

User manual



V1.0

<https://water-proof.org>

The Nature
Conservancy 

Contenido

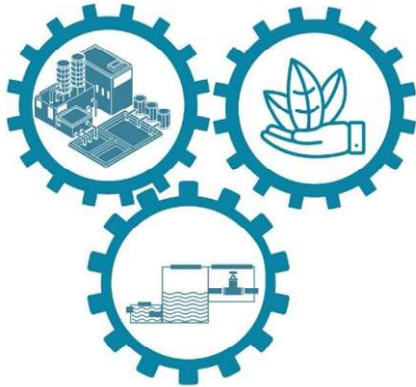
Main page.....	4
1. Preliminary exploration.....	5
2. Register.....	5
3. Main menu	6
4. Search your city	7
5. Nature based Solutions	9
6. Create a Case study.....	11
7. Water intakes	11
Location.....	12
Infrastructure	12
Water demand	15
Implementation area of the NBS	16
8. Create a Treatment Plant.....	18
Add new technology	19
9. Cost Functions	20
Advanced options.....	21
10. Develop a case study.....	23
Definition.....	23
Carbon market	24
Portfolio objectives	24
Modeling parameters.....	24
Financial parameters.....	25
NbS activities.....	26
Analysis parameters	27
11. View reports	28
12. Share your case study	36
13. My Case studies.....	36
14. Compare case studies	37
15. Contact us:.....	39

What is WaterProof?

WaterProof is a tool for developing ROI assessments at pre-feasibility level and is designed to provide users interested in NbS with the ability to develop high-level ROI estimates for portfolios of potential NbS investments. The tool has been configured so it can be applied anywhere globally.

The first version (WaterProof V1.0) places special emphasis on ROI analysis for drinking water supply systems, but the system is flexible so that it can incorporate other infrastructure types in future versions.

WaterProof relies on a **case study** format that relies on user-defined inputs for water intakes, treatment plants and the portfolio implementation objectives. These inputs are used in the following manner:



- WaterProof relies on the geographic location of water intakes to delineate the basin area in which the NbS portfolio will be implemented
- User-defined inputs for the **water intake and treatment schematic** are required to inform how the ecosystem services provided by NbS translate into cost savings for infrastructure operation and maintenance; these calculations inform the monetized benefits in portfolio ROI estimation.

System requirements

Please ensure that your computer meets or exceeds the following system requirements before using WaterProof.

RAM	64 Gb
Available disk space	700 MB
Internet explorer	We recommend the use of Chrome in its version 96.0.4 or higher
Speed of your connection	Verify that you have a connection of at least 5.0 Mbps download

The TNC team is attentive to answering your questions and accompanying you in the configuration of your case studies. Do not hesitate to write to us at the email account casesupport_waterproof@tnc.org

Main page

To access WaterProof, visit the link <https://water-proof.org>. The header image provides a link inviting users to start compiling their own case studies.

The screenshot shows the WaterProof website homepage. At the top, there is a navigation bar with the WaterProof logo, links for Home, About us, and Take action, and options for Register and Sign in. The main header features a large image of a boat on water with the text "Begin your Nature based Solutions journey" and a "Start now" button. Below this is a section titled "What is WaterProof?" which includes a brief description and five icons representing different stages: "Before starting", "What is a case study?", "Support data", "See an example", and "Who can use the system?". The next section, "Why use WaterProof?", lists five benefits: Fast, Compelling, Customizable, Free, and a commitment to equipping local NBS actors. This is followed by a circular diagram titled "How does WaterProof work?" showing a central "Water Proof" logo surrounded by six steps: "Find Your city", "Select / create your Nbs", "Configure water intakes", "Define infrastructure", "Create a case study", and "Analyze outputs". Below this is a "Realize the Investment" section with a "Take action" button and an icon of a mountain and a dollar sign. The bottom section is the "Knowledge bank" with a "Keep reading" button. The footer includes logos for The Nature Conservancy and the Gordon and Betty Moore Foundation.

The “What is WaterProof” strip provides a general overview of key information to consider before building your case study.

The “Why use WaterProof” identifies some of the characteristics that differentiates this tool from other options that parties may consider for determining the ROI of watershed NBS portfolios.

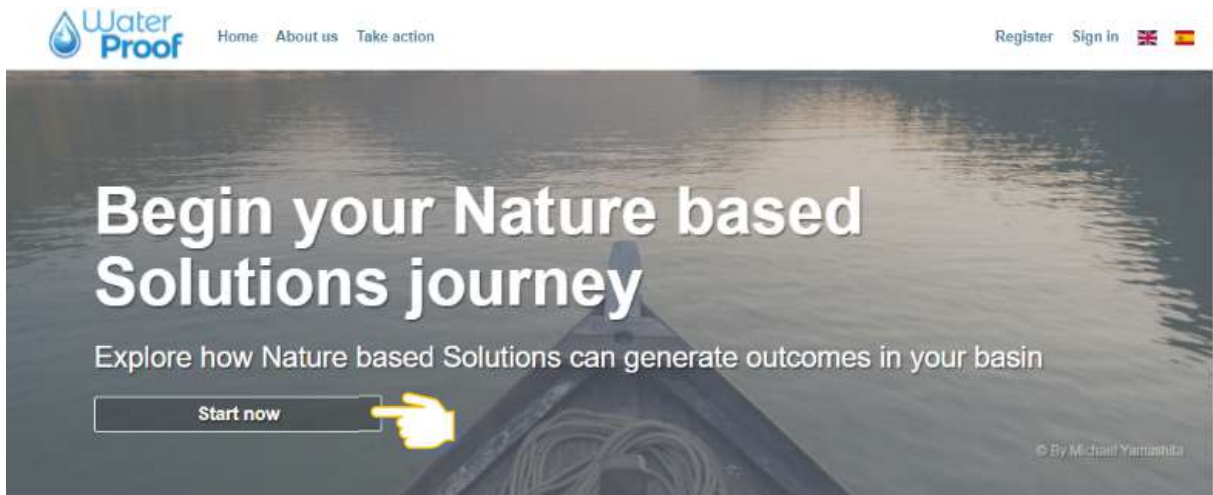
The section “How does WaterProof work?” provides a brief overview of the main inputs required by WaterProof to run a case study; clicking each element links to a short video providing further detail.

The bottom of the homepage links to the ‘Take Action’ section that provides tips on how to utilize your WaterProof analysis results and identify next steps for advancing your NBS portfolio with stakeholders and catchment partners.

The ‘Knowledge Bank’ section offers a set of articles on key concepts used in WaterProof’s development.

1. Preliminary exploration

You can find out if there are already case studies in your city that other users have registered. search for available case studies, click on the first section of the page and click on the "Start now" button. However, to start building your own case study requires registering first as a user.



2. Register

To register, click on the option found in the right-hand portion portion of the top banner. The system will provide the following form:

Create a new local account

To access the case study creation functionalities in WaterProof, it is necessary to have login credentials. Enter the following information and review the Terms and Conditions.

E-mail (*)

Username (*)

Nickname (*)

Your initials (*)

Organization (*)

Professional Role (*)

Purpose of your analysis (*)

Country (*)

City (*)

Password (*)

Password (again) (*)

Agree Terms and Conditions

Show conditions

Sign up

3. Main menu

When you log in, the main menu now offers additional options including **NbS** and **My Case studies**.



4. Search your city

The starting point for configuring your case study is to identify the geography of interest. This is done by searching for the city name adjacent to your study site. Notice that your **nickname** is visible at the top of the page.

WaterProof Tester

Begin your Nature based Solutions journey

Explore how Nature based Solutions can generate outcomes in your basin

Start now

What is WaterProof?

WaterProof provides a rapid and indicative NbS investment portfolio and associated ROI. The tool is intended to engage stakeholders interested in exploring solutions to local water challenges and prioritization of locations for possible NbS water security programs (such as Water Funds).

- Before starting
- What is a case study?
- Support data
- See an example
- Who can use the system?

The system will show you in the Geographical Viewer the country in which you indicated that you are located. In the text box, enter the city where you want to do your analysis.

Observe that the system updates a small table with the data of the city and currency of your city. Then click on the button "Case studies current list".

Start now looking for your city of analysis

Zoom in, out or pan on the map to identify your area of interest. Enter the city name in the text box to set the analysis site. A list of options will be displayed. Confirm your selection by clicking on the city of interest in the city list. Click on the button "Case studies current list".

Region	Country	Selected City	Currency
Latin America and Caribbean	Colombia	Perímetro Urbano Bucaramanga	COP

Case studies current list

Next, the system will show you a new screen with the information of existing case studies in the system for the city entered.

To further define your case study, it is important to understand the purpose for each element of the user interface, as indicated below:

The screenshot displays the WaterProof interface with several key components:

- 1. Configuration Menu:** A sidebar menu with options for '1. Water intakes', '2. Treatment plants', and '3. Case study'.
- 2. Basic background data:** A section titled 'Case studies' providing information for 'Colombia', 'Selected City: Perimetro Urbano Bucaramanga', 'Region: Latin America and Caribbean', and 'Currency: COP'. It includes a 'Create case study' button.
- 3. Basin identification viewer:** A map showing the 'Bucaramanga' basin highlighted in blue.
- 4. Case Studies Table:** A table listing existing case studies with columns for ID, Public status, Name, Description, Status, User, Date, City, Drinking water treatment plants (DWTP), Water intake source, Currency, Execution status, and Options.


ID	Public	Name	Description	Status	User	Date	City	Drinking water treatment plants (DWTP)	Water intake source	Currency	Execution status	Options
1219		Case study for Bucaramanga (Demo)_	Case study in which we will evaluate NBS for the Frio River basin		Admin WaterProof	03-12-2021	Bucaramanga	DWTP of Bucaramanga - Example	Bucaramanga Waterintake - Example	USD		

4 Table detailing the case studies available within the city area, including options at right for the various associated reports available for each of the case studies.

5. Nature based Solutions

Nature based Solutions refers to actions that protect, sustainably manage and restore natural or modified ecosystems that effectively and adaptively address societal challenges while simultaneously providing benefits for human well-being and biodiversity. Use the NbS option in the main menu to view the list of available NbS or create your own.



Click on the "Current list" option, which then displays the current set of NbS available. Clicking the icon  to allows users to view the details of each individual NbS:


Menu


Use this menu to configure the inputs for a case study

- 1. Water Intakes
- 2. Treatment plants
- 3. Case study





Nature based solutions (NbS) ?

The system offers you a default list of Nature based Solutions (NbS) by country, with standard information on their implementation and maintenance costs, time required to obtain benefits and the possible transformations that are expected through its implementation.

United States
Region: North America
Currency:(USD) - United States
Create a new NbS 



Show entries

Id	Name	Description	User	Country	Benefit percentage at time t = 0	Implementation cost (currency/ha)	Maintenance cost (currency/ha)	Opportunity cost (currency/ha)	Maintenance periodicity (years)	Currency	Options
106	Forest conservation	Actions that seek to conserve current coverage by signing conservation agreements, paying forest rangers and fencing off areas. This action does not generate changes in the coverage, but it prevents the coverage from being downgraded in a scenario without a project.	Admin WaterProof	United States	100.00%	2778.00	354.00	0.00	1	USD	 
107	Passive restoration	Combination of actions that facilitate the natural regeneration of the systems. These actions mainly seek to remove the source of degradation of a vegetation cover.	Admin WaterProof	United States	0.10%	2778.00	354.00	0.00	1	USD	 

Default NbS that have been configured in the system include:

- **Forest conservation:** Actions that seek to conserve current coverage by signing conservation agreements, paying forest rangers and fencing off areas. This action does not generate changes in the coverage, but it prevents the coverage from being downgraded in a scenario without a project.
- **Passive restoration:** Combination of actions that facilitate the natural regeneration of the systems. These actions mainly seek to remove the source of degradation of a vegetation cover.
- **Active Restoration – Enrichment:** Combination of actions that seek the recovery of a vegetation cover. In the strict sense of the word, this process seeks to replicate the ecosystem that has been degraded.
- **Agroforestry:** Active introduction of productive plants, usually shrub or arboreal, often in combination with other species (for example, coffee with shady or cocoa with banana).
- **Silvopastoral Systems:** Active introduction of shrub and arboreal plants that serve to improve soils and serve as fodder for livestock for greater productivity. This is generally associated with an improvement of previously compacted soils as well as an improvement in the quality of the pastures.



All default NbS were developed using the United States as the reference country. As a result, the costs, currency and time of delivery for NbS are provided with U.S. reference in mind. WaterProof converts these reference values and, depending on the country selected for your analysis, uses a **Cost multiplication factor** to convert them to the country of interest.

If you wish to create your own NbS you will need to enter the name, description, time required to obtain maximum benefits (years), and details on cost profile (including implementation, maintenance, and opportunity costs).

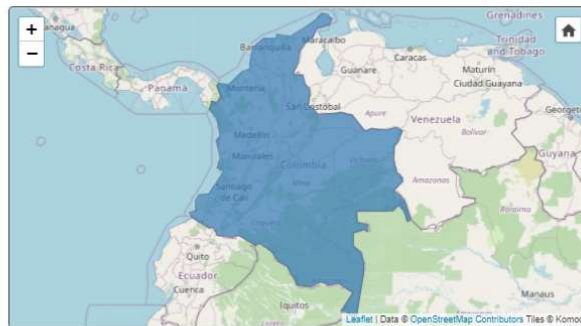
When developing new NbS categories, pay special attention to the **Transitions section** which indicates the type of landscape transition category associated with the NbS.

Create a new NbS ?

Through this form you can create a custom NbS. Select the country to which the NbS will be associated and fill in the identification information, costs and the transitions obtained with its implementation.

Colombia

Region: Latin America and Caribbean
 Currency: (COP) - Colombia



General information

Name (*)

Description (*)

Time required to obtain maximum benefits (years) (*)

Benefit percentage at time t = 0 (*)

Maintenance periodicity (years) (*)

Unit costs

Implementation cost (COP/ha) (*)

Maintenance cost (COP/ha) (*)

Opportunity cost (COP/ha) (*)

Transition

Select the preferred RIOS land use transition category per the drop-down list

If you want the NbS not to be implemented in the land cover in the left column, do not select any transformed land cover in the right column

Land use / Land cover where the activity can be implemented	Land use / Land cover transformed (*)
Forest	<input type="radio"/> Forest
Grassland	<input type="radio"/> Grassland
Shrublands	<input type="radio"/> Shrublands
Sparse vegetation	<input type="radio"/> Sparse vegetation

[Clear options](#)

Restricted areas

If there are areas with restrictions for the implementation of the NbS, attach them to the form through a geographic file by clicking on the following button.

[Help](#)



Each NbS option can **only be associated with a single transition category**. Select the preferred category in this drop-down menu. Next, select the intended Land Use by clicking on the radio buttons on the right.

The NbS considered for the system are based on the possibilities offered by the **RIOS Model**, which, based on a **transition**, transforms the land cover from an initial situation to a projection scenario.

Note: as a rule in the system, each NbS can only be associated with a single landscape transition.

6. Create a Case study

If you are interested in creating your own Case Study, certain user-inputs are required:

1. Indicate the location of the catchment or catchments that provide water to your city. Indicate the characteristics of your water intake system: types of connection, existence of reservoirs, external entrances, among others.
2. Define the functions that determine how the operation and maintenance costs of the water system. calculated. If you don't have them, the system will use default values
3. Indicate which processes and technologies are part of your treatment plant. Each technology has its cost function.
4. Define the cost functions for operation and maintenance of the treatment plant. If you don't have them, the system will use default values.
5. Link all the catchments and treatment plants that you want
6. Configure the objectives and activities that you want to integrate into analysis
7. Create the financial settings
8. Launch the analysis by indicating to the system the climatic conditions that you believe will be present during the course of implementation of your project.

Please visit <https://water-proof.org/pages/en/how-wp-work/> for additional details.

7. Water intakes

To define a water intake, go to the **left menu**, click on **Water intakes** and then on **Current list**. The system will then provide the following screen.

1 Menu with options to define a Water intake

2 Basic city background information

3 Basin identification viewer with water intakes

4 Table with data from the water intakes available accompanied by administration options

ID	Name	Description	Creation Date	Water source name	City	Status	Water demand	Options
922	WI Demo	Demo	07-12-2021	Frio river	Bucaramanga	🟢	💧	👁️ 🗑️

Location

The system provides a series of forms to define the Water intake. The first screen requires entering the following data:

Water Intake City of creation: Bucaramanga, Colombia


Location Infrastructure Water demand External input NbS area

Name
Bucaramanga 2021 Waterintake Example

Description
Water intake that supplies Bucaramanga Metropolitan Area, Rio Frio basin in the municipality of Floridablanca, Santander, in Colombia (Example)



Water source name
Frio River

Water intake location



Next

In order to generate the **analysis area** for your case study, follow these steps:

- Indicate the location of the catchment via the  button and enter the coordinates.
- Click on the  symbol so that the system takes the coordinates. You can edit them if you consider it necessary.
- Click on the "Draw Basin" button, which will delineate the watershed automatically. The system will then show a polygon for the analysis area recommendation.

Infrastructure

The next section let you to define the elements of your collection system. Notice that an icon representing your **River** appears by default in the drawing panel.











Water intake infrastructure setup

In this section you can build your water intake infrastructure and define operating cost functions. Note that in the drawing panel shows the river from which the water comes and that a series of icons representing the elements that can be part of your catchment system are provided. Click on the element that you want to incorporate into your scheme and then click on the graphic panel to include the desired element. Then establish the connections between the elements to define their topology.

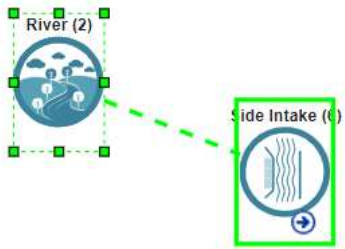
Select the elements that make up your capture system and click on the drawing area to add them; when finished, click validate graph.



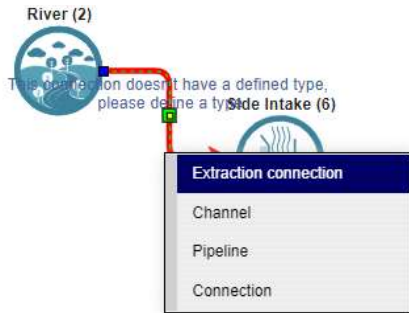
To build a water infrastructure system, the system offers you the following options:

-  Represents a big reservoir, or structure that contains a large water reservoir, where river water is stored.
-  Represents pumping mechanisms to absorb water to deliver it to another element of the water intake system.
-  Represents a reservoir in which water is deposited.
-  It represents a bottom intake in which the water collection is located horizontally and below the flow of the current.
-  It represents a lateral intake in which the water collection is located on one side of the stream.
-  Represents a floating intake that is installed on top of a floating surface (slab) and anchored to the bottom of the body of water.
-  It represents a sand trap that, by reducing the speed of the water, makes large particles fall under their own weight to the bottom of the sand trap for subsequent removal.
-  Represents a breaking chamber in charge of reducing the pressure of the pipeline at a point along its path.
-  Represents the case study infrastructure. In the case of creating a case study oriented to Drinking Water Treatment Plants (DWTP), this node represents the DWTP. In a custom case this node represents the custom analysis infrastructure.
-  Represents external inputs to the main analysis basin that may come from inter-basin transfers or diversions. WaterProof can consider these external inputs by directly entering the Flow, Sediments, Nitrogen and Phosphorus series.

Click and **hold** on the river element, and drag your mouse from the **River** to the element that represents the Side intake:



Right click to indicate the type of connection



Channel: Represents structures that collect the collected water and lead it to another element of the collection system.

Pipeline: Rigid type or flexible hoses operated either via pumping, re-pumping, or gravity.

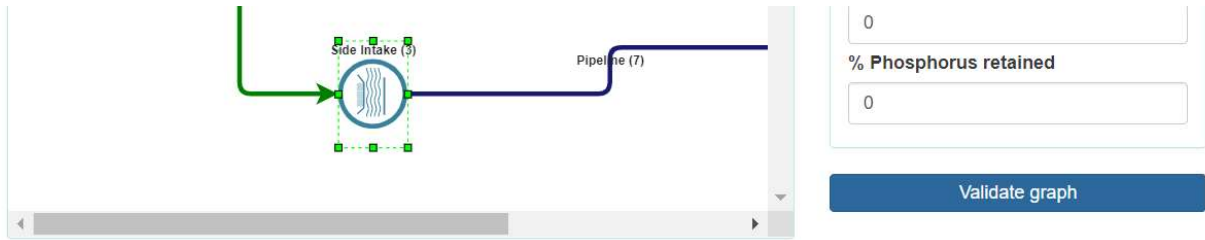
Connection: Where no channel or pipe exists, but additional element is required to symbolize their topological connection relationship.

Each element has a function in terms of **retention of nutrients, phosphorus and sediments**, and it is also responsible for **transporting a certain percentage of water**.

This information can be consulted and adjusted in the panel on the right:

Pipeline	
ID	7
% Water transported	100
% Sediments retained	0.5
% Nitrogen retained	0.2
% Phosphorus retained	0.3



To continue, click on "Validate the graph". The system will validate if the topology is correct and will allow you to review and edit the cost functions for each element. To do this, click on any element:





Cost functions

Add new cost

The infrastructure elements of the water intake system have associated operating and maintenance costs. You can modify them, discard them or add new costs.

Cost function name	Function	Currency	Multiplication factor of the total cost	Options
Annual Operation and Maintenance Cost	fx	(USD) - United States	1	 

By hovering the mouse over the icon , the system will show you the cost function formula. You can see and edit it by clicking on the  icon that will allow you to see the following window:

Edit Cost function ✕

Use this form to configure your cost function by selecting the variables of your interest: flow, concentration or loads.
Expand the list of infrastructure and click to build the function.

Cost function name
Annual Operation and Maintenance Cost

Cost function description
Side intake

Currency for definition of costs (COP) - Colombia **Multiplying factor for overall cost** 1

Syntax keyboard
Basic Advanced

= + - × a/b a^b √ min max

Create / Edit function in Python Syntax.
Click on the validate button to check the syntax of the function.

$$317.03Q_3^{0.3305} \left(1 + 0.1 \frac{CSed_3 - 203}{203} + 0.06 \frac{CN_3 - 30}{30} \right)$$

To understand the cost function construction process, [Error! Reference source not found.](#)

Water demand

The next step is to indicate the **water demand** that is served with this catchment.

- Linear interpolation
- Potential interpolation
- Exponential interpolation
- Logistics interpolation

You must enter the number of years for which you want to estimate demand and the expected minimum and maximum demand flow (extraction) values (unit in l / s). Then, click the **Generate** button. You will see that the table on the right is filled with data:

Water demand ?

Please indicate the expected demand (extraction) from your catchment. You can use the interpolation tool or enter it manually.

Interpolation wizard Manual edit

Data analysis

Please select the method you wish to use to autofill the table associated with annual water extraction from the source

Interpolation method (*)

Number of years for time series (10-100) Year (*)

Extraction

Initial year (l/s)(*)

Final year (l/s)(*)

Click here to calculate the water extraction in each year **Generate**

Results


Year	Extraction value (l/s)
0	410.00
1	411.67
2	413.33
3	415.00
4	416.67
5	418.33
6	420.00

Previous Next

Notice that the system offers the "Manual edit" tab. This feature is useful if you have annual projected water demand (withdrawal) data and allows for manual entry of such information. For this, just enter the number of years for which you have information and WaterProof will generate a table in which you can enter the data (units in l/s):

Water demand ?

Please indicate the expected demand (extraction) from your catchment. You can use the interpolation tool or enter it manually.

Interpolation wizard Manual edit 

Number of years for time series

Enter the number of years for the water extraction and fill out the demand table

Number of years (10-100) Year (*)

Click here to calculate the water extraction in each year **Generate**

Results

Year	Extraction value (l/s)
0	<input type="text"/>
1	<input type="text"/>
2	<input type="text"/>

Implementation area of the NBS

The **last step** in the creation of the Water intake is the definition of the implementation area of the NBS.

1. Click on "Delimit the implementation area of the NBS"
 The system will show you the vertices of the polygon, available so that you can move them according to your needs.

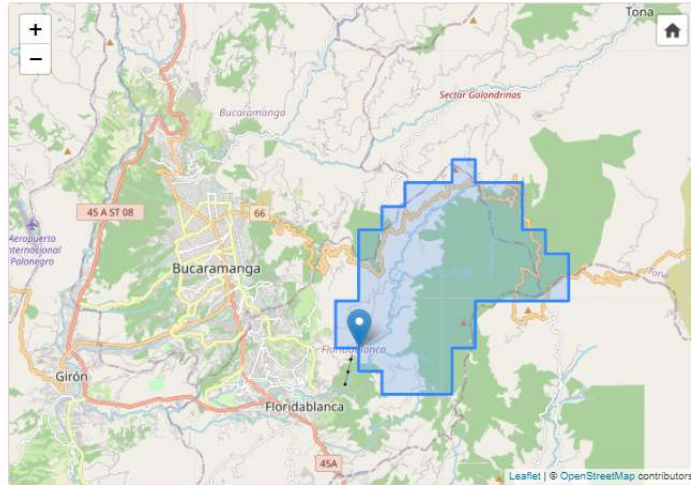


2. Click on "Validate delimited area".

NbS implementation area ?

You can delimitate the area within the basin in which the implementation of Nature Based Solutions (NBS) will be considered. By default, the system will consider the entire basin area for NBS implementation.

However, if you'd like to limit the area considered for implementation, you can do so either manually or by uploading a spatial file.



NbS implementation area

Alternatively, you can upload a zip file with SHP spatial data that delimits the polygon where NBS implementation is possible. Choose between "Delimit NBS implementation area" or uploading a "geographic file"

[Manually delineate area](#)

or

[Upload file](#)

Once the implementation area is defined, you must validate the process by clicking the button below

[Validate area](#)

[Previous](#) [Save](#)

You will see the system confirmation that the delimited area is suitable for analysis. Click on [Save](#) button.

8. Create a Treatment Plant

Look at the menu on the left from where you can **Create new**. It is important that you know how the elements are distributed in the page:

Menu with options to create a Treatment Plant




1

2 Analysis city data

3 Basin identification viewer with treatment plant

4

The screenshot shows the WaterProof web application interface. On the left is a navigation menu with options for 'Water Intakes', 'Treatment plants', and 'Case study'. The 'Treatment plants' section is active, showing a 'Create new' button. The main content area is titled 'Drinking water treatment plants (DWTP)' and includes a map of Bucaramanga, Colombia, with a blue polygon indicating the treatment plant's location. Below the map is a table listing existing treatment plants.

ID	Name	Description	Creation Date	City	Water intake	Options
461	DWTP Demo	DEmo	2021-12-07	Bucaramanga	WI Demo:CSINFRA:5	  

Clicking on **Create new** the system will show you a form in which you must enter the following data. The form requires you to indicate the specific **Water intakes** from which the treatment plant draws water.

Create Treatment Plant ?

City of creation: Bucaramanga, Colombia

General information

In this section you can create a Drinking Water Treatment Plant according to the quality of the water from your source.

Name (*)

DWTP Demo

Description (*)

DEmo

Water Intake (*)

Select the water intakes that supply the drinking water treatment plant. The selected intake will be automatic added to the table.

Select an option

Name	Water intake sources	Infrastructure associated with the DWTP	Options
WI Demo	Frio river	CSINFRA	

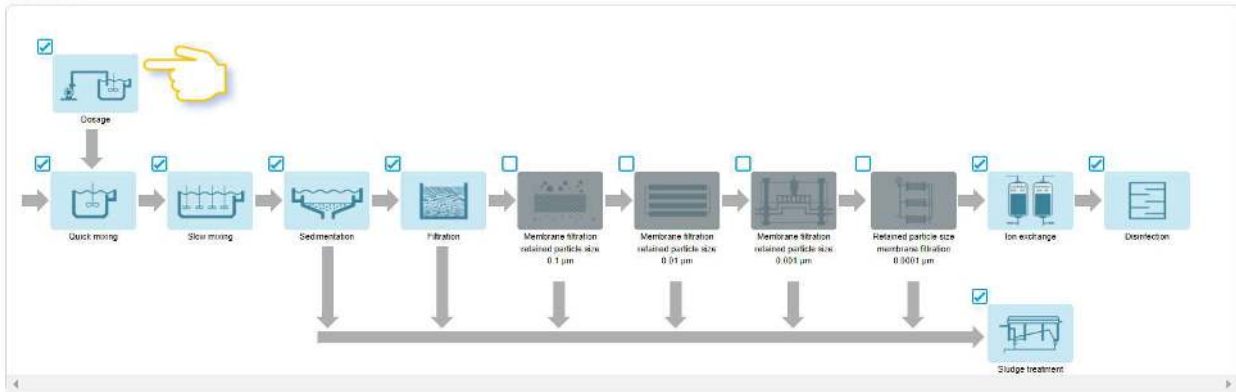
To enable the diagram, click in the following button:

Confirm water intakes

Click on the **Confirm water intakes** button for the system to show you the **processes and technologies** that are most likely to be used. Look at the diagram where you can verify the processes:

Treatment unit process diagram (*)

WaterProof presents below the suggested components or processes for treating the water quality of the selected catchments. Click on the processes that are part of your treatment plant and use the checkbox to enable or disable them.



Each blue box represents a water treatment process that can be turned on or off in the analysis; clicking the associated **checkbox** will enable / disable the process in your analysis.

By clicking on any process, the system will update the page showing in the form of a **tree**, which showcase the possible technologies used in water treatment. Each technology is accompanied by the icon that will allow you to see its efficiency in sediment retention, nitrogen retention and phosphorus retention.

Processes, technologies and cost functions (*)

Define the processes that are part of your treatment plant and use the checkbox to enable or disable cost functions. You can also edit, delete or add cost functions..

Treatment Plant

- Dosificación
 - Subprocess: Coagulant
 - Technology: Liquid Aluminum Sulfate

[Add new technology](#)

% Transported water		% Sediments retained	
<input type="text" value="100"/>		<input type="text" value="0"/>	
% Nitrogen retained		% Phosphorus retained	
<input type="text" value="0"/>		<input type="text" value="0"/>	

Activate	Function name	Function	Currency	Factor	Options
<input checked="" type="checkbox"/>	Annual operation and maintenance costs		USD	0.38	
<input type="checkbox"/>	Annual operation and maintenance costs - Polymer		USD	0.38	

[Add function](#)

- Technology: Granulated Aluminum Sulfate
- Technology: Ferric chloride

You will also find suggested cost functions. However, you can select another, edit them, or add custom cost functions.

Add new technology

If you use another technology, you can add it by clicking on the "Add new technology" link, the system will generate the capture fields at the end of the form:

Technology: Granulated Aluminum Sulfate
 Technology: Ferric chloride
 Technology:

% Transported water % Sediments retained
 % Nitrogen retained % Phosphorus retained

Activate	Function name	Function	Currency	Factor	Options
----------	---------------	----------	----------	--------	---------

[Add function](#)

You must indicate the name of the technology, the retention values and add the corresponding cost function. To do this, click on the “Add function” link.

9. Cost Functions

In the creation of **Water intakes** and **Treatments plants** you have seen that cost functions are used. This section describes how to set up a cost function. The cost functions must have a name, a description, the money to be used in the operations, and its formula, which must comply with the **Python syntax**. To do this, the system will present you a functionality where you can indicate which mathematical operations to integrate in your formula.

Edit Cost function

Use this form to configure your cost function by selecting the variables of your interest: flow, concentration or loads.
Expand the list of infrastructure and click to build the function.

Cost function name

Cost function description

Currency for definition of costs (COP) - Colombia **Multiplying factor for overall cost** 1

Syntax keyboard
Basic Advanced

Infrastructure

- 2 - River
- 3 - Side Intake
- 4 - Desander
- 5 - CSINFRA
- 6 - Extraction connection
- 7 - Pipeline
- 8 - Pipeline

Create / Edit function in Python Syntax.
Click on the validate button to check the syntax of the function.

$$317.03Q^0.3305 \left(1 + 0.1 \frac{CSed3 - 203}{203} + 0.06 \frac{CNR - 30}{30} \right)$$

To build your formula you must combine variables of the catchment system that are available in the right panel under the heading "infrastructure". Drop down the "Infrastructure" options and select the element that influences the cost to be evaluated.

Use this form to configure your cost function by selecting the variables of your interest: flow, concentration or loads.
Expand the list of infrastructure and click to build the function.

Cost function name

Cost function description

Currency for definition of costs (COP) - Colombia **Multiplying factor for overall cost**

Syntax keyboard
Basic Advanced

= + - × a/b a^b √ min max

Infrastructure

- 2 - River
- 3 - Side Intake
- 4 - Desander
 - Q4
 - CSed4
 - CN4
 - CP4
 - WSed4
 - WN4
 - WP4
 - WSedRet4
 - WNRet4
 - WPRet4

Create / Edit function in Python Syntax.
Click on the validate button to check the syntax of the function.

CSed4

You should know that the prefixes of the elements are:

- Q= Flow rate
- C= Concentration
- W= Weight
- Sed= Sediment
- N= Nitrogen
- P= Phosphorus
- Ret= Retention

When your formula is finished, click on the "Validate" button. The box will be highlighted in red if there are errors in the formula. Otherwise it will be highlighted in green and you will see that your formula will be displayed below.

```
(23-1) if (15>12) else (23+1)
```

15 > 12, 23 - 1
Another Case, 23 + 1

Advanced options

The system also offers a tab for **advanced** operations in the creation of cost functions. These include logarithms, exponentials, percentages, least and greatest what validations, as well as conditionals.

Syntax keyboard

Basic Advanced

π e ln log mod > < if

Clicking on the "if" button enables the conditional expression in the constructor, which consists of 5 elements:

```
(expression) if (conditional) else (other_case)
```

The first element "(expression)" contains the expected result if the condition returns true.

The "if" separates the expected expression from the conditional.

The "(conditional)" element corresponds to the condition to be evaluated.

The "else" indicates that there is a second option in case the condition does not meet the expected result

The "(Other_case)" element represents the alternative result in case the "(expression)" does not apply for the defined "(conditional)".

Example:

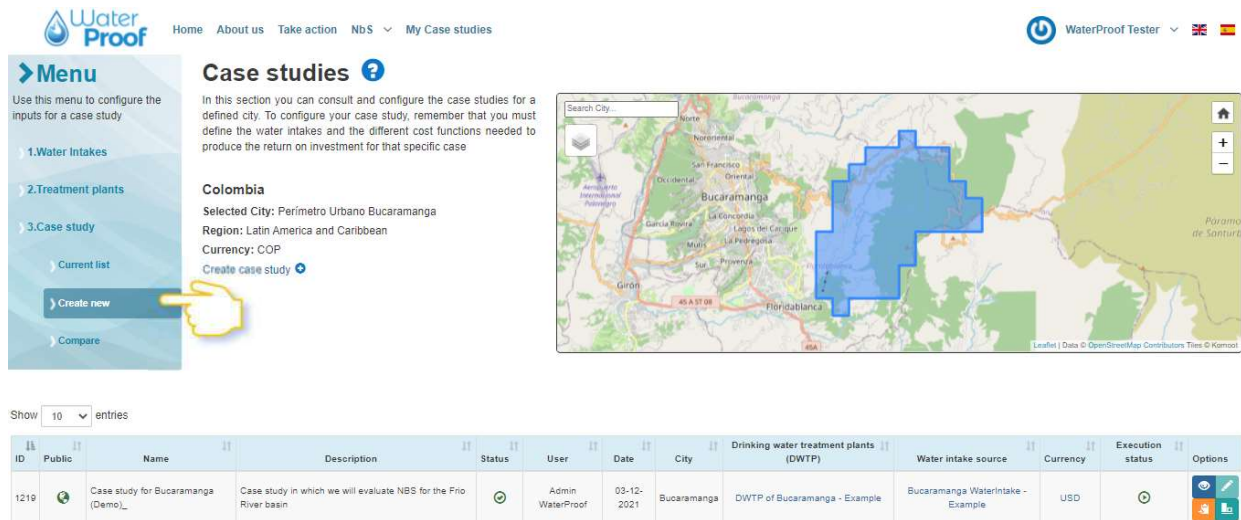
```
(23) if (a>12) else (24)
```

This would be interpreted as:

The result is (23) IF (a is greater than 12) otherwise the result is (24).

10. Develop a case study




If you already have configured your intakes and treatment plants (optional), you can start developing your case study. To do this, you must click on **Create new** as shown in the following image



Case studies

In this section you can consult and configure the case studies for a defined city. To configure your case study, remember that you must define the water intakes and the different cost functions needed to produce the return on investment for that specific case

Colombia
Selected City: Perimetro Urbano Bucaramanga
Region: Latin America and Caribbean
Currency: COP
Create case study

ID	Public	Name	Description	Status	User	Date	City	Drinking water treatment plants (DWTP)	Water intake source	Currency	Execution status	Options
1219	<input checked="" type="checkbox"/>	Case study for Bucaramanga (Demo)_	Case study in which we will evaluate NBS for the Frio River basin	<input checked="" type="checkbox"/>	Admin WaterProof	08-12-2021	Bucaramanga	DWTP of Bucaramanga - Example	Bucaramanga Waterintake - Example	USD	<input type="checkbox"/>	  

The system provides a series of forms which require filling out the following information:

Definition

Create case studies

Creation city: Bucaramanga, Colombia



Define case study

Enter the information that will identify your case study. Then select whether you will be analyzing benefits for a drinking water treatment plant or a custom return on investment case.

Name

Description

Select the type of infrastructure to analyze in the case study

WaterProof can consider for ROI analysis the operating and maintenance costs associated with the analysis infrastructure. You can use the costs of a previously created drinking water treatment plant or you can create costs for a custom infrastructure. Select the desired option.

- Drinking water treatment plants (DWTP)
 Custom case

Next

WaterProof case studies can rely on previously defined drinking water treatment plants, or you can create your own custom infrastructure. Select the desired option.

When you select **Drinking water treatment plants (DWTP)** you should

- Add** the Water intake created in the previous step
- Add** the Treatment Plant created in the previous step

When you select **Custom case** you should

- **Add** the Water intake created in the previous step

Carbon market

The next form that is presented is to indicate if you want to calculate the **benefits per carbon market**.

Create case studies

Creation city: Bucaramanga, Colombia



Carbon Market Benefits ?

WaterProof may consider benefits associated with the Carbon market, click the checkbox to include it in the analysis.

Carbon market

Previous Next

For this analysis to be generated, check this option and enter the value that is paid in your country per TonCO₂eq and click the **Next** button

Portfolio objectives

Next you must select the objectives that are sought with the implementation of the NbS. In our test we will select the following:

Create case studies

Creation city: Bucaramanga, Colombia



Portfolio objectives ?

Select the objectives for which the system will generate portfolios of Nature based Solutions, using the RIOS technical framework

<input checked="" type="checkbox"/> Erosion Control for Drinking Water Quality
<input type="checkbox"/> Erosion Control for Reservoir Maintenance
<input checked="" type="checkbox"/> Nutrient Retention (Phosphorus)
<input checked="" type="checkbox"/> Nutrient Retention (Nitrogen)
<input type="checkbox"/> Flood Mitigation
<input type="checkbox"/> Groundwater Recharge Enhancement
<input checked="" type="checkbox"/> Baseflow

Previous Next

Modeling parameters

The next step is to define the biophysical parameters. You can explore the default options by clicking the **Advanced options** button.

Create case studies

Creation city: Bucaramanga, Colombia



Modelling parameters ?

In this step you will find the biophysical parameters required for the execution of the models. If you want to see or edit these parameters, click on Advanced options, otherwise click on next and the system will use the default values.

[Advanced options](#)

Below are the biophysical tables that will be used in modeling un iNVEST and RIOS. You can edit the values according to the specific knowledge of the supplying basins

Please see the InVEST documentation

Intake Bucaramanga 2021 WaterIntake

description	lucode	root_depth	usle_c	usle_p	load_n	eff_n	load_p	eff_p	crit_len_n	crit_len_p
Ice	0	1421.000000	0	1.000000	0	0	0	0	200.000000	20
Water	1	1657.000000	0	1.000000	0	0	0	0	200.000000	20
Forest	2	1189.000000	0.000120	1.000000	0.248900	0.432000	0.681500	0.220000	200.000000	20
Grassland	3	1689.000000	0.001200	1.000000	0.750500	0.280800	0.087000	0.190000	200.000000	20
Agriculture	4	1829.000000	0.036000	1.000000	0.779000	0.345600	1.175000	0.110000	200.000000	20
Urban	5	1533.000000	0.003600	1.000000	0.613700	0.270000	0.356300	0.190000	200.000000	20

Financial parameters

The system will display the form to configure the **financial parameters** that you have to manage your project annually. This section presents typical expense categories such as personnel, office costs, travel, equipment and contracts. Your screen should look as shown below:

Financial parameters ?

In this section, the system offers you pre-loaded costs required for the implementation of the NbS. Confirm or edit values according to your local situation:

Currency

(USD) - United States ▼

Platform cost per year

Personnel salary and benefits	250310.06
Program director	188873.43
Monitoring and evaluation manager	71901.04
Finance and administrator	53530.15
Implementation manager	37306.57
Office costs	26135.67
Travels	10359.16
Equipment	0
Vehicle	20000.00 ▼
Overhead	0
Others	31077.47
	0

Transaction cost per year as a percentage of implementation, maintenance and opportunity costs

Transaction cost (%)	20.00
----------------------	-------

Discount rates for ROI Analysis

Discount rate (%)	5.08
Sensitivity analysis - Minimum discount rate (%)	3.08
Sensitivity analysis - Maximum discount rate (%)	7.08

[Previous](#) [Next](#)

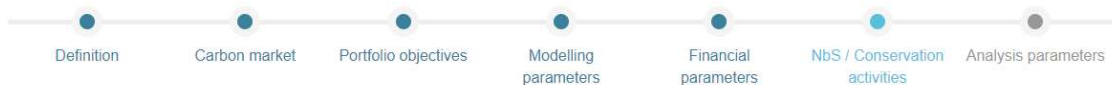
Click the [Next](#) button

NbS activities

Next, you must indicate the NbS that you want to be part of the analysis.

Create case studies

Creation city: Bucaramanga, Colombia



NbS / Conservation activities ?

Select the NbS that you want to consider for the analysis:

<input checked="" type="checkbox"/> Active Restoration - Enrichment
<input type="checkbox"/> Agroforestry
<input checked="" type="checkbox"/> Forest conservation
<input type="checkbox"/> Passive restoration
<input type="checkbox"/> Silvopastoral Systems

Click the [Next](#) button.

Analysis parameters

This is last step of the process details certain parameters for running the ROI analysis. Your screen should look like the following:

Analysis parameters

Analysis time period (years) (10-100)	<input type="text" value="30"/>	Currency	<input type="text" value="(USD) - United States"/>
Implementation time of NbS (yr)	<input type="text" value="3"/>	Climate selection for baseline and NbS scenario analysis	<input type="text" value="HISTORIC"/>
Investment scenario			
Enter here the amount of money you want to spent on each NbS per year. If you do not want to pre-determine how much is spent on each NbS, enter the total budget in the Yearly Floating Budget box. You can also enter values of some NbS and enter the remaining budget in the Floating Budget box. Please take into account that WaterProof will consider the values indicated as investment for each of the basins involved in the analysis. If you establish a budget of 100,000 USD but the analysis involves 2 basins, the system will consider 200,000 USD as the total available investment.			
Yearly floating budget			
<input type="text" value="50000"/>			
Yearly activity allocation			
Activity	Investment		
Active Restoration - Enrichment	<input type="text" value="60000"/>		
Forest conservation	<input type="text" value="70000"/>		


If activity money cannot be spent, proportionally reallocate

[Previous](#) [Save](#) [Run analysis](#)

Click the [Run analysis](#)

The case study calculation process may take a few minutes, for which the system is configured to send you an email indicating when you can re-enter and check the results.

11. View reports

To consult the reports section and see the results of the different indicators, locate your case study within the list and click on the button 

Menu

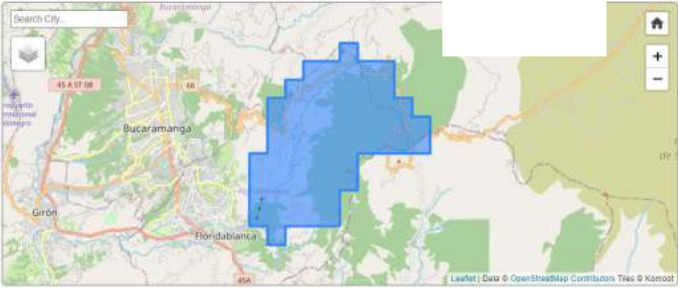
Use this menu to configure the inputs for a case study

- 1. Water Intakes
- 2. Treatment plants
- 3. Case study

Case studies ?

In this section you can consult and configure the case studies for a defined city. To configure your case study, remember that you must define the water intakes and the different cost functions needed to produce the return on investment for that specific case

Colombia
Selected City: Bucaramanga
Region: Latin America and Caribbean
Currency: COP
[Create case studies](#)




Show 10 entries

ID	Public	Name	Description	Status	User	Date	City	Drinking water treatment plants (DWTP)	Water intake source	Currency	Execution status	Options
934		Ecopetrol - Las Blancas	Este caso de estudio incorpora la planta de tratamiento Las Blancas y la captación de 209.5 l/s en la quebrada Las Blancas - Acueducto de Acacias		Carlos Rogeliz	11-11-2021	Acacias	PTAP - Acueducto Acacias - Quebrada Las Blancas	Captación - Quebrada Las Blancas	COP		

The system will show you a page with the results of the analysis:

Explore your case study analysis reports

In this section WaterProof provides you to understand the possible changes in soil and water resources due to the implementation of Nature-Based Solutions, becoming powerful tools to make investment decisions

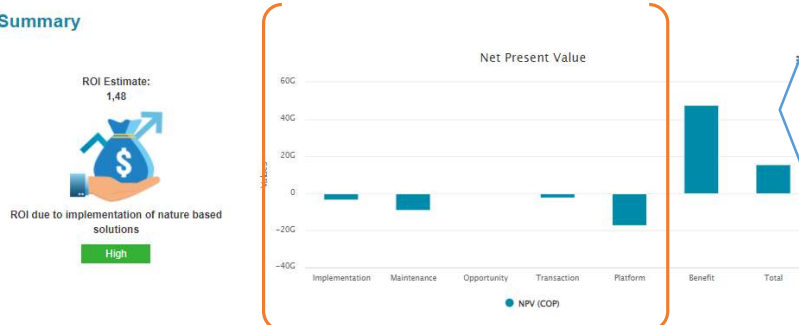


Ecopetrol - Las Blancas_clone2

City:	Acacias	Quantity of water intakes considered in analysis:	1
Country:	Colombia	Quantity of DWTP in analysis:	1
Region:	Latin America and Caribbean	Currency:	COP
Time frame (years):	50	Discount rate (%):	9.00

Area chosen for the analysis and case study

Financial Summary



- ROI value which indicates that the opportunity
- Net present value

The **Net Present Value** chart shows you costs and benefits bars. The costs include:

- *Implementation costs*: Details required material, supplies and labor costs for initially implementing the NbS.

- **Maintenance costs:** Costs associated with maintaining NbS
- **Opportunity costs:** These are landowner-related costs when choosing NbS over a traditional productive alternative; this usually requires direct or in-kind payments ('payment for ecosystem services') to appropriately incentive landowners to adopt the NbS measure
- **Transaction costs:** Administrative expenses for organizing and monitoring the NbS
- **Platform costs:** Fixed expenses for managing the overall NbS program, e.g. program direction, implementation management, vehicles, office costs, etc.

The **Net Present Value** chart also indicates the **benefits** associated with the NbS portfolio, in particular the savings realized in the water treatment system and the catchment operation. In the graph you see the **Total bar**, which is the difference between costs and benefits, which for this case study is positive.

Water Intake : Captación - Quebrada Las Blancas

Water risk summary AQUEDUCT

Below is a summary of the risks associated with the selected water intake (results draw from the Aqueduct database; compiled by WRI)



Risk summary values as provided by the Aqueduct database. Indicators shown include: physical risks (quantity), quality, and reputational

Intervention and budget summary

Nature based Solution	Actual spend	Area converted (Ha)
agroforestry	1.093.326.610,05	105,76
forest-conservation	2.905.428.403,28	634,57
passive-restoration	220.108.212,37	48,07

Summary table of the investment needed for each NbS category, and the number of hectares under

Estimated maximum change in ecosystem services (Business as Usual Scenario Vs Nature based Solutions Scenario)



Ecosystem service changes achieved with the target NbS portfolio.

On the end of this page, you can find icons to access to detailed reports:



Please note that the system will display the following icon to return to the reports home page

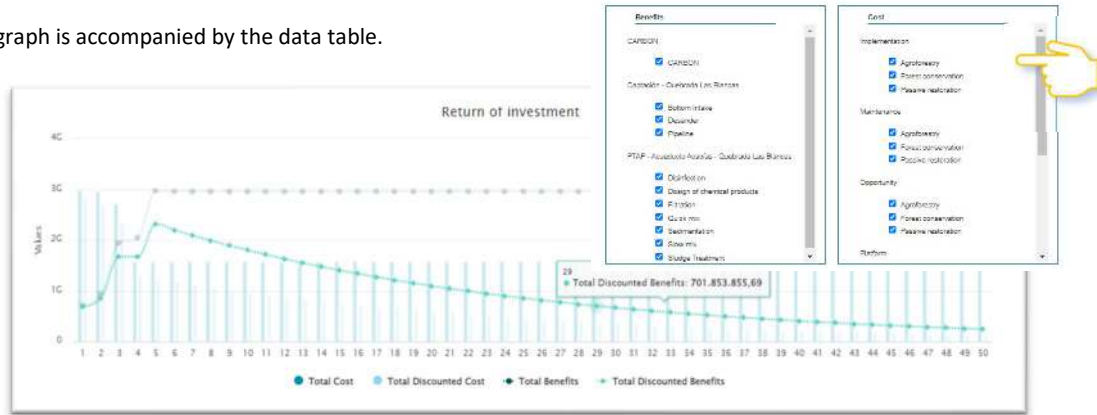




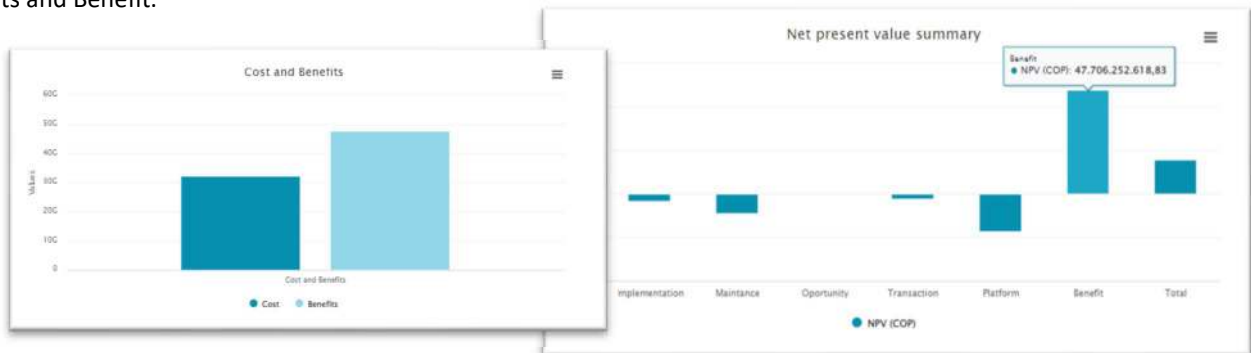
Financial Indicators: summarizes the proportions in investment and benefits that will be achieved by the implementation of the NbS.

Report that organizes the financial data of NbS implementation into benefits and costs: Visit this section to see a graph that compares the costs and benefits of your project in the analysis period defined in your analysis. Click on the checkboxes to modify the benefit and cost calculations according to your interest.

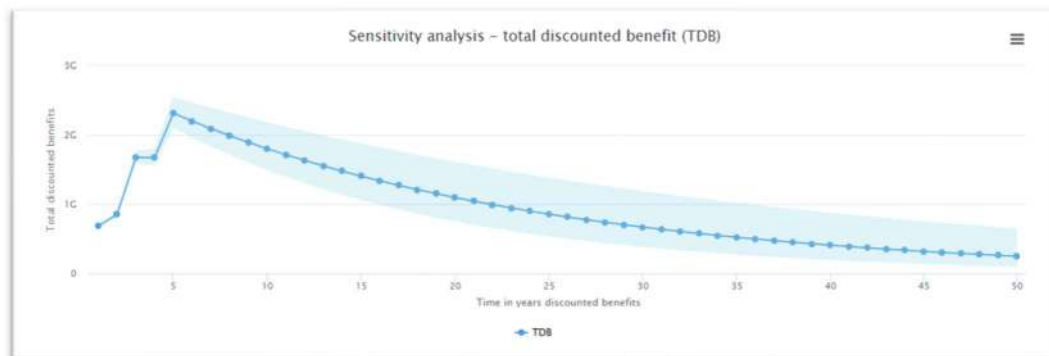
Note that the graph is accompanied by the data table.



Net Present Value NPV of the implementation costs of the selected NBS: See the Net Present Value of your costs and benefits. You can also consult the individual values of Implementation, Maintenance, Opportunity, Transaction, Platform costs and Benefit.



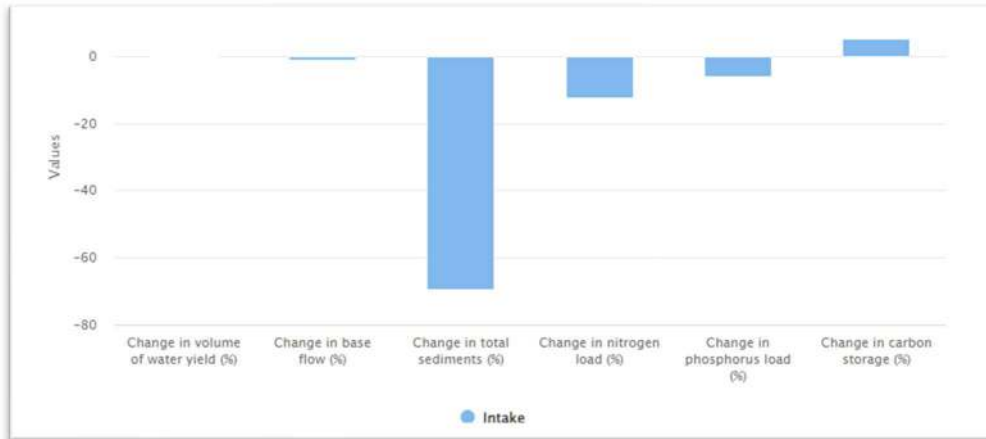
Report about the sensitivity analysis of benefits and discounted costs: using the minimum and maximum discount rates defined for the analysis. Note that the graph is accompanied by the data table.





Physical indicators: shows the synthesizes the change in the physical parameters experienced by the study basins when implementing a Nature-based Solution as part of the analysis.

Outcomes caused in the basin by the implementation of the selected NbS: This report is based on data provided by InVEST from its indicators for Change in volume of water yield, Change in base flow, Change in total sediments, Change in nitrogen load, Change in phosphorus load, Change in carbon storage:



Note that the graph is accompanied by the data table.

Risk indicators from Aqueduct: Aqueduct is a platform that compiles global quality and quantity risk results, remote sensing data, and other datasets. Below you can see an example of the type of outputs related with Physical Risk associated with Amount of Water, Physical risk quality, and Regulatory and reputational:



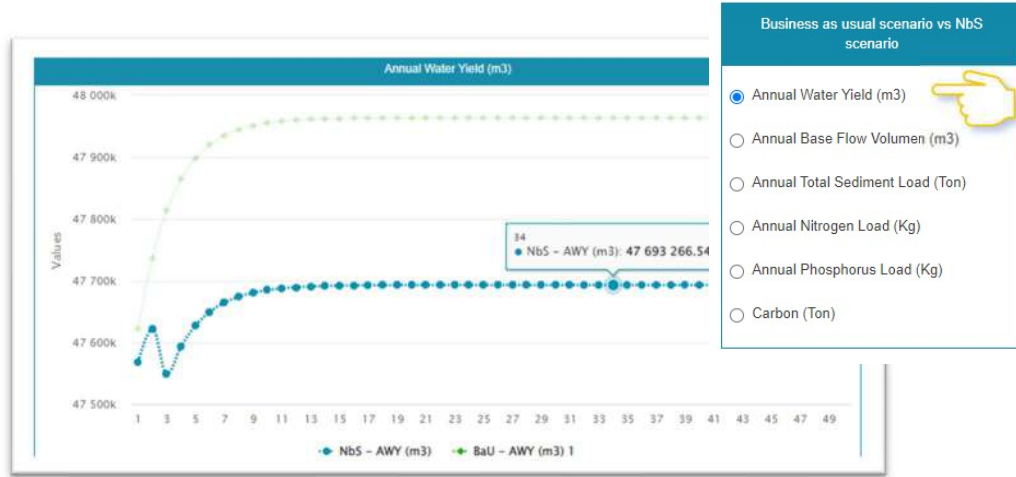
Interventions results: In this report you can get a view, per each basin, the percentage of area in which the NbS portfolio will be located, activity implementation costs per hectare and quantify the distribution of the types of activities:

Watershed information		
NbS Activity	Cost per hectare	Recommended intervention (Ha)
agroforestry	1093326610.05	105.76
forest-conservation	2905428403.28	634.3
passive-restoration	220108212.37	48.0

NbS portfolio size as a percent to total area

22.85 %

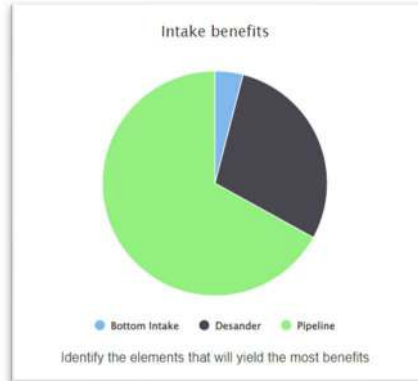
Temporal projection: This report presents the behavior of ecosystem services for the analysis period. It allows you to see how these variables behave in the Business as Usual - BaU scenarios versus the Nature-Based Solutions - NbS scenario over time.



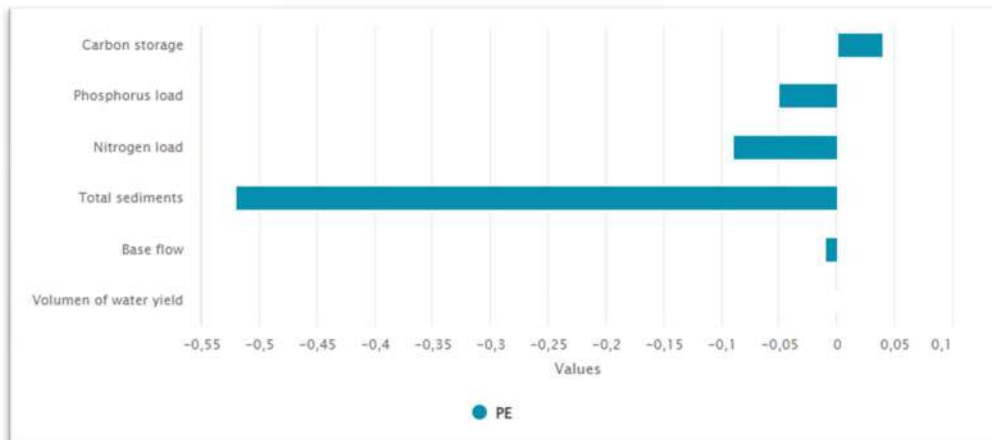


Decision indicators: shows the proportions in investment and benefits that will be achieved by the implementation of the NbS.

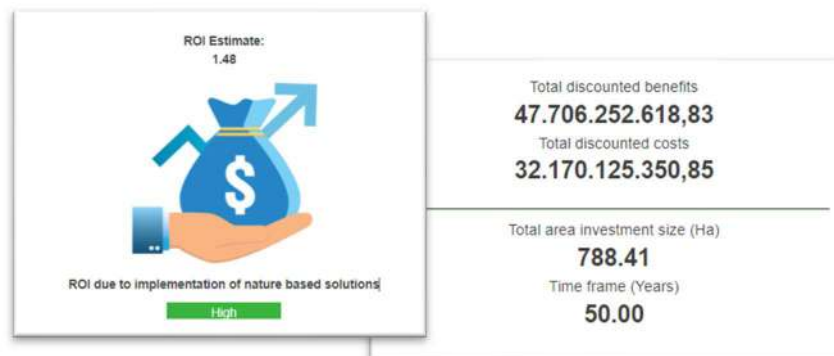
Incidence of benefits and cost: This report synthesizes the benefits for each **Intake** and **DWTP**, the costs of NbS portfolio implementation. The following are some examples:



Portfolio efficiency: This section shows the efficiency of **the portfolio**, expressed as a physical variation of the parameters (in percentage) in relation to the amount of the investment.



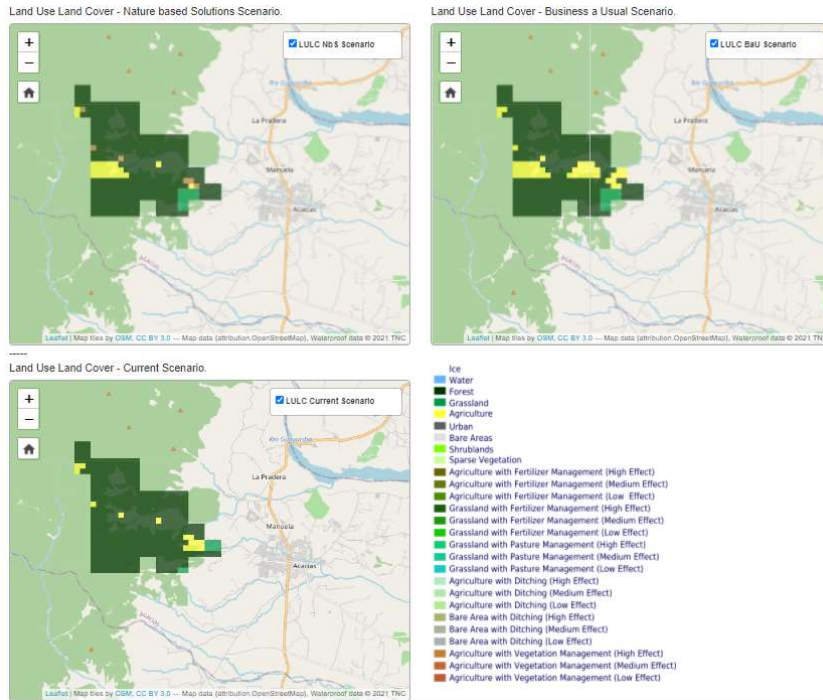
Opportunity result: In this report you will find the overall investment and savings values that will result from the implementation of the selected NbS in your case study:





Geographic visualization: allows users to observe analysis results via specialized maps

Land cover comparison: This page has a feature that allows you to zoom in on the map that allows you to compare the change in land use area in the analysis watershed when applying the NbS.

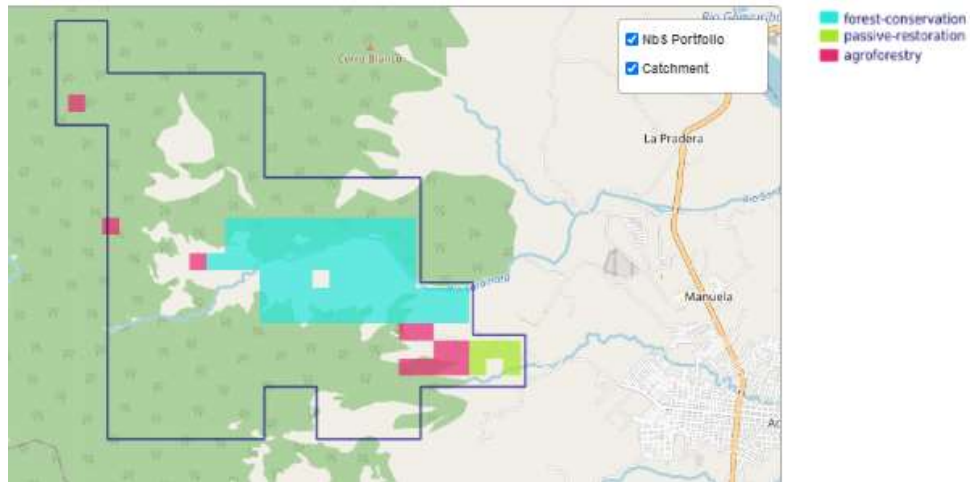


Move the mouse over the area of interest and you will see the maps move simultaneously to compare Land Cover Land Use under the scenario in which Nature based Solutions are present, Land Cover Land Use under the Business as Usual Scenario, and Land Cover Land Use under the Current Scenario.

Physical changes: This report lets you to view the behavior of ecosystem services for the selected basin when implementing the NbS portfolio. This, for each **InVest indicators**, it means Annual Water Yield (mm), Seasonal Water Yield (mm), Sediment Delivery Ratio (t), NDR Nitrogen (kg), NDR Phosphorus (kg), and Carbon storage and sequestration (t).




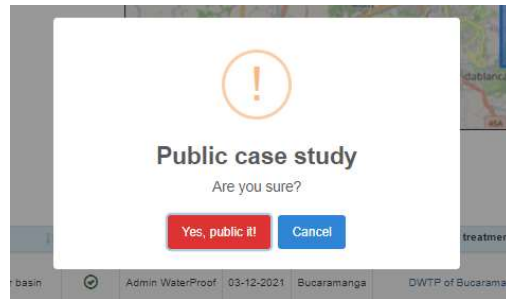
NbS portfolio: This report lets you to view the spatial location of the implementation portfolio suggested by the RIOS model, each pixel color represents each of the NbS configured for the analysis.















Note: you can download analysis results on PDF and ZIP reports.

12. Share your case study

We suggest that when your case study is fully configured, you share your results. Use the  icon to change the status of the case study to Public. By clicking there, the system will show you a confirmation window.



When you confirm your decision, the table will refresh as follows:

ID	Public	Name	Description	Status	User	Date	City	Drinking water treatment plants (DWTP)	Water intake source	Currency	Execution status	Options
1219		Case study for Bucaramanga (Deme...	Case study in which we will evaluate NBS for the Pro River basin		Admin WaterProof	03-10-2021	Bucaramanga	DWTP of Bucaramanga - Example	Bucaramanga WaterIntake - Example	USD		  
1225		Case...			WaterProof Tester	07-10-2021	Bucaramanga	DWTP Deme...	WI Deme...	USD		  

13. My Case studies

If you want to consult all the case studies that you have created in WaterProof, visit this section. From there you can see the case studies of **all the cities** that you have developed.



The screenshot shows the 'My Case studies' page in the WaterProof application. The page has a header with the WaterProof logo, navigation links (Home, About us, Take action, NbS, My Case studies), and user information (WaterProof Tester, language flags). A left sidebar contains a 'Menu' with options for '1. Water Intakes', '2. Treatment plants', and '3. Case study'. The main content area is titled 'My case studies' and includes a brief description: 'Edit, delete, clone, and view the results of your WaterProof case studies here.' Below this is a list of case studies, with a yellow hand cursor pointing to the 'City' column header. The table below is a detailed view of the case studies.

ID	Public	Name	Description	Status	User	Date	City	Drinking water treatment plants (DWTP)	Water intake source	Currency	Execution status	Options
842		CS_22-10-2021	CS_22-10-2021		WaterProof Tester	22-10-2021	Pitalito	- PTAP_22-10-2021	- Intake_2_22-10-2021 - Intake_3_22-10-2021 - Intake_4_22-10-2021 - Intake_1_22-10-2021	USD		  
859		W0001-CS-JNP	W0001-CS-JNP		WaterProof Tester	04-11-2021	Acevedo	- W0001-PTAP-JNP	- W0001-Intake-JNP	USD		  
860		W0002-CS-JNP	W0002-CS-JNP		WaterProof Tester	04-11-2021	Acevedo	- W0001-PTAP-JNP	- W0001-Intake-JNP	USD		  

14. Compare case studies

The system offers this option so that you can easily compare the values of the main results of the models and indicators analyzed by WaterProof. To do that, the system will offer you a **graph of parallel axes** that facilitates the simultaneous visualization of the values obtained for the main indicators.

To access this functionality, click on the **Case study** menu and then on **Compare**

Case studies comparison

In this section you will find case studies with results available to be compared. The system will offer you a graph of parallel axes that facilitates the simultaneous visualization of the values obtained for the main indicators.

Click in to add the case studies of interest

Colombia
Selected City : Perimetro Urbano Bucaramanga
Region : Latin America and Caribbean
Currency:COP
Show all cities:

Show 10 entries

Name	User	Date	City	Drinking water treatment plants (DWTP)	Water intake source	Actions
Ecopetrol - Villavicencio - La Esmeralda	crogeliz	11-11-2021	Villavicencio	- PTAP - La Esmeralda	- Captación - Quebrada Honda - (1600 l/s)	
Ecopetrol - Cascajales	Jonathan_TNC	07-10-2021	Barrancabermeja	- Ecopetrol - La Liana GCT	- Ecopetrol - Cuenca Río Cascajales	
Ecopetrol - Ciénaga San Silvestre	Jonathan_TNC	07-10-2021	Barrancabermeja	- Ecopetrol - Tratamiento Refinería	- Ecopetrol - Cuenca Ciénaga San Silvestre	
Ecopetrol - La Colorada	Jonathan_TNC	07-10-2021	Barrancabermeja	- Ecopetrol - La Colorada GCT	- Ecopetrol - Cuenca Río La Colorada	
Ecopetrol - Las Blancas	crogeliz	11-11-2021	Acacías	- PTAP - Acueducto Acacías - Quebrada Las Blancas	- Captación - Quebrada Las Blancas	

The system indicates that you must click on the icons that accompany each case study to add them to the comparison. For each click the system will generate a table like the shown below:

Cases for comparison

Name	User	Date	City	Drinking water treatment plants (DWTP)	Water intake source	Actions
Ecopetrol - Las Blancas	crogeliz	11-11-2021	Acacías	- PTAP - Acueducto Acacías - Quebrada Las Blancas	- Captación - Quebrada Las Blancas	
Ecopetrol - Villavicencio - La Esmeralda	crogeliz	11-11-2021	Villavicencio	- PTAP - La Esmeralda	- Captación - Quebrada Honda - (1600 l/s)	

[Compare](#)

If your selection is ready, click the "Compare" button. The system will show you the following page where you will find the data of the selected study cases and the list of available comparison variables.






Case studies comparison

In this section you can compare the main indicators of the selected case studies using a parallel axis graph. You can also add axes to the chart for comparison.

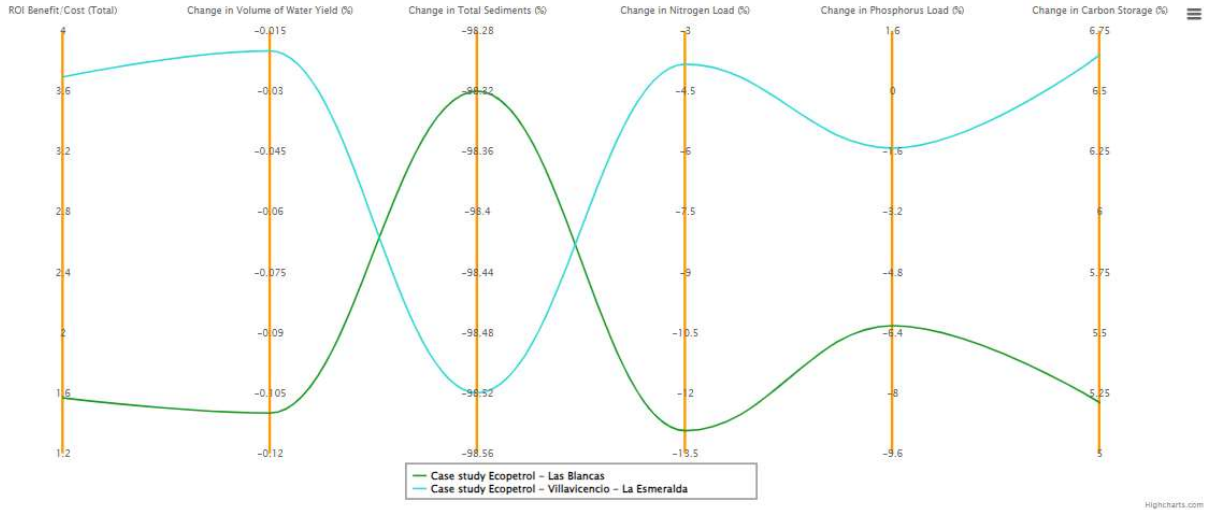
Ecopetrol - Las Blancas
Country: Colombia
City: Acacías
Region: Latin America and Caribbean
Time frame: 3
Number of intakes: 1
Number DWTP: 1
Currency: COP

Ecopetrol - Villavicencio - La Esmeralda
Country: Colombia
City: Villavicencio
Region: Latin America and Caribbean
Time frame: 3
Number of intakes: 1
Number DWTP: 1
Currency: COP

[Add axis](#)

Axis	Action
ROI Benefit/Cost (Total)	
Change in Volume of Water Yield (%)	
Change in Total Sediments (%)	
Change in Nitrogen Load (%)	
Change in Phosphorus Load (%)	
Change in Carbon Storage (%)	

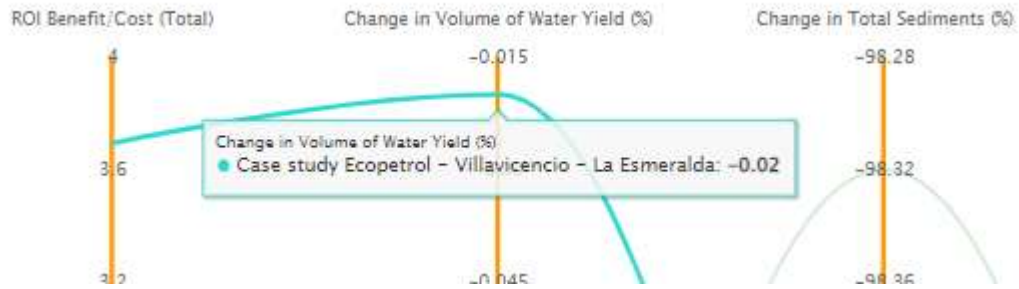
Parallel Axis Graph



Click on "Select axis to show" to list the available variables and click on the "Add axis" button. You will be able to compare:

- ROI Benefit/Cost (Total)
- Change in Volume of Water Yield (%)
- Change in Total Sediments (%)
- Change in Nitrogen Load (%)
- Change in Phosphorus Load (%)
- Change in Carbon Storage (%)
- Cost Implementation NPV
- Cost Maintenance NPV
- Cost Opportunity NPV
- Cost Transaction NPV
- Cost Platform NPV
- Total NPV

Hover the mouse over the axes to see the values of each Case study, which is represented with a color for each one:



15. Contact us:

The TNC team is attentive to answering your questions and accompanying you in the configuration of your case studies. Do not hesitate to write to us at the email account casesupport_waterproof@tnc.org