edit, or co-own your project. Only project co-owners can delete projects or scenarios; project editors can add/delete data (if not used in any scenarios), create new scenarios, and modify existing ones.

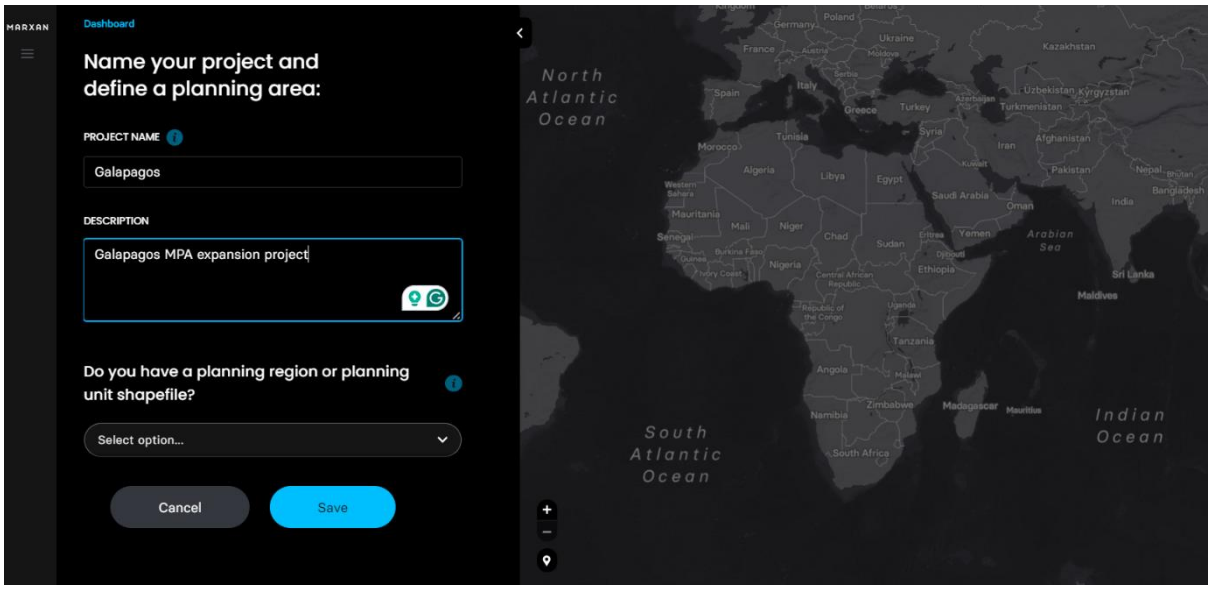
Important note: All projects and data are stored on the cloud, and thus, valuable resources are used, even if not used. If you are not using a project anymore, please delete it from your dashboard. You can download and upload a copy later to work on it again. You can download or delete projects by clicking the corresponding buttons under each project in your dashboard. For this tutorial, please delete the project once you have finished all activities and are not using the project anymore.



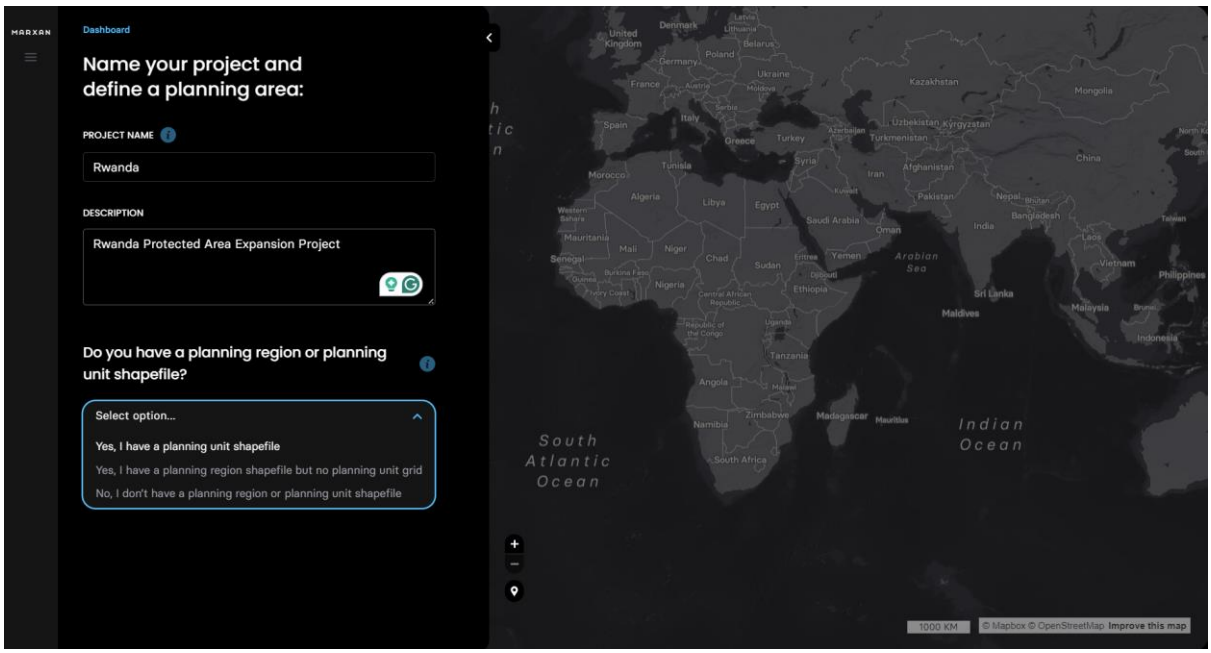
You can create a new project by clicking on '*Create new project*' in your Dashboard.



Enter a short but meaningful name for your project (e.g., Galapagos tutorial); remember, this is the only thing you will see in your dashboard. Now, add a brief description of the project; this is a high-level description of your project. For example, you could indicate it is a tutorial about expanding Galapago's protected areas. Note that each scenario will have its name so you can add more details and relevant descriptions to that section.



Besides the name and description, you need to create a spatial definition for your project, i.e., the planning region (a.k.a. planning area or planning domain). You can use your map (zipped shapefile) to define the boundary of your planning region. MaPP supports layers in projected coordinate systems, but using a geographic coordinate system is better. Verify the map has no overlapping polygons and always check and repair geometry problems using GIS software before zipping and uploading any shapefile in MaPP. Below is a summary of the three options available in MaPP to create a spatial definition for your project.



Yes, I have a planning unit shapefile.

If you have an existing planning unit grid, upload it by clicking the first option and following the instructions. The platform will prompt you to import the grid, enabling project creation based on the boundary of your predefined units. When uploading a planning unit grid, please ensure that there are no overlapping units and that the grid creates a continuous surface, ensuring no accidental (unintentional) gaps between units. Also, it is advisable to create a planning unit ID (name: 'puid,' type: long) with a unique number per planning unit, corresponding with the number of planning units in your grid.

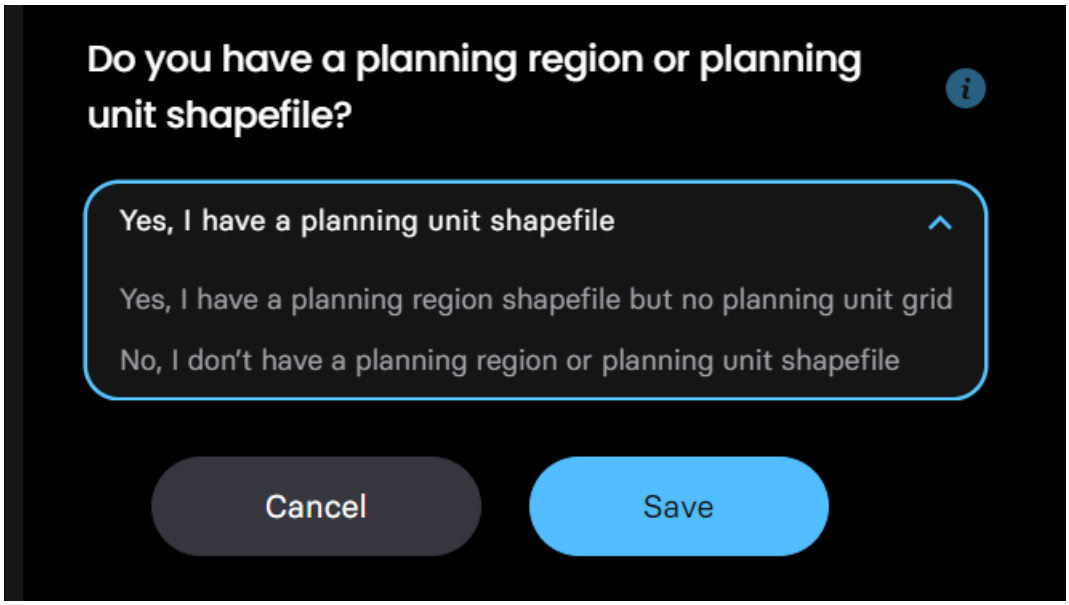
Yes, I have a planning region shapefile but no planning unit grid.

Alternatively, you can upload a shapefile of the planning region, and the platform can automatically generate a planning unit grid based on the designated area. This option can be helpful when you are unsure about the size of planning units and have no particular reasons to use a grid that aligns with existing data or other planning efforts. MaPP will suggest a default planning unit size (given in square km) appropriate to your planning region's extent and will maximize the performance of spatial analyses and visualization. However, you can increase or decrease the planning unit size based on your planning requirements and input data, such as the spatial resolution of your input data, the scale of the conservation interventions, etc.

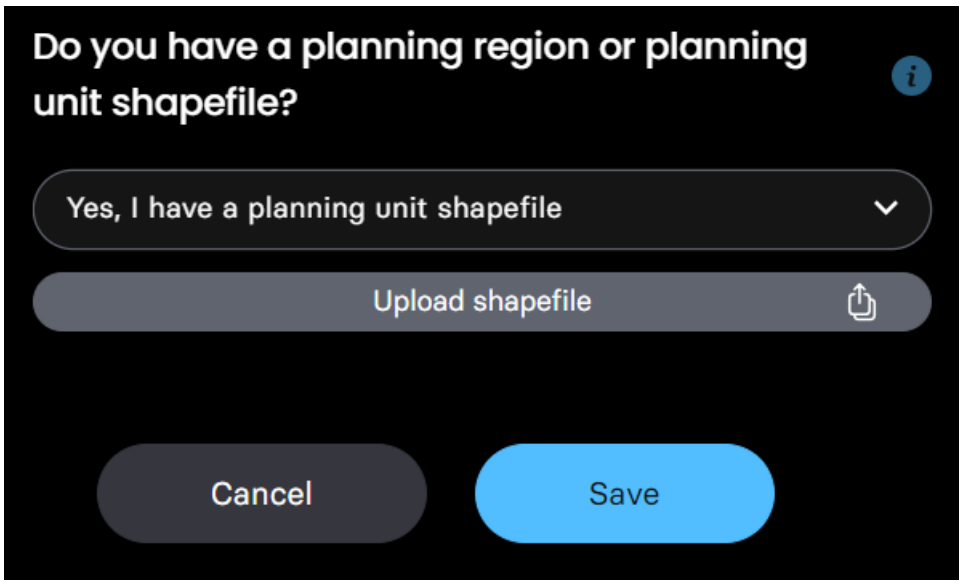
To upload a planning unit grid or a planning regions shapefile, you must provide a zipped file with all the minimum files to work in any GIS software (.shp,.shx,. prj, .dbf).

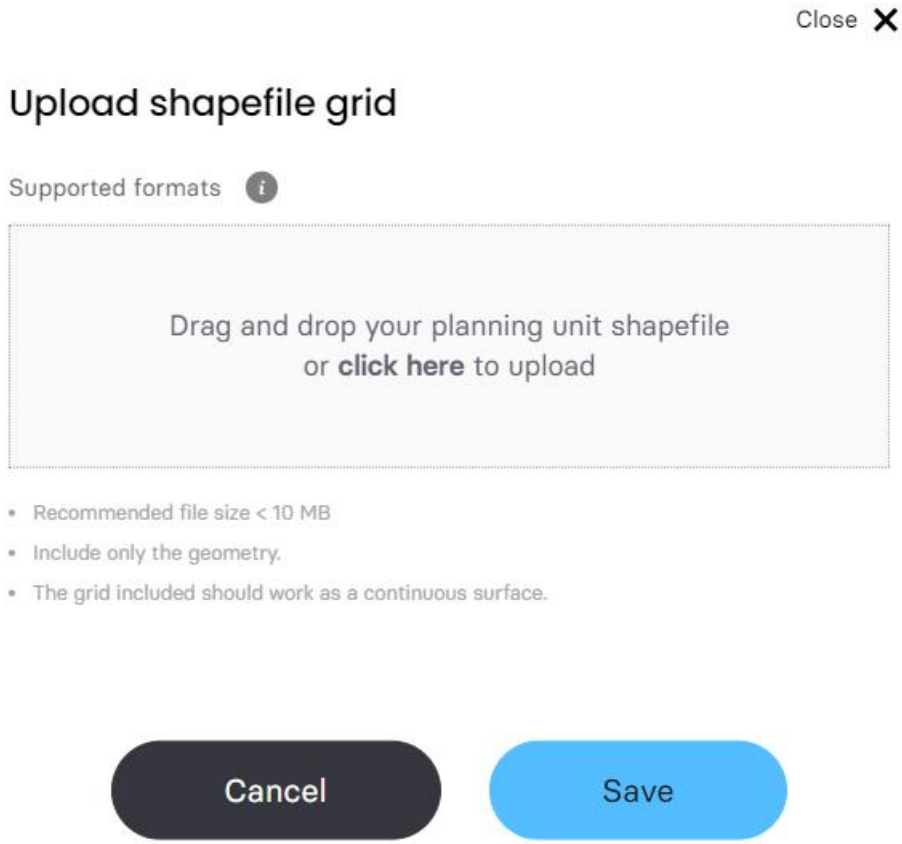
No, I don´t have a planning region shapefile or a planning unit grid.

In cases where you lack a planning unit grid or region, you can indicate geopolitical boundaries (e.g., country, region, state) and then create the planning unit grid within the platform, allowing you to define the spatial structure according to your geopolitical specifications. Notice how the planning unit size changes as you select smaller political boundaries.

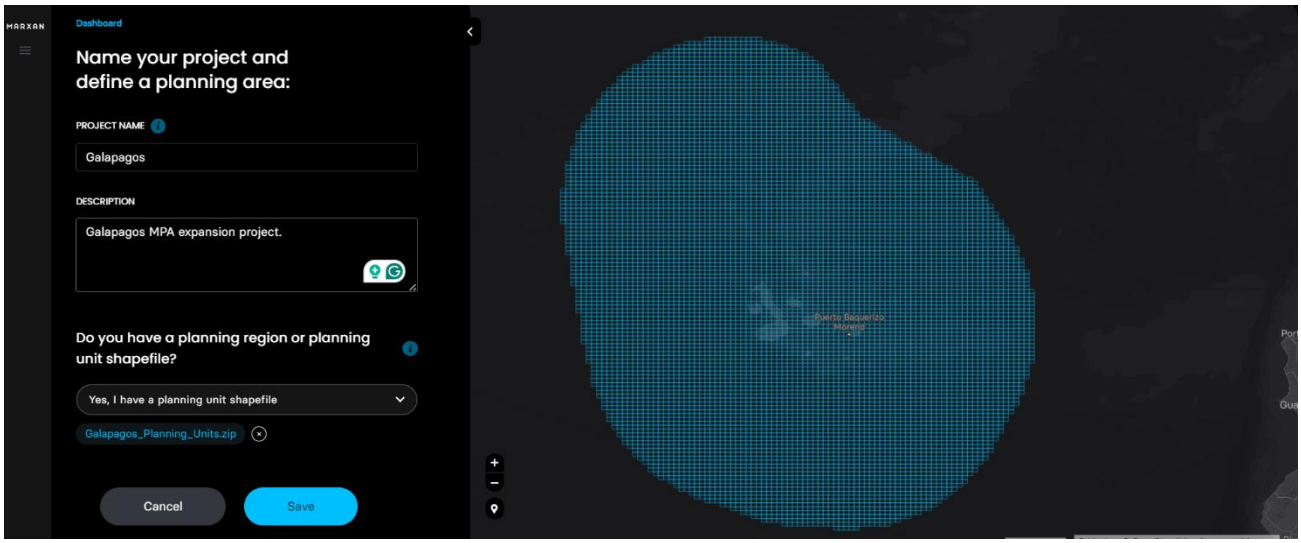


Click to upload the shapefile and follow the instructions…

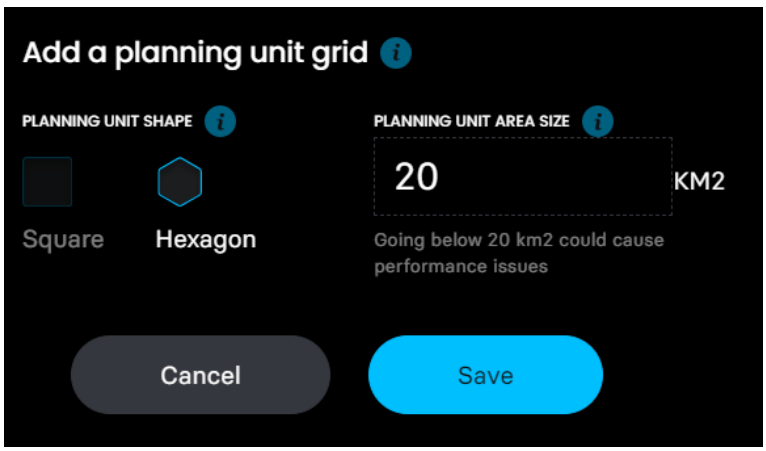




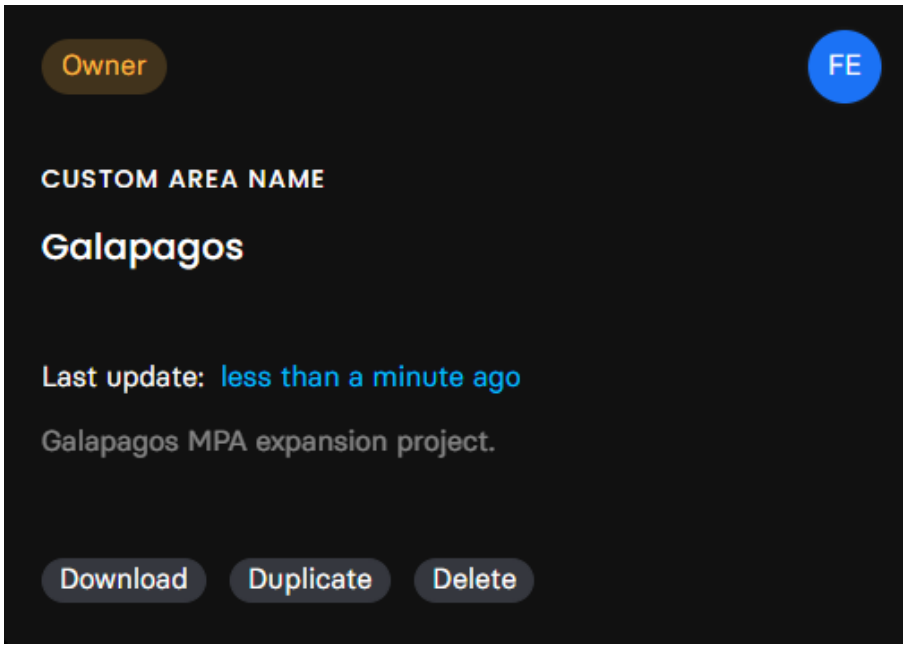
MaPP will add the grid to the map, creating the project when you click save. Remember, the planning grid is set at this stage and cannot be modified. All your scenarios will be built upon this grid. If you wish to explore other grids, such as smaller or different shapes, you have the power to create a new project. Stay informed by reading the messages at the top right of the screen, as they will guide you through MaPP's actions and the next steps.



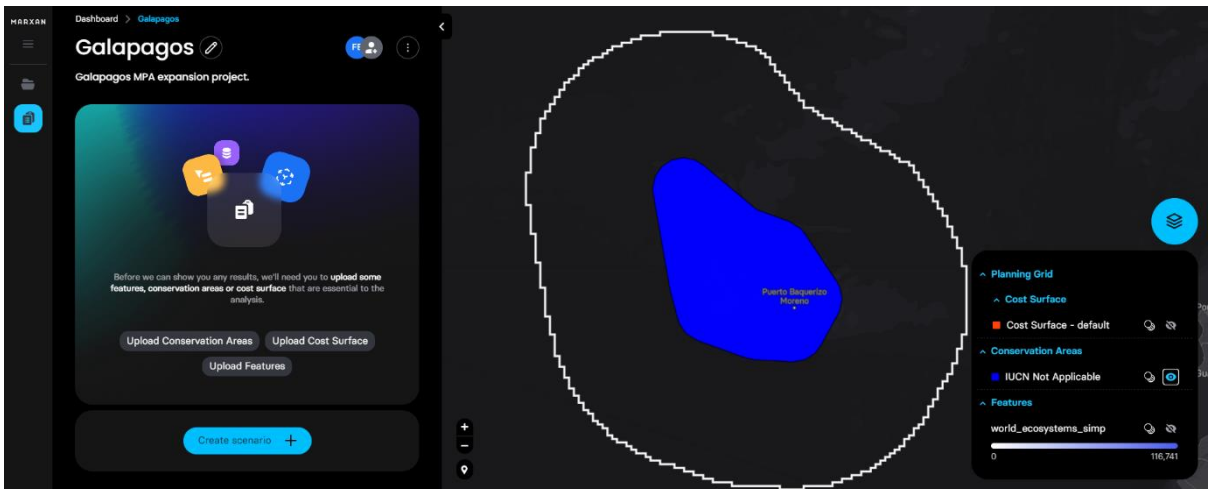
Suppose you are creating the planning unit grid in the platform (e.g., uploading a zipped file of the shapefile delineating the boundaries of your planning region). In that case, you must choose your planning units' shape and area size. You can select between squares or hexagons for shape. If you are unsure about which shape to use, it is advisable to use hexagons as they will provide more flexibility in the designs (can connect to mode adjacent units than squares), align better with the natural curvature in spatial data (e.g., vegetation boundaries), and are helpful for point data (e.g., species occurrences, populations). The platform will suggest a minimum size regardless of the shape of the planning unit. This minimum planning unit area suggestion is based on the size of the planning region and the computational capability to handle a large number of planning units. You must upload an external shapefile to use planning units smaller than 1 km^2 or with different shapes (e.g., parcels, subcatchments).



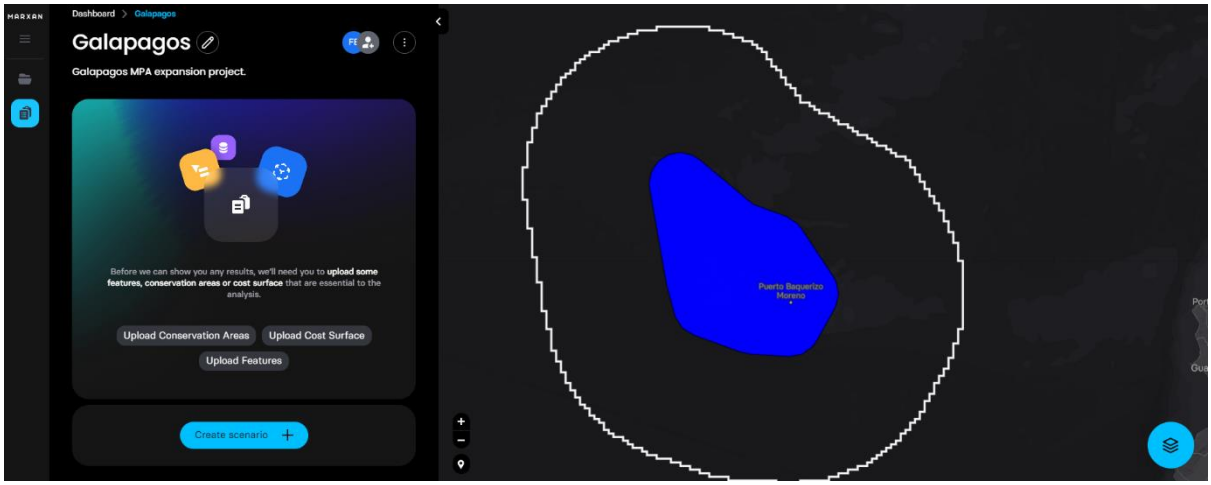
You are ready to start working on your project and adding new data! You should see your newly created project in your dashboard (MaPP will automatically redirect you to it after saving your project). To start working on your project, click on the name of your project to open it; you will notice a blue line to the left of the project when hovering over it. You will be the project owner by default, but you can share it (see details in the Sharing your project' section below).



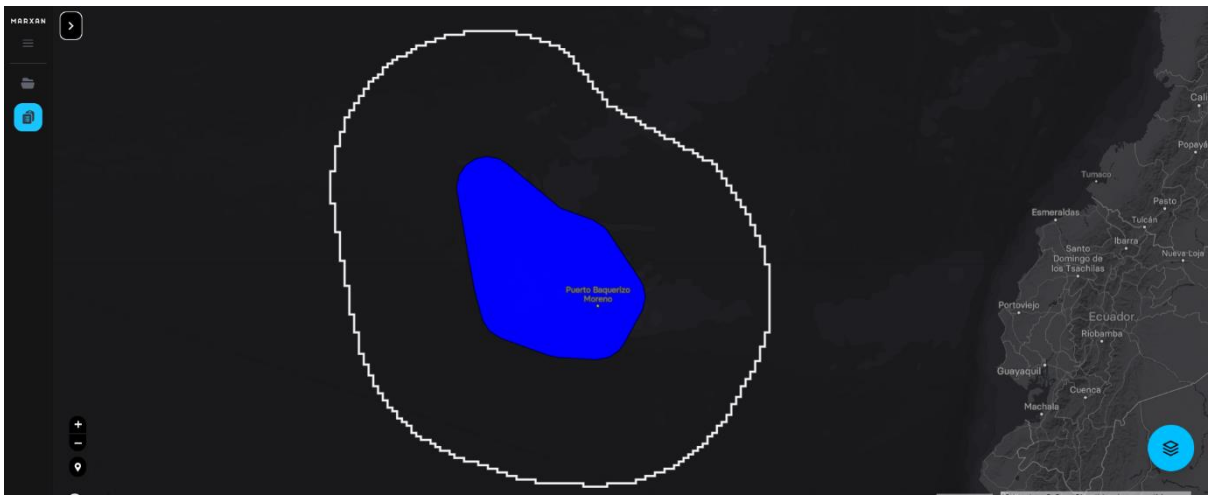
Upon opening your project, you'll have the option to start creating scenarios right away. You'll also notice the preloaded layer of protected areas (WDPA). Don't worry; we can ignore this preloaded data for now. This is the most common approach, and you're more likely to follow and use your data, making the platform more tailored to your needs.



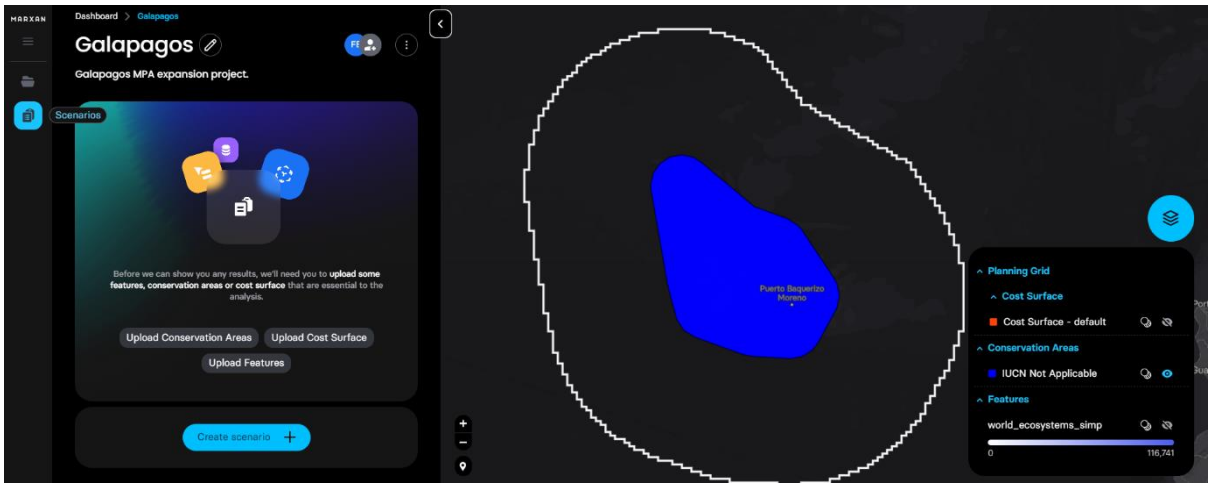
At this point, it's important to test a couple of functions in the platform: first, you can easily minimize the legend by clicking on the blue icon of the stack of layers at the top right of it.



You can also minimize the left panel by clicking on the white arrow at the top right and then clicking again to restore it. Minimizing these elements will allow you to explore the map across your entire screen, which can be helpful when looking at your data and results in more detail.



For now, restore both. Click on the ‘folder icon’ on the left section of the platform to open the inventory panel and add some data. When you hover the mouse pointer over an icon, you will see text indicating which icon to open the inventory panel.



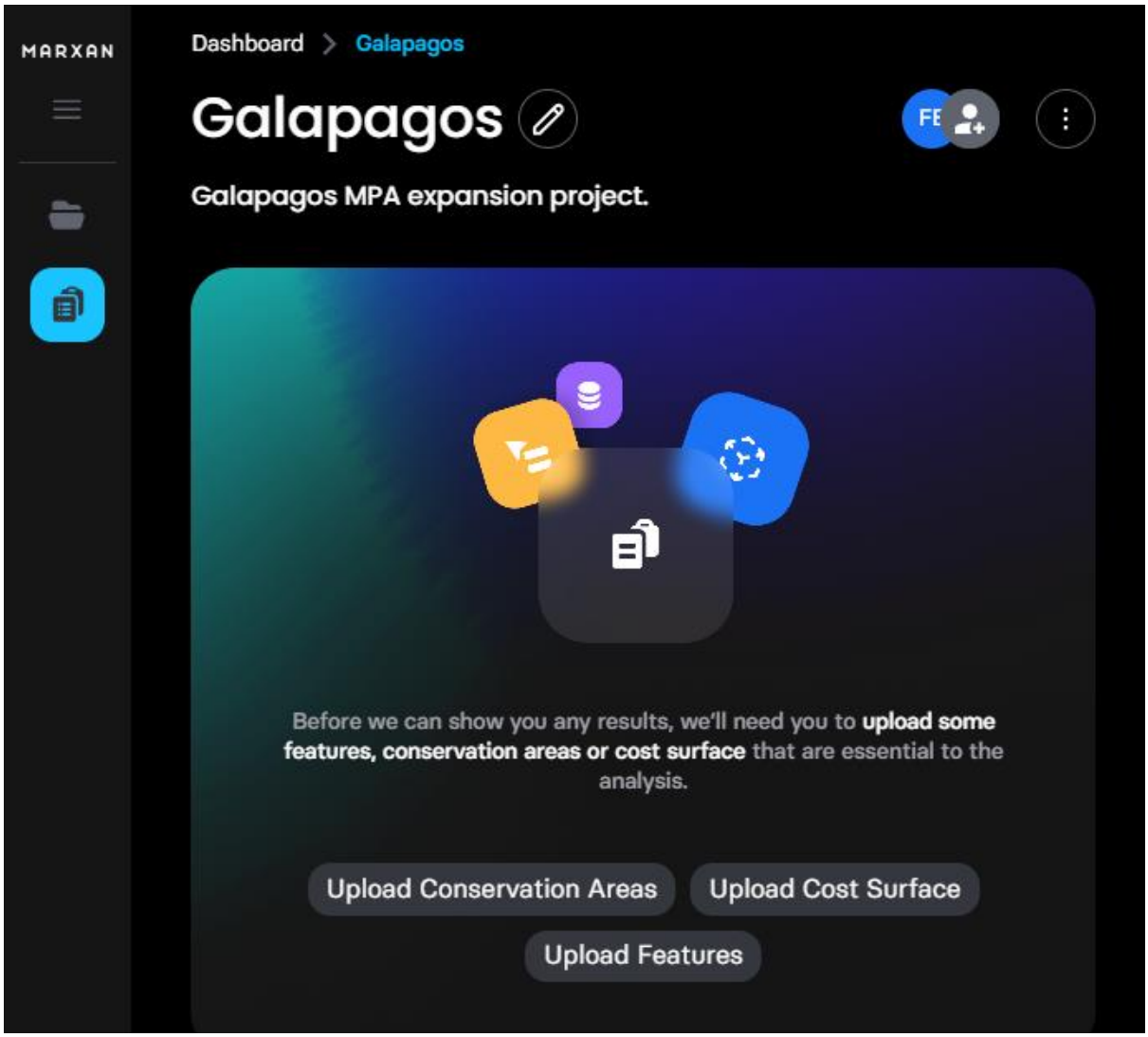
When clicking on the icon, you will see a dropdown menu corresponding to the three data types you can add to the inventory: conservation areas (e.g., maps of existing protected areas), cots, and conservation features.

Inventory Panel

In most planning exercises, spatial data will be used in different ways (e.g., different scenarios) to explore the effect of various inputs and select the most appropriate data and the final setup to identify conservation priorities. The Inventory Panel is designed to centralize and manage all crucial information required for effective scenario building. This includes features, protected areas, and cost layers. The Inventory Panel provides tools for efficient file management, allowing for viewing, editing, and deleting files and adding/filtering/bulk editing using the *feature tagging system*. It is advisable to think carefully about the information that will be added to the inventory and only add data that will be used in a prioritization scenario. The panel is not a substitute for a GIS to store and visualize data being considered and refined for spatial prioritization. Also, note that each project has a single extent and associated planning unit grid, so all scenarios will be created within those constraints. There are ways to work with subsections of the grid, but not with different planning unit shapes or sizes within the same project.

2.Conservation areas:

Let us start by adding a map of existing protected areas in Galapagos, which we have created, checked for quality, and zipped. It is advisable to remove any fields that are not critical; for example, for protected areas, you may want to know the name, category (e.g., IUCN), and type (e.g., national park, forest reserve). You won't be able to explore or modify this information in MaPP; the smaller and less complex the Shapefile, the better. You can keep a copy of the complete data for external use in GIS software.

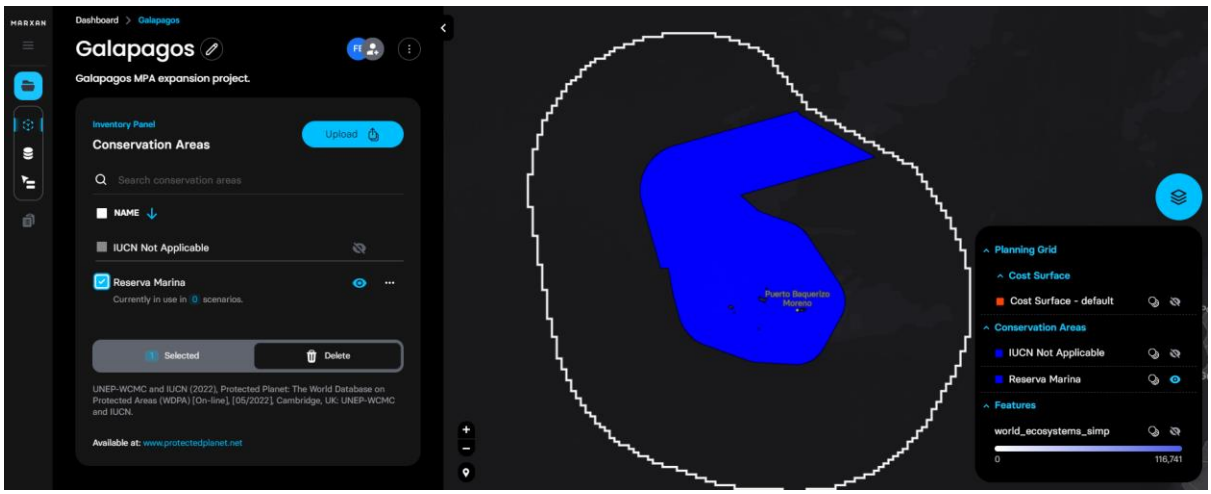


The Conservation Areas section allows users to add units to assess the contribution of existing conservation efforts and, if desired, to lock in planning units in scenarios, which can be based on protection status. For example, users may decide to consider or lock in all existing protected areas and other effective conservation measures (OECMs) or use those with higher levels of protection (e.g., IUCN categories I and II) or a subset of conservation

areas that are deemed appropriate to conserve the features of interest or, more generally, that would contribute to the conservation goals and targets set in the project (e.g., based on governance, known effectiveness or enforcement/compliance, etc.). Users can choose between pre-uploaded IUCN areas or upload their shapefile. Access the "Upload Conservation Areas" tab in the Inventory Panel to upload a custom shapefile.

Upon opening this section, you gain control over the layer of preloaded conservation areas. You can toggle this layer on and off, visualizing it on the map by clicking the eye icon. You'll also notice that the legend updates automatically when you toggle the preloaded conservation areas.

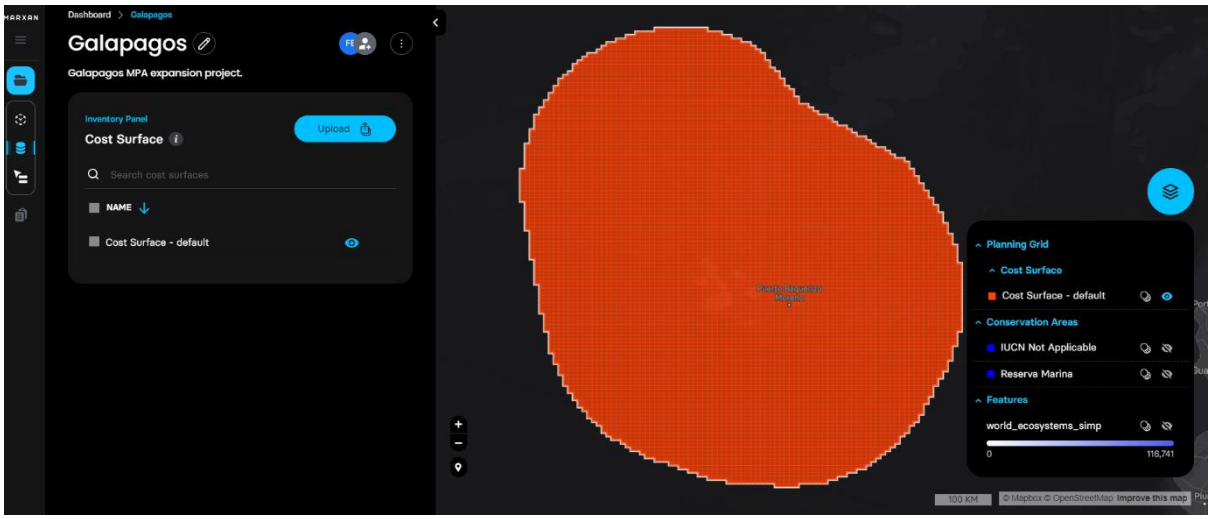
Click on the upload button to add the zipped file; at this point, you can also name your layer of conservation areas. This feature is helpful because you may want to create different scenarios using different layers of conservation areas, for example, to compare scenarios where distinct sets of conservation areas are locked into your system for conservation areas created in MaPP. As a tip, use simple names that relate to the nature of the conservation areas, for example (Highly protected areas, highly effective areas, Only reserves, etc.). Remember, the conservation areas should be relevant to your planning goals and the type of conservation interventions/actions considered (e.g., current reserves if you prioritize areas for strict protection; restoration areas if you optimize restoration efforts).



Once uploaded, you will see the file and name, and you can click on save to process the layer in MaPP.

3.Cost Surface:

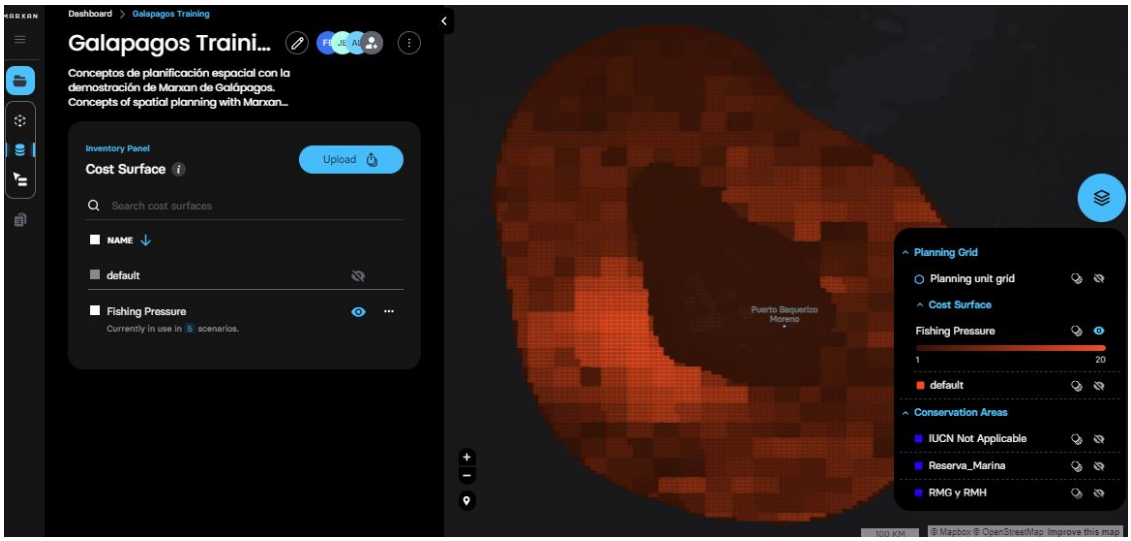
The next step is to upload the cost layer(s) used to minimize the conservation costs. Here, you can upload/edit/delete cost layers that will be considered throughout the scenario planning. Please note that once a cost layer is used in one scenario, you won't be able to remove it unless you delete it from all scenarios using that cost layer or delete those scenarios. By default, the platform will create a uniform cost layer based on the area of your planning units, which you can visualize after clicking the cost icon.



While MaPP uses "equal area" as a default cost, you can customize and upload different cost surfaces. Access the "Cost Layers" tab in the Inventory Panel and download the cost shapefile template. Work in a GIS to extract cost values per planning unit, leaving only the puid and cost (both lowercase) attributes. Upload the updated cost shapefile to integrate custom cost layers.

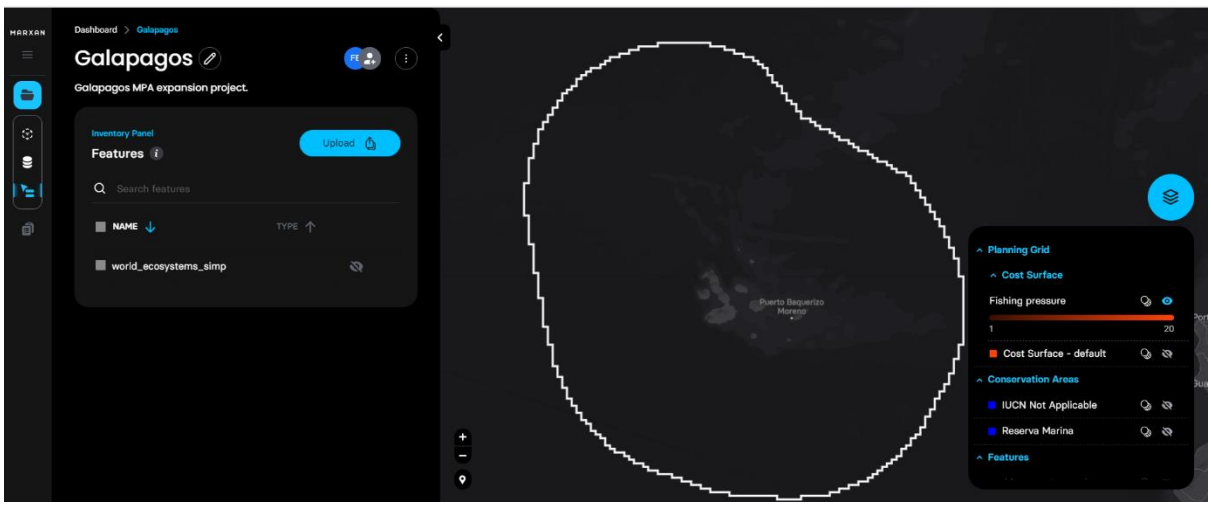
You must also provide a name for each cost layer you upload. As before, you should use a simple but meaningful name that you can then use to identify which cost layer is used in each scenario. Once you see the uploaded layer, click save to continue.

Now you can visualize your cost layer by clicking the eye icon on the left panel…



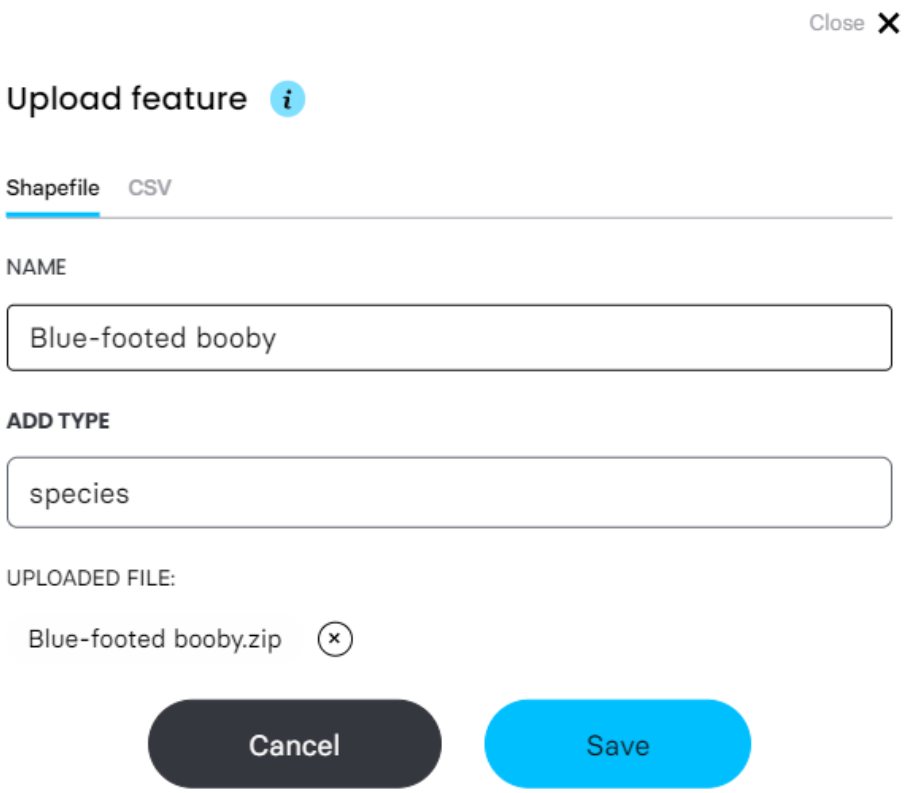
4.Features:

The next step is to upload the layers that will be used to represent the spatial distribution of the features of conservation interest. Here, you can upload/edit/delete feature layers that will be considered throughout the scenario planning. Please note that once a feature is used in one scenario, you won't be able to remove it unless you delete it from all scenarios using that feature or delete those scenarios. The Features section lets users upload elements using zipped shapefiles or CSV files. Navigate to the "Features" tab within the Inventory Panel.



For CSV files, ensure proper formatting (comma-separated values) with puid and feature values. The procedure for obtaining the feature values per PU is similar to the cost surface. Download the shapefile template, work in a GIS to extract feature values per planning unit and save them as CSV. Upload the CSV file.

You will need to provide a name for each feature layer that you upload; as before, you should use a simple but meaningful name that you can then use to identify which feature was used in which scenario(s). A piece of additional information you can add to each feature (and it is advisable to do it) is a 'tag' to identify the type of feature (e.g., species, habitat, ecosystem service, cultural site). Creating a system in advance that will help you classify, group, and edit multiple features simultaneously is advisable. The tagging system's primary goal in MaPP I is to allow filtering, editing (e.g., targets, SFP), and deleting groups of features with the same tag. Once you have used a tag, you can select that tag for other features, which facilitates tagging new features and avoiding mistakes when tagging. Once you see the uploaded layer, click save to continue. In this case, you have layers representing ecoregions and mammal species.



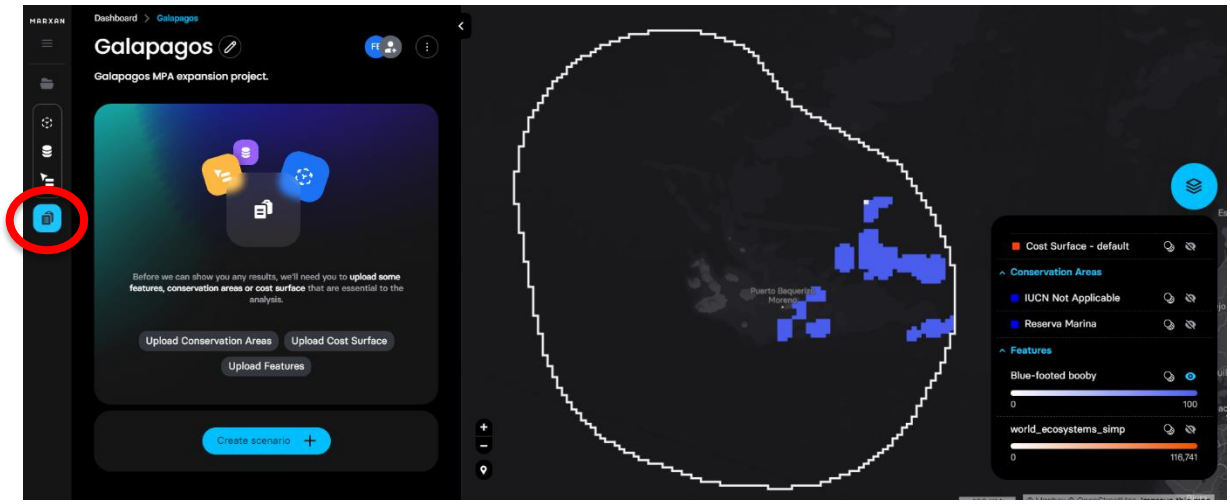
Once each layer is uploaded, the name and type (tag) will appear on the left panel. You can edit the name or tag and delete the feature (before it has been used in any scenarios).

Once all your features are named and tagged, you can sort them in the inventory panel by name or tag by clicking on arrows at the top of the table. If you click on any of the tags to the right of any feature, you will automatically apply a filter, and you will only see the features associated with that tag. By clicking on the X, you can remove the filter. You can also turn on/off each feature to visualize it on the map.

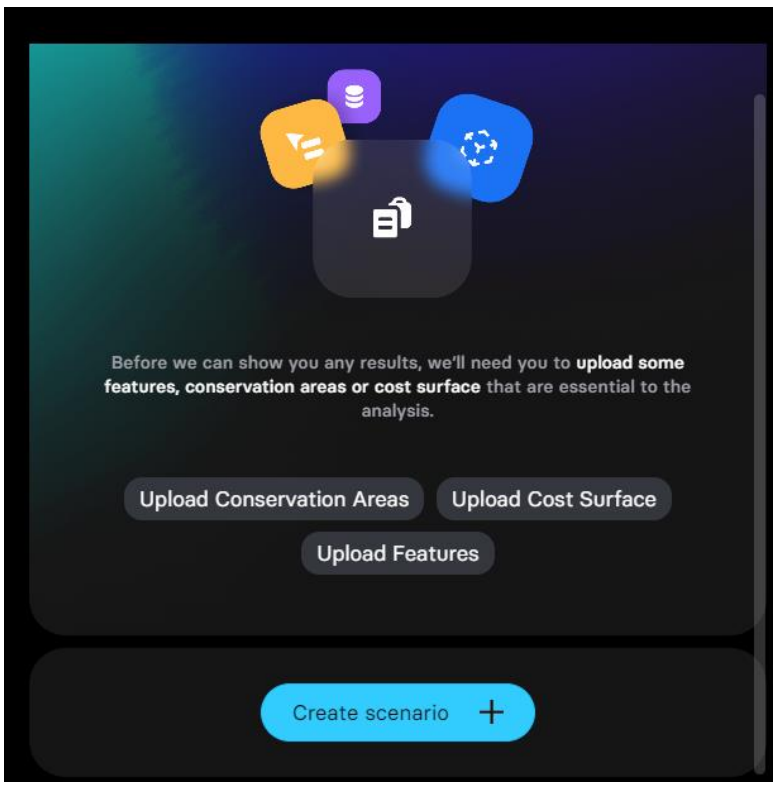
Now, you are ready to create your first scenario!

Creating a new scenario

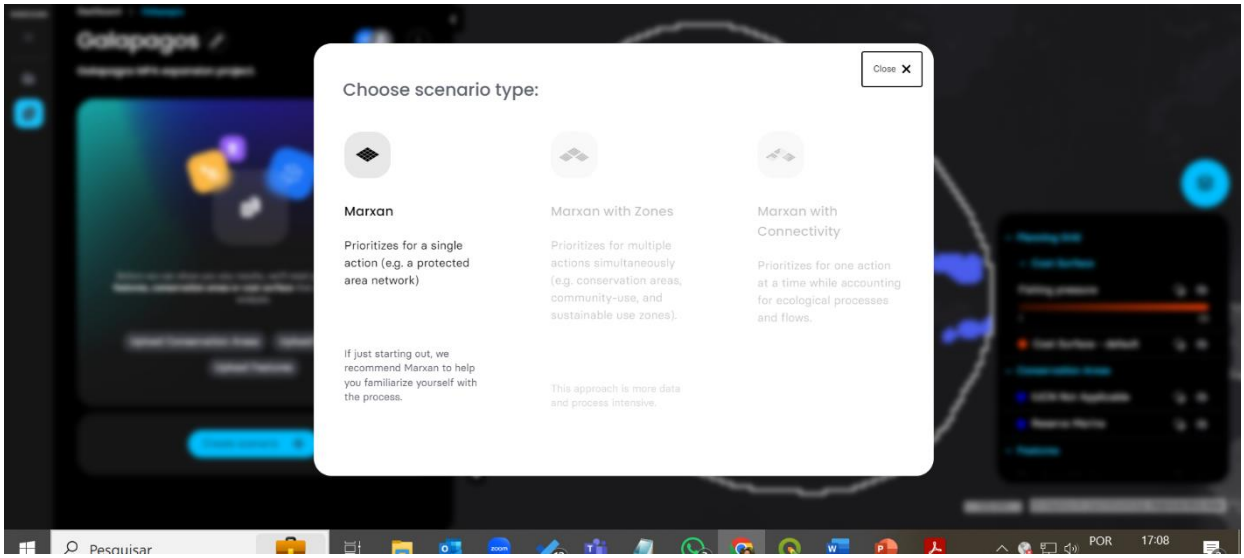
To start creating a scenario, navigate to the scenarios section by clicking the scenario icon at the bottom of the left panel.



Once you open this section, you can start creating your first scenario. Please note that we have already uploaded all the required data (conservation areas, features, cost) for this case in advance. Still, you can also create a scenario and use this step to upload data specific to that scenario. This data will be automatically added to the inventory panel and thus can be used in other scenarios.

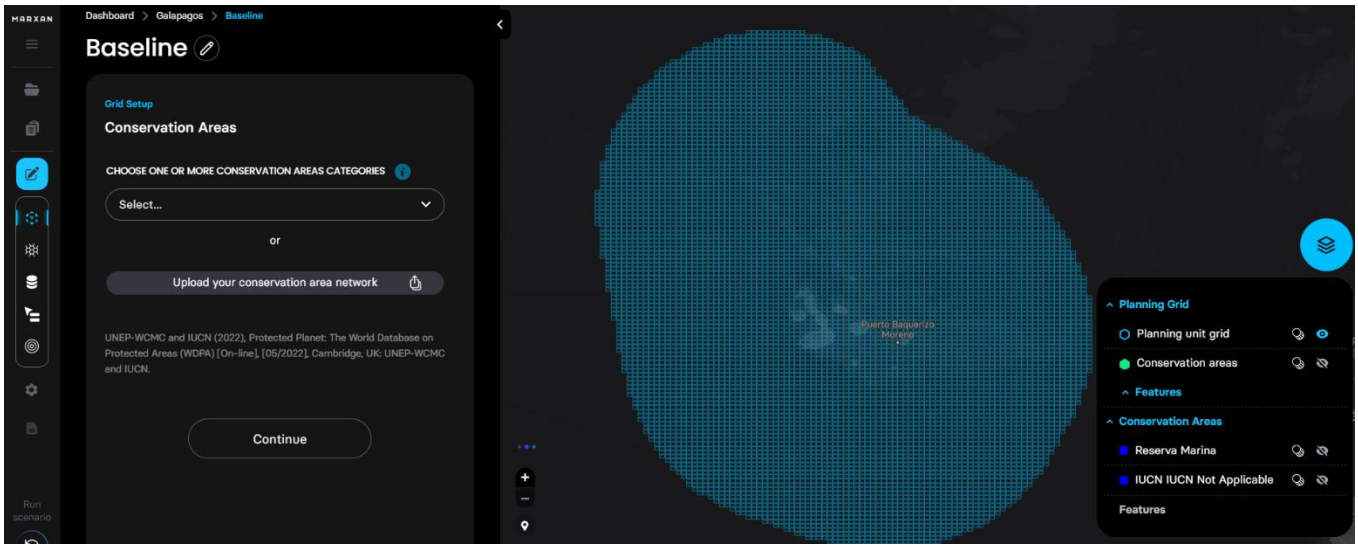


Press the "Create Scenario" button and choose the Marxan option. Navigate through the left bar menu for Grid setup, Marxan settings, Run scenario, and Solutions. Please note that the options to use Marxan with zones and Marxan with connectivity are not available yet.



When you access this scenario, you will find a left bar menu with three functionalities: (1) Grid setup (more details pages 9, 22, 25, 27), (2) Marxan settings (page 13), and (3) Solutions (page 17). These are the three stages in the MaPP workflow; you will follow them whenever you create a scenario.

Once the scenario is created, you will see your grid, the scenario's name, and the ability to turn on/off the map of preloaded conservation areas.



Now you´re ready to customize your scenarios and run Marxan with different settings. Have fun!