Nature for Water FACILITY Local solutions. Global impact.

User Manual VWBA Tool v1.0

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1 Introduction

The VWBA Tool v1.0 emerges as a solution to operationalize the methods consolidated in the Volumetric Water Benefit Accounting (VWBA) guide. This tool allows decision-makers and technicians of watershed investment programs to quickly estimate the volumetric benefits generated by nature-based solutions interventions in a watershed.

According to the VWBA guide, nature-based solutions are grouped into five categories: Agricultural practices, Demand management, Green and gray infrastructure, Land conservation and restoration, and WASH. A summary of the methods by nature-based solution category is presented in Table 1.

Table 1. Synthesis of methods by nature-based solution category

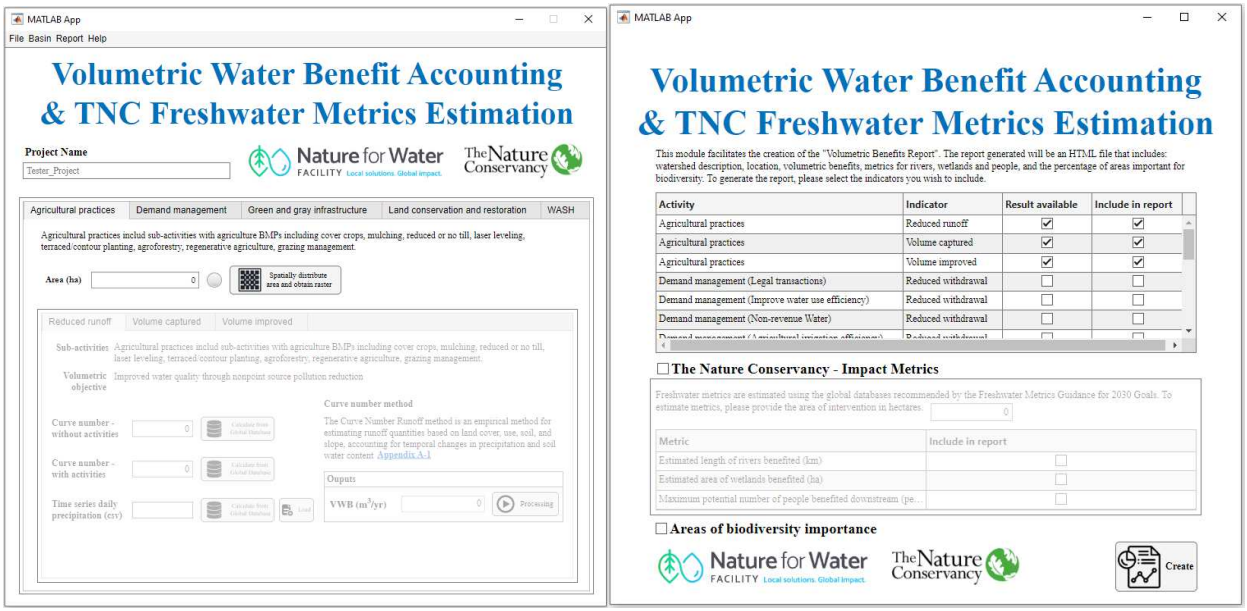
What activity are you interested in pursuing?		Volumetric objective (i.e., How is the activity addressing a local shared water challenge?)	VWB indicator (i.e., What will you measure to determine if the volumetric outputs are delivered?)	VWB method (i.e., How will you measure the volumetric outputs?)	Appendix
Agricultural practices	Agriculture BMPs including cover crops, mulching, reduced or no till, laser leveling, terraced/contour planting, agroforestry, regenerative agriculture, grazing management, and others	Improved water quality through nonpoint source pollution reduction	Reduced runoff	Curve number method	A-1
		Improved water balance through increased supply	Volume captured	Soil water holding capacity method	A-14
	Agricultural nutrient management, pesticide management, herbicide management, and others	Improved water quality through nonpoint source pollution reduction	Volume improved	Nonpoint source pollutant reduction method	A-13
Demand management	Legal transactions to keep water in-stream, operational efficiency measures, water reuse and recycling, changes in industrial processes or agricultural practices that reduce demand, changes in water sources, low flow fixtures, or other activities that reduce demand	Improved water balance through reduced demand	Reduced withdrawal	Withdrawal and consumption methods	A-2
		Improved water balance through reduced demand	Reduced consumption	Withdrawal and consumption methods	A-2
	Leak repair	Improved water balance through reduced demand	Reduced withdrawal	Withdrawal and consumption methods	A-2
	Removal of invasive species, forest thinning, crop switching, fallowing, and others	Improved water balance through reduced demand	Reduced consumption	Withdrawal and consumption methods	A-2
Green and gray infrastructure	Rain gardens, bioswales, stormwater detention or retention ponds, pond dredging/desilting, drainage water management, blind inlets, and others designed to capture runoff.	Improved water quality through nonpoint source pollution reduction	Volume captured	Volume captured method	A-5
		Improved water balance through flood/drought mitigation	Volume captured	Volume captured method	A-5
	Green infrastructure activities including constructed wetland treatment system, bioretention basins, and others.	Improved water quality through nonpoint source pollution reduction	Volume treated	Volume treated method	A-6
	Gray infrastructure including wastewater treatment plants, and others.	Improved water quality through point source pollution reduction	Volume treated	Volume treated method	A-6
	New water supply for irrigation or domestic use (including handwashing, bathing and cleaning), water reuse, water collection and storage, water treatment, rain barrels and others that provide an increased water supply.	Improved water balance through increased supply	Volume provided	Volume provided method	A-3
	In-stream barrier removal, dam reoperation, floodplain reconnection, levee or berm removal, side channel reconnection, riparian habitat improvements, process-based restoration, wet meadow restoration, beaver dam analogs, water level management for habitat, wetland or peat bog protection or restoration, wetland creation and others	Improved water-related habitat	Increased inundation	Inundation method	A-11
		Improved water-related habitat	Maintained inundation	Inundation method	A-11
		Improved water-related habitat	Volume provided	Habitat volume method	A-12
		Improved water-related habitat	Increased recharge	Recharge method	A-4
		Improved water-related habitat	Maintained recharge	Recharge method	A-4
	Sustainable drainage systems, check dams, infiltration basins, infiltration wells, infiltration trenches, infiltration shafts, and other activities that facilitate increased recharge	Improved water balance through increased supply	Increased recharge	Recharge method	A-4
	Invasive species removal, dredging, and other restoration and creation activities to improve wetlands or other aquatic habitats that store water	Improved water-related habitat	Volume captured	Volume captured method	A-5
	Conservation easements or other activities that protect wetlands or other aquatic habitats that store water	Improved water-related habitat	Volume maintained	Volume captured method	A-5

What activity are you interested in pursuing?		Volumetric objective (i.e., How is the activity addressing a local shared water challenge?)	VWB indicator (i.e., What will you measure to determine if the volumetric outputs are delivered?)	VWB method (i.e., How will you measure the volumetric outputs?)	Appendix
	Washing stations, pollutant storage equipment, street sweeping, impervious area disconnect, and urban soil amendments, among others	Improved water quality through nonpoint source pollution reduction	Volume improved	Nonpoint source pollutant reduction method	A-13
Land conservation and restoration	Forest conservation, meadow conservation, grassland conservation, and other activities that preserve land vegetation cover	Improved water quality through nonpoint source pollution reduction	Avoided runoff	Curve number method	A-1
		Improved water balance through increased supply	Maintained recharge	Increased recharge and seasonal water availability method	A-15
		Improved water balance through increased supply	Maintained seasonal water storage	Increased recharge and seasonal water availability method	A-15
	Reforestation, grassland restoration, and other activities that restore vegetation cover	Improved water quality through nonpoint source pollution reduction	Reduced runoff	Curve number method	A-1
		Improved water balance through increased supply	Increased recharge	Increased recharge and seasonal water availability method	A-15
		Improved water balance through increased supply	Increased seasonal water storage	Increased recharge and seasonal water availability method	A-15
WASH	Activities that increase access to drinking water supply.	Improved WASH	Volume provided	Volume provided method	A-3
	Activities that increase access to sanitation facilities where excreta are safely disposed of in situ or removed and treated offsite	Improved WASH	Volume treated	Volume treated method	A-6

Additionally, the tool allows for the estimation of metrics such as kilometers of rivers, hectares of wetlands, and the number of people benefited in the hydrographic basin under analysis. These values are relevant to the formulation of projects within The Nature Conservancy.

The tool has been developed using the Matlab R2023b App Designer. Among the functionalities provided by the VWBA Tool are the estimation of volumetric benefits, TNC metrics, and areas of importance for biodiversity. Below is a preview of some of the functionalities offered by this tool.

Figure 1-1. VWBA Tool v1.0 functionality preview.

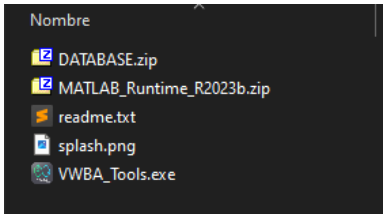


2 Installation

VWBA Tools allows the estimation of the volumetric benefits generated by Nature-Based Solutions interventions in a basin. At a computer level, this tool has been developed in the Matlab R2023b App Designer, so it is necessary to have the Matlab Runtime (compiled Matlab libraries) for the R2023b version. For user convenience, the Matlab Runtime installer has a wizard to guide the process step by step. The installation process is presented below:

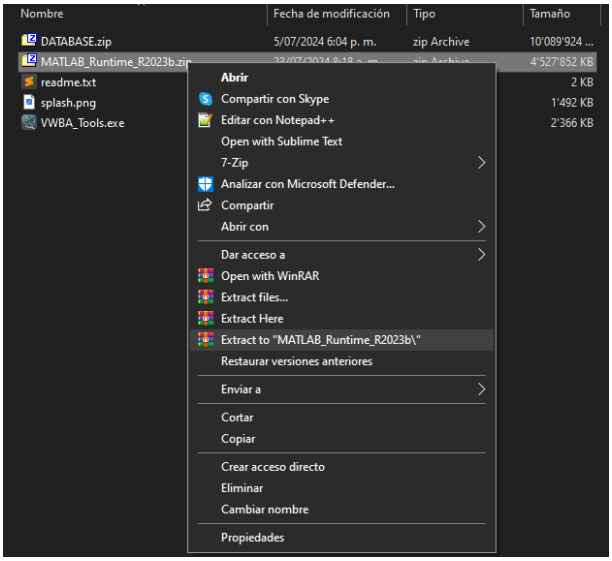
1. Download the installation files (LINK) in the folder of your choice (see Figure 2-1)

Figure 2-1. ***Files for installation***



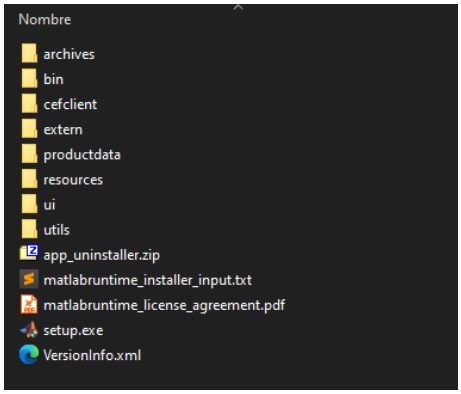
2. Unzip the zip name in the same folder *MATLAB_Runtime_R2023b.zip*. For this you can use the WinRAR decompression program (see Figure 2-2).

Figure 2-2. ***Executable file decompression***



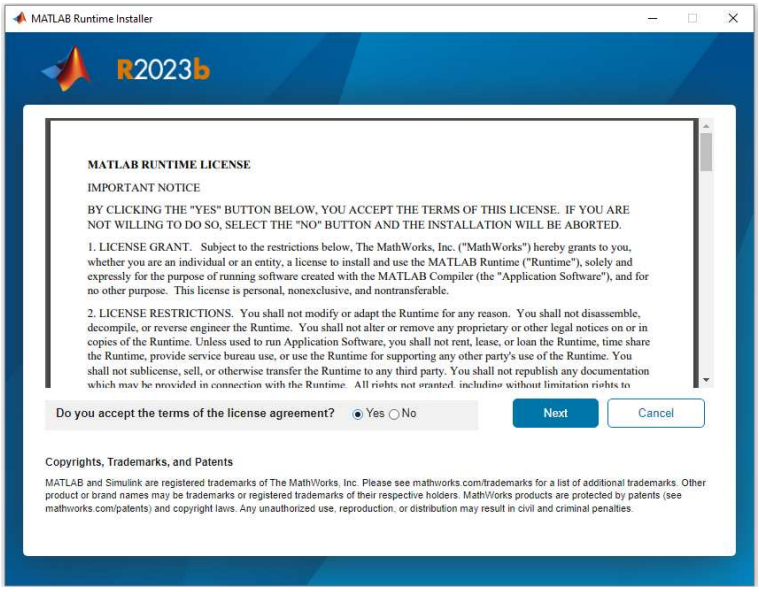
The list of files contained in the zip *MATLAB_Runtime_R2023b.zip* is presented in the Figure 2-3

Figure 2-3. ***Executable file decompression***



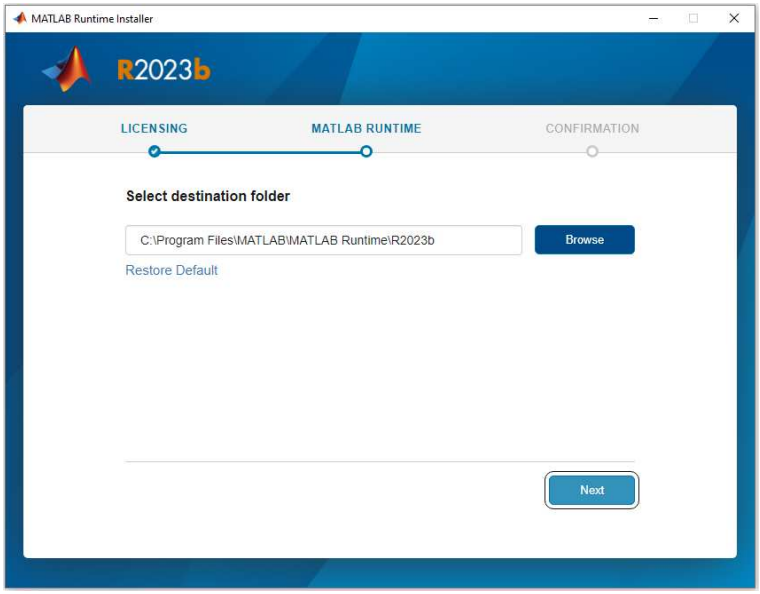
3. Run the file *setup.exe* as administrator (right click on the file and select the option **Execute as an administrator**) and grant the necessary permissions. When you see the window shown in Figure 2-4, carefully read the terms of use of the software and click the button **Next >.**

Figure 2-4. ***Matlab Runtime Terms and Conditions of Use Window***



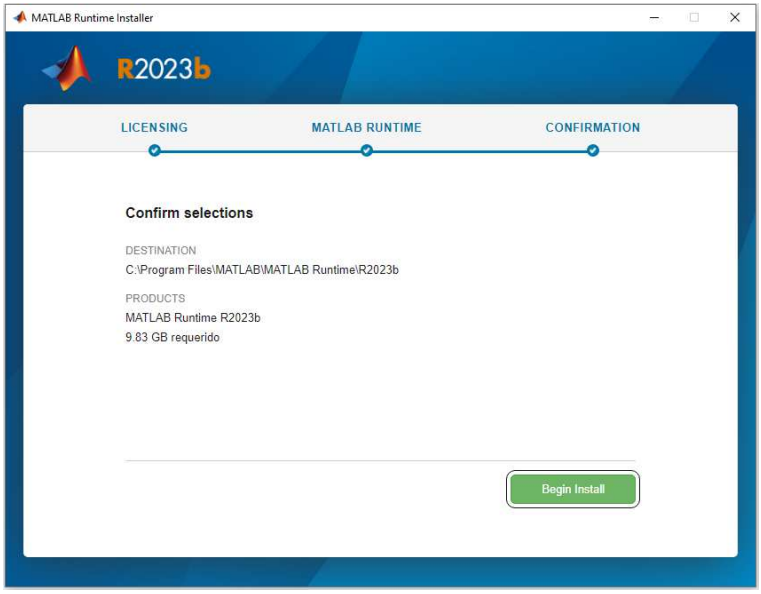
4. In the option of **select installation folder** You can leave the default options and click the button **Next >** (see Figure 2-5).

Figure 2-5. ***Matlab Runtime Installation Path Window***



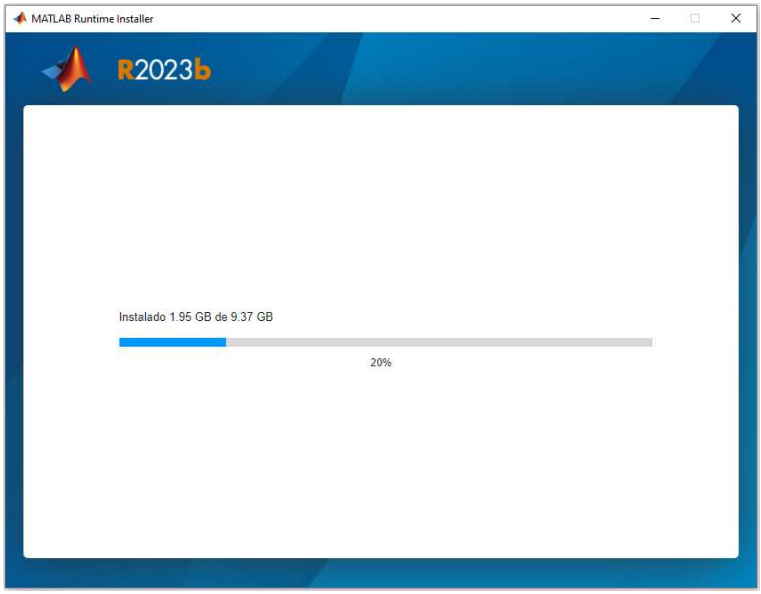
5. The wizard will show you the installation confirmation window (see Figure 2-6). To start the installation, click the button **Begin Install >**.

Figure 2-6. ***Installation parameter confirmation window***



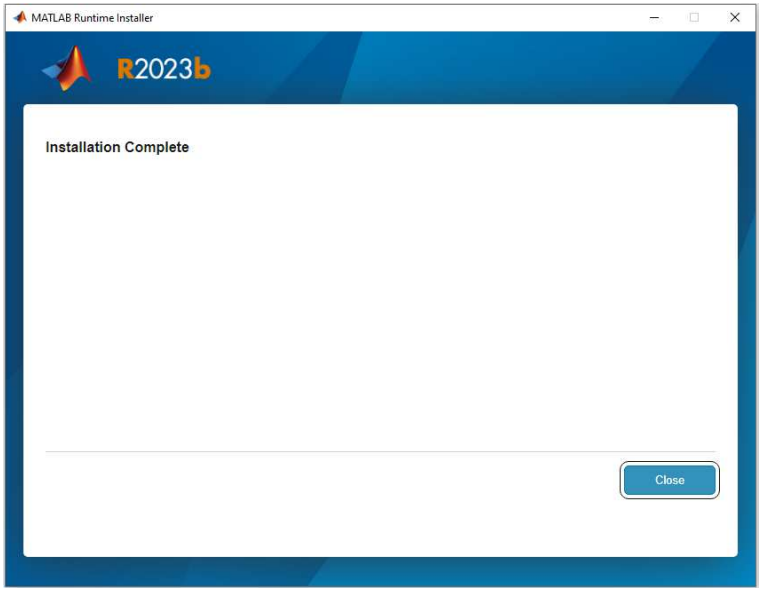
6. At this point, the installation will have started. The wizard will display a window with a progress bar where you can monitor the installation progress. When the bar reaches 100%, it means that the installation is complete (see Figure 2-7). Depending on the characteristics of the computer on which you are performing the installation, this process may take several minutes. Please be patient and do not close the progress window, as this will cancel the installation.

Figure 2-7. ***Installation progress window***



7. When the process finishes you will see a window like the one presented in Figure 2-8. In this case, click the button **Close >** and the installation will be completed.

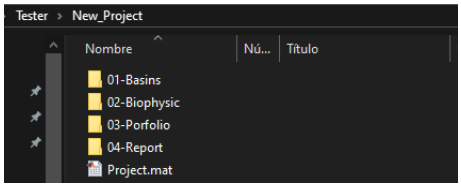
Figure 2-8. ***Installation Completion Window***



3 VWBA Tools

VWBA Tools interprets a project as a folder that contains a specific configuration of files and folders. The structure of a project is presented in Figure 3-1.

Figure 3-1. ***Structure of a project for VWBA Tools***

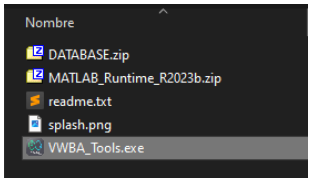


The project or working directory (see Figure 3-1) usually refers to a basin and contains all the files that the tool requires for its execution. It is important that **the names of the folders and the structure in general are not modified, otherwise the tool will present errors during its execution**.

3.1 How to run VWBA Tool?

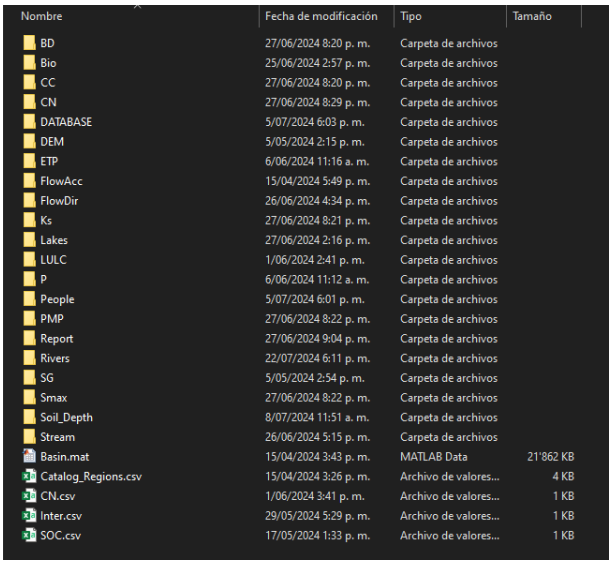
To run VWBA Tools, go to the folder where the files downloaded from the LINK. Then locate the icon with the name *VWBA_Tools.exe* shown in Figure 3-2 and click on it to run.

Figure 3-2. ***VWBA Tool executable***



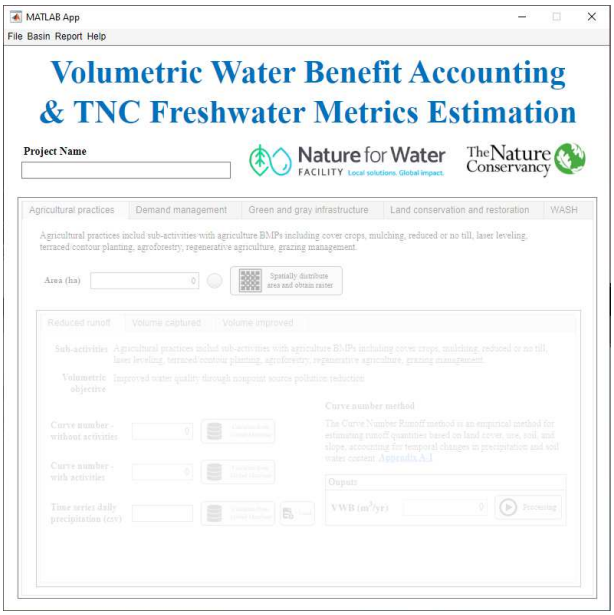
The first time the tool is run, it proceeds to unzip the files contained in the *DATABASE.zip*. It's very important **Make sure the file in question is located in the same folder where VWBA_Tools.exe is located, otherwise the tool will present errors during its execution.** When the tool has finished the configuration, you will see that the file *DATABASE.zip* has been removed and replaced by a folder named DATABASE. This folder contains the global databases that the tool uses for its execution (see Figure 3-3).

Figure 3-3. ***DATABASE folder contents***



Once all the previous configuration is completed, a window like the one seen in Figure 3-4 will be displayed.

Figure 3-4. ***VWBA Tools main window***



From this point you will be able to use the tool to calculate the volumetric benefits in the basin of your interest.

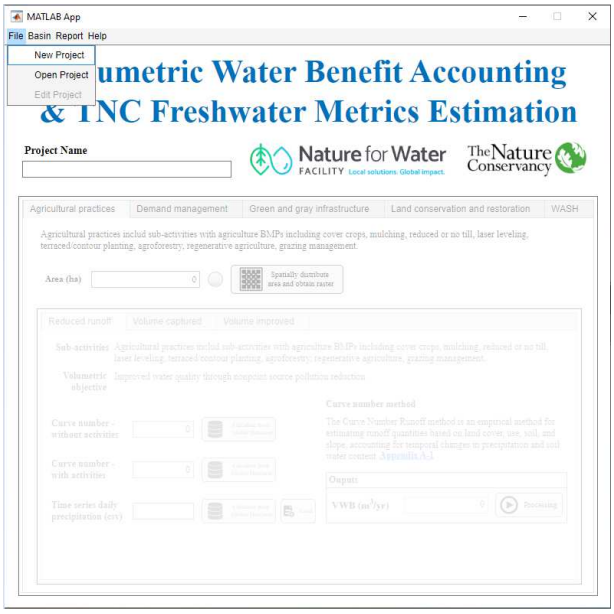
3.2 VWBA TOOLS FEATURES

Below are details of each of the functionalities that the user may have available to configure, edit and visualize data in the SIGA-CAL tool.

3.2.1 New Project

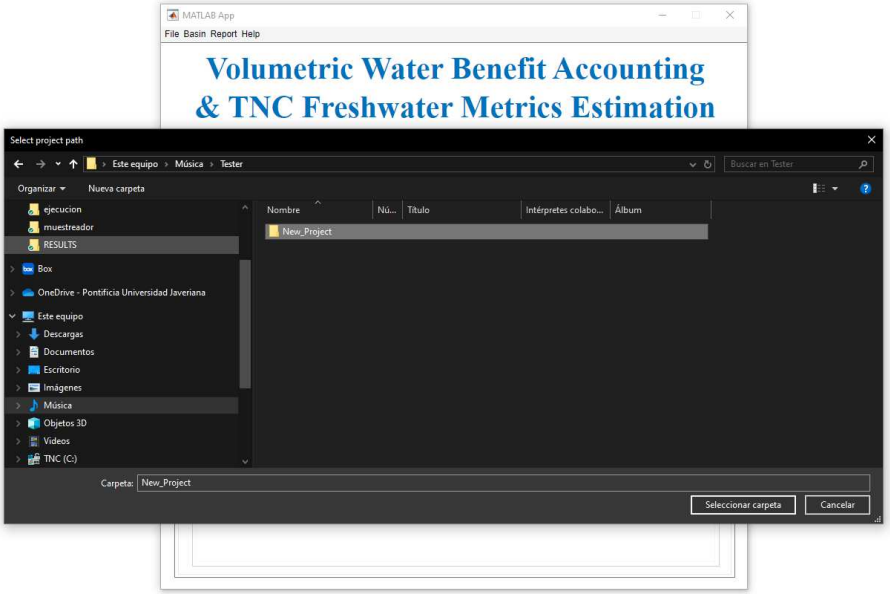
The option **New Project** allows you to create a new project in VWBA Tools. As seen in Figure 3-5, this option is available in **File** inside the toolbar.

Figure 3-5. ***Location of the New Project option in VWBA Tool***



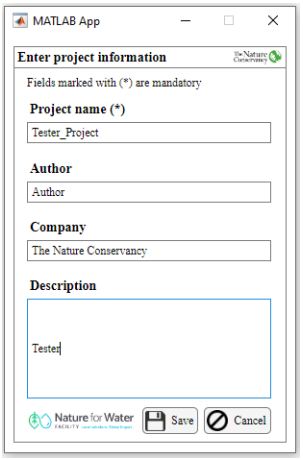
By clicking on the option **New Project** A Windows File Explorer will be displayed with which you can locate the folder that will configure the project you want to work with (see Figure 3-6).

Figure 3-6. ***Windows File Explorer - New Project Option***



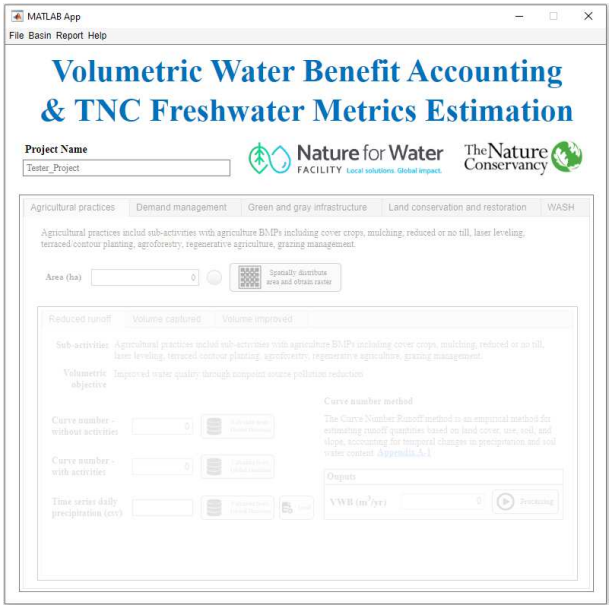
Once the folder for the project is defined, the tool will display a window in which basic information is requested such as: Name of the project, author, company and a brief description of the basin of interest. It should be noted that the information entered in this window will be used to construct the results report.

Figure 3-7. ***Location of the Open option in VWBA Tool***



Once the information has been completed, click **Save**. You will notice that, in the main window, the checkbox **Project Name** will take the name of the project that has been previously entered (see Figure 3-8).

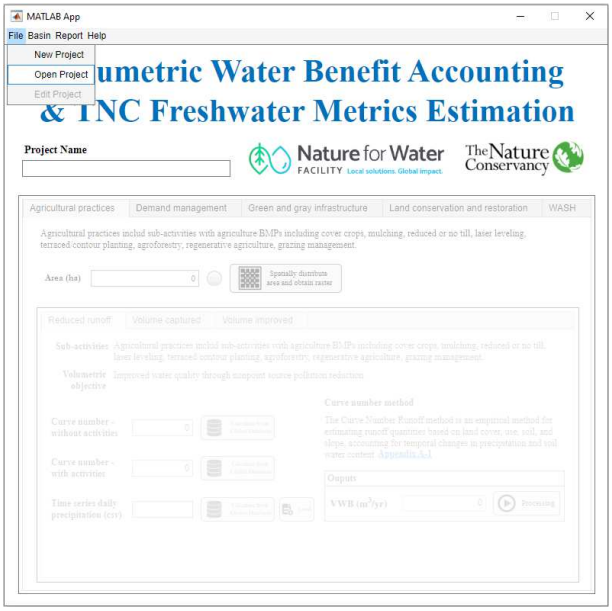
Figure 3-8. ***VWBA Tool main window***



3.2.2 Open Project

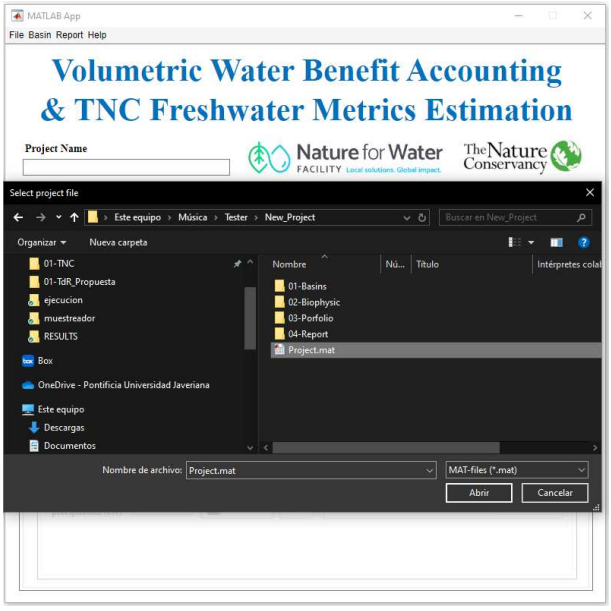
The option **Open Project** allows you to open a project previously configured in VWBA Tools. As seen in Figure 3-9, this option is available in **File** inside the toolbar.

Figure 3-9. ***Location of the Open Project option in VWBA Tool***



By clicking on the option **Open Project** A Windows File Explorer will be displayed with which you can locate the ".mat" file of the project you want to open (see Figure 3-10).

Figure 3-10. ***Windows File Explorer - Open Project Option***

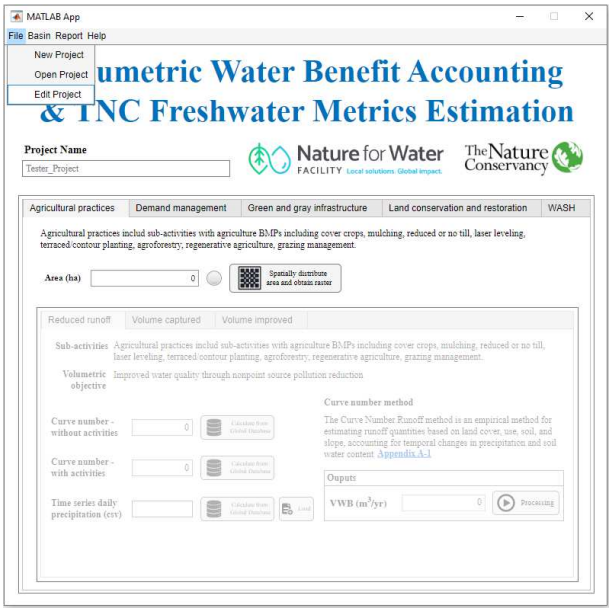


Once the project is opened, the tool will enable the options according to the current state of the project.

3.2.3 Edit Project

The option **Edit Project** allows you to edit the information entered by a user in a project previously configured in configuration in VWBA Tools. As seen in Figure 3-11, this option is available in **File** inside the toolbar.

Figure 3-11. ***Location of the Edit Project option in VWBA Tool***

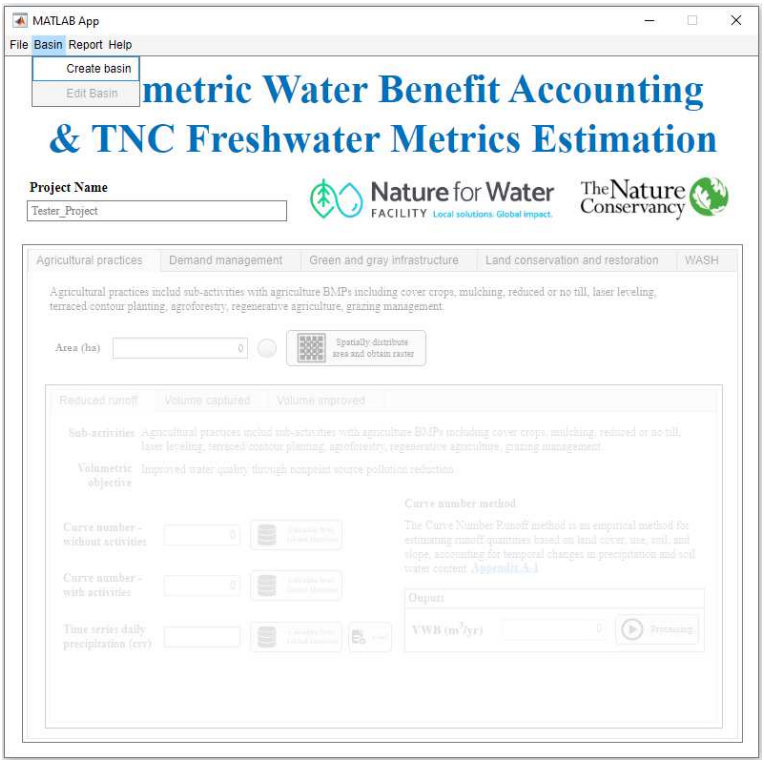


By clicking on the option **Edit Project** The window presented in Figure 3-7 will be displayed. In it, you can edit the information previously filled out. When you finish editing, click the button **Save.**

3.2.4 Create and Edit Basin

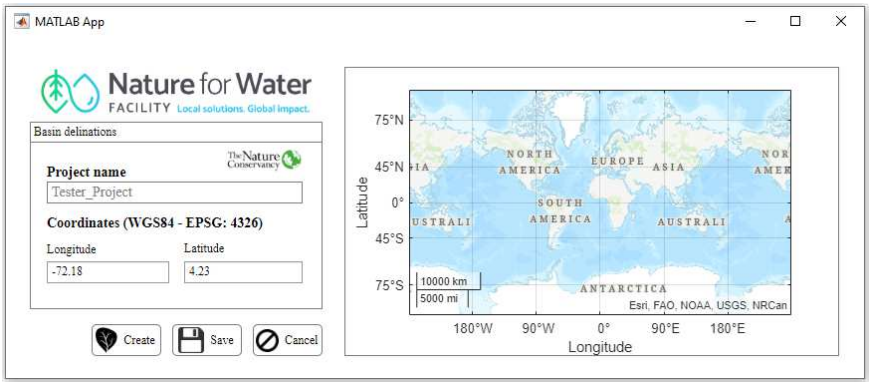
VWBA Tool understands a study area as a hydrographic basin. Therefore, to estimate the volumetric benefits, the hydrographic basin in which the nature-based solutions interventions are being carried out must be delimited. For this, click on the option **Create Basin** which is available in **Basin** inside the toolbar (see Figure 3-12).

Figure 3-12. ***Location of the Create Basin option in VWBA Tool***



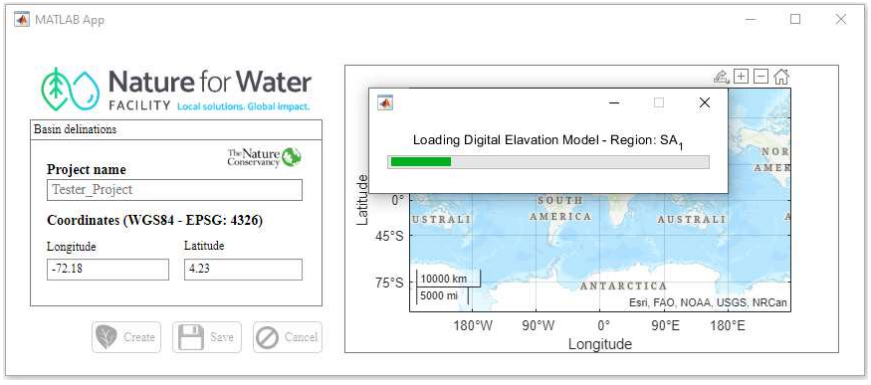
You will notice that a window like the one presented in Figure 3-13 will appear. To delimit a hydrographic basin, you must enter the geographic coordinates (latitude and longitude) of the closure point and click on the button **Create**.

Figure 3-13. ***Window for hydrographic basin delimitation***



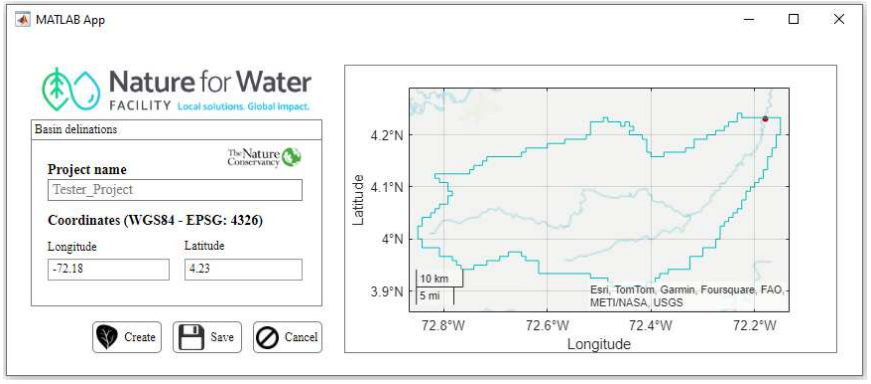
A progress window will be displayed, showing the progress of processing the digital terrain elevation model for the delimitation of the watershed (see Figure 3-13). Depending on the characteristics of the computer on which you are running the tool, this process may take several minutes, so be patient and do not close the progress window.

Figure 3-14. ***Watershed delimitation processing***



Upon completion, the polygon of the hydrographic basin afferent to the coordinate of the given closure point will be displayed in the geographic viewer of the window. Likewise, the coordinate of the assigned point is displayed in red (see Figure 3-15).

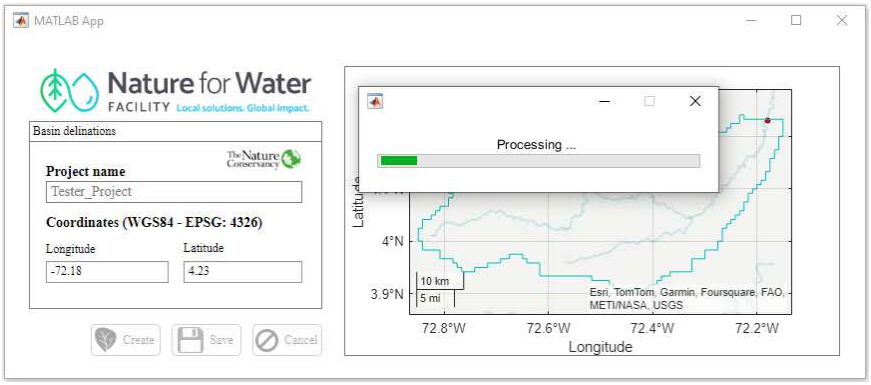
Figure 3-15. ***Delimited hydrographic basin***



If the polygon presented in the geographic viewer is correct, click the button **Save**. By doing so, the tool will begin the configuration and processing of the global databases, specifically for the delimited watershed. The progress of the processing

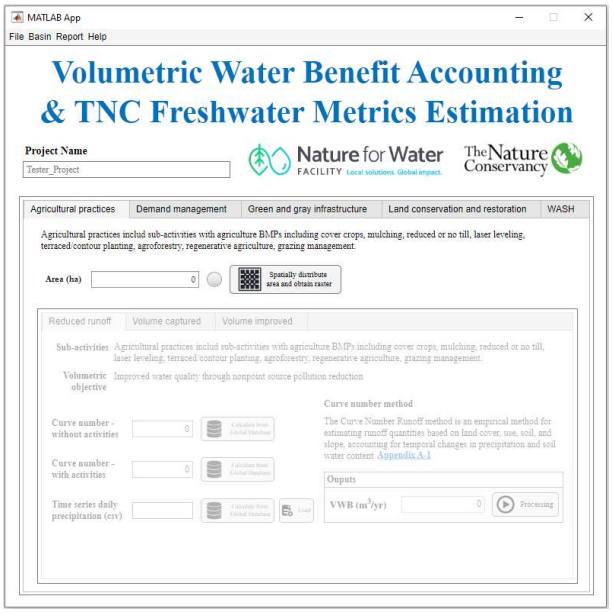
can be viewed in the progress window displayed by the tool (see Figure 3-16). Depending on the characteristics of the computer on which you are running the tool, this process may take several minutes, so be patient and do not close the progress window.

Figure 3-16. ***Database processing***



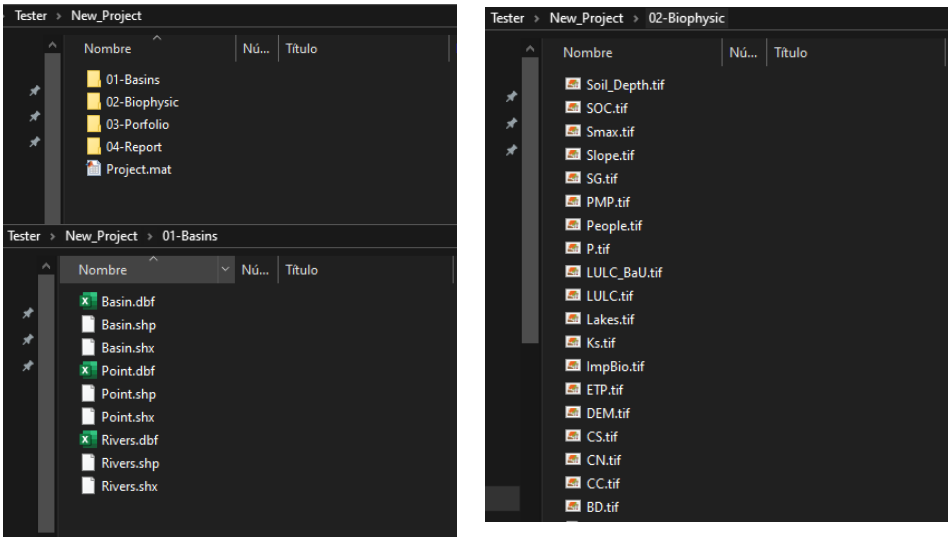
At the end of the configuration, the delimitation window will close and the models for estimating the volumetric benefits will be activated (see Figure 3-17).

Figure 3-17. ***VWBA Tool configured for calculation***



If the user is in the folder defined for the project, they will notice that the folder *01-Basin* contains the shapefile files of the delimited hydrographic basin and its closure point. Likewise, in the folder *02-Biophysic* You will be able to find the biophysical information specifically for the delimited hydrographic basin, which the tool uses for its calculations (see Figure 3-18). All this information can be viewed and processed in a geographic information system according to the user's needs.

Figure 3-18. ***Consolidation information in the project folder***

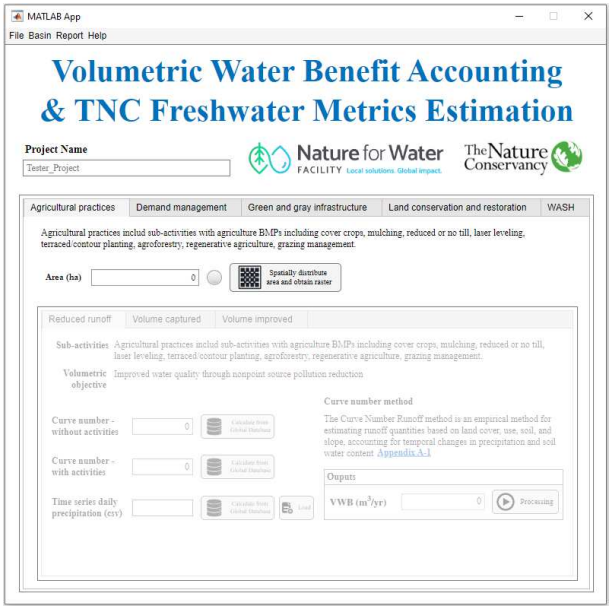


If you want to edit the basin you created, click the option **Edit Basin** which is available in **Basin** inside the toolbar (see Figure 3-12). Repeat the steps described above for the creation process.

3.2.5 Calculation of volumetric benefits

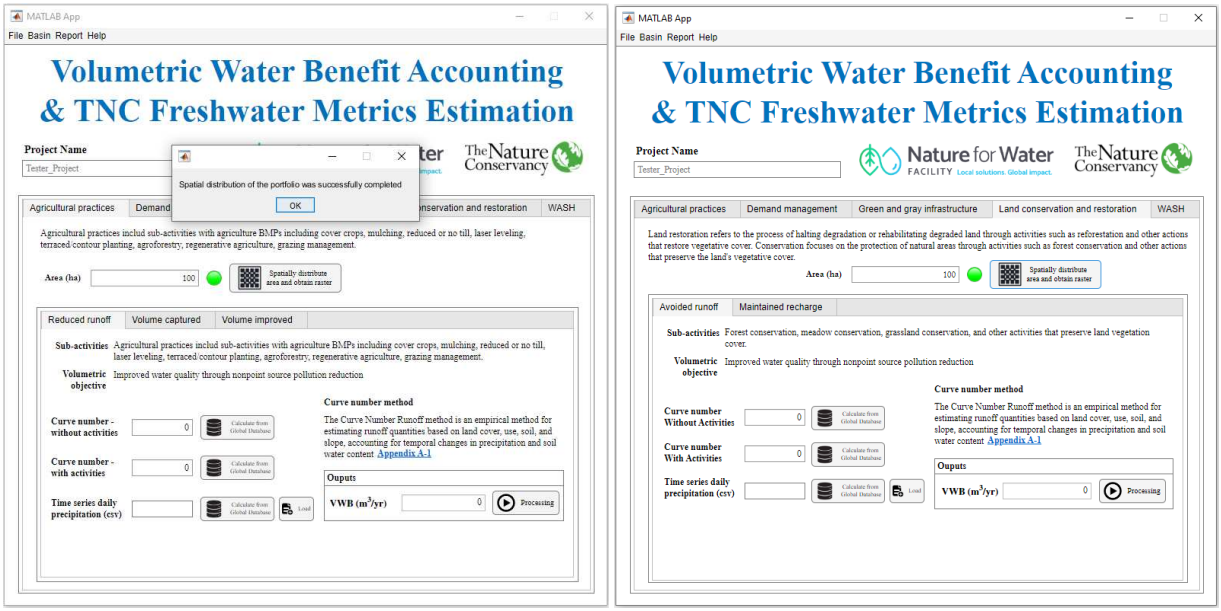
The VWBA Tool estimates volumetric benefits according to the methods described in the Volumetric Water Benefit Accounting (VWBA): A Method for Implementing and Valuing Water Stewardship Activities guide and the Volumetric Water Benefit Accounting 2.0 – Installment 4 Updated VWB Calculation Methods guide. According to these guides, nature-based solutions are grouped into five categories: Agricultural practices, Demand management, Green and gray infrastructure, Land conservation and restoration and WASH. This same distribution is what the tool uses to group the volumetric profit indicators (see Figure 3-19).

Figure 3-19. ***Distribution of intervention categories***



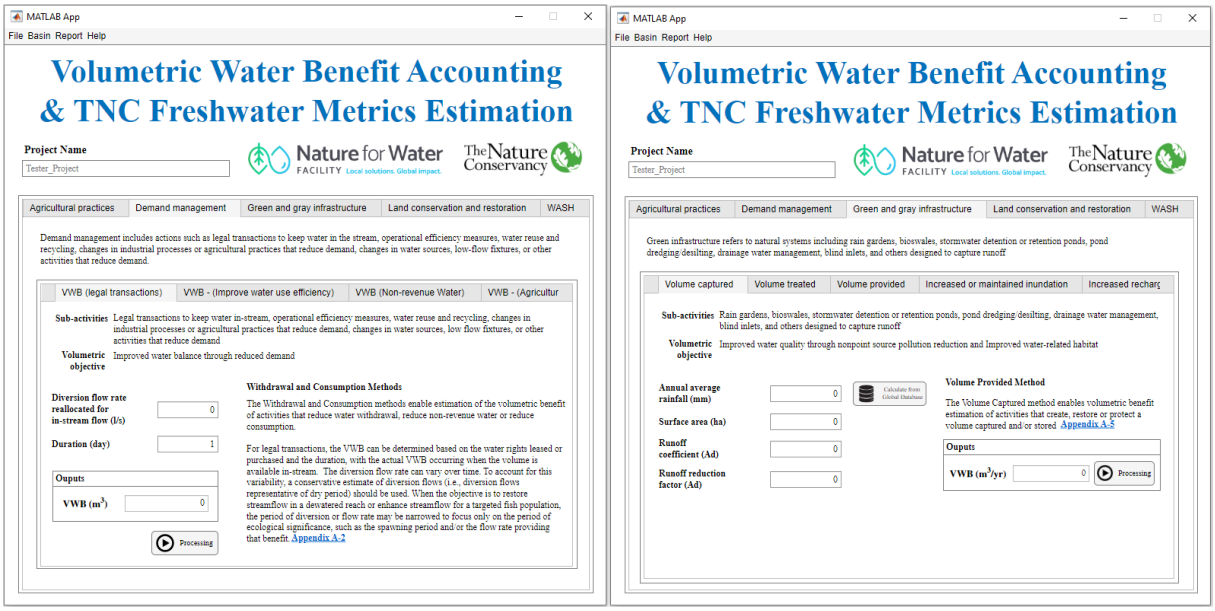
Initially you will notice that the Agricultural practices and Land Conservation and Restoration modules will appear disabled. To enable them, it is necessary to enter the area (in hectares) of the terrestrial intervention of nature-based solutions (which are part of each category) whose benefit you want to estimate. Then click the Button **Spatially distribute area and obtain raster**. The tool will immediately specialize the entered area within the basin and enable the indicators of each category for estimation (see Figure 3-20).

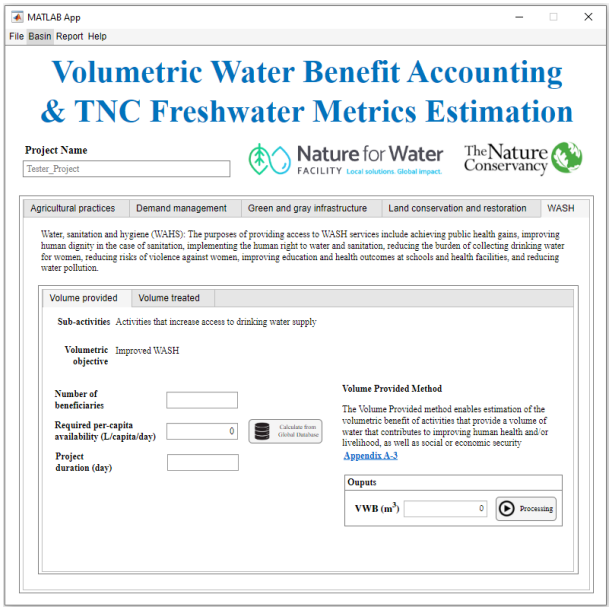
Figure 3-20. ***Agricultural practices and Land Conservation and Restoration module***



Due to the methods they incorporate, the Demand management, Green and gray infrastructure and WASH modules will always be enabled for use when a hydrographic basin for analysis has been delimited (see Figure 3-21).

Figure 3-21. ***Módulos de Demand management, Green and gray infrastructure and WASH***





In some of the methods to estimate volumetric benefits, the tool offers the possibility of estimating the values of the input variables from global databases, using the button **Calculate from Global Database**. By clicking on any of these buttons, the tool will process the information from the database corresponding to the variable in question and estimate a specific value for the analysis basin. The data it uses can be consulted in the button **Database** which is available in **Help** inside the toolbar.

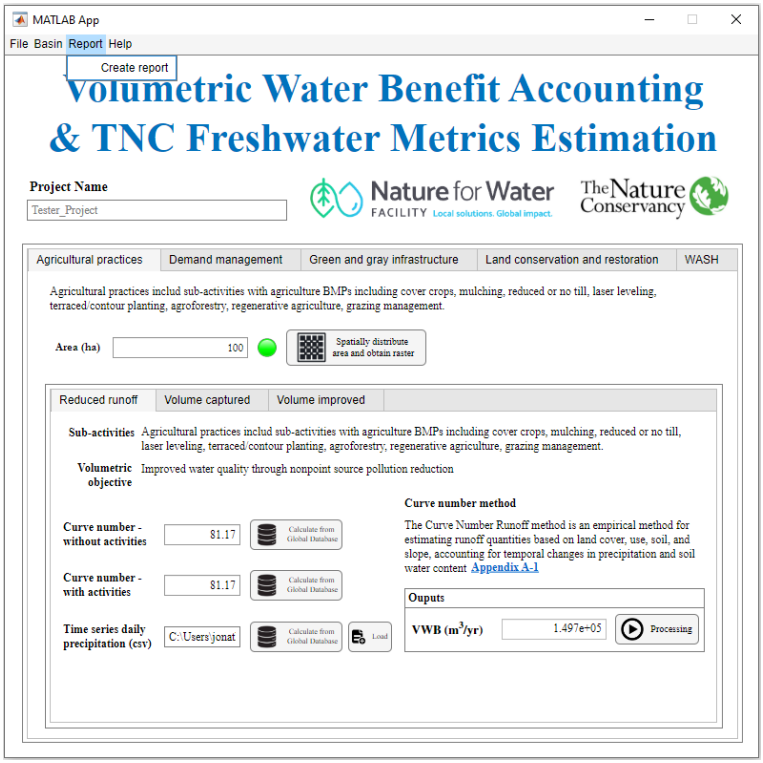
Furthermore, all methods have a brief description. Next to it, there is a hyperlink that, when clicked, refers the user to the appendix that contains the detailed description of the method.

3.2.6 Results report

The VWBA Tool v1.0 allows users to generate reports to document and present the results of their analyzes clearly. The tool creates reports that summarize the volumetric benefits of nature-based interventions, the metrics of kilometers of rivers, hectares of wetlands and number of people benefited in the analysis basin, as well as areas important for biodiversity.

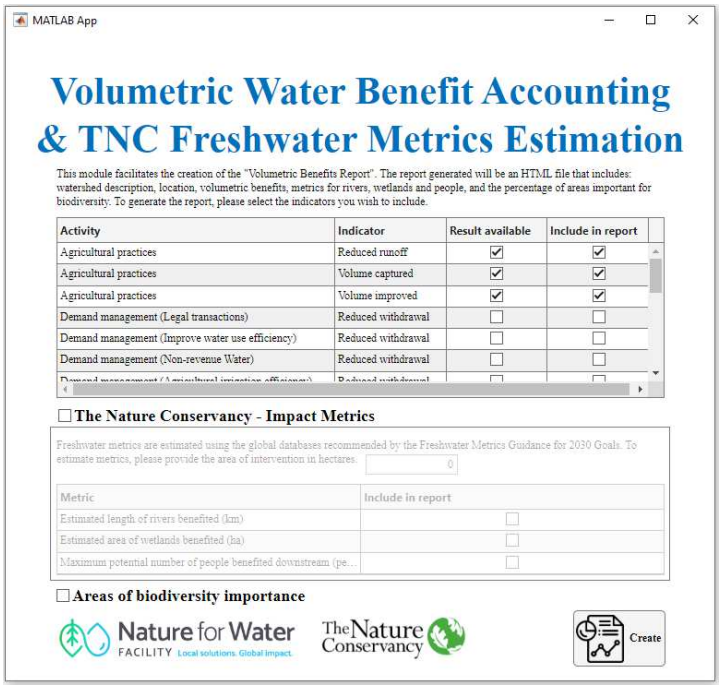
To generate a report, click on the option **Create Report** which is available in **Report** inside the toolbar (see Figure 3-22).

Figure 3-22. ***Location of the Report option in VWBA Tool***



By clicking on the option **Create Report** A window with the one presented in Figure 3-23 will be displayed.

Figure 3-23. ***Report generation window***

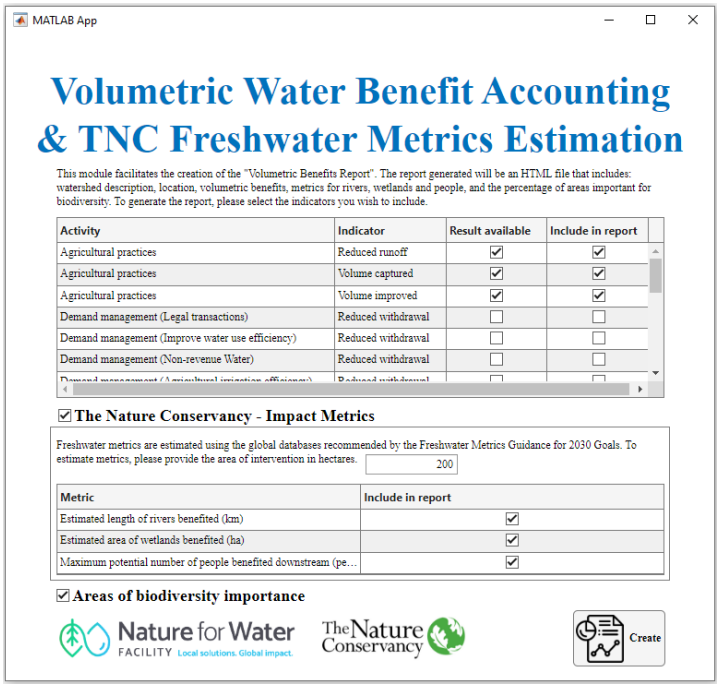


You will notice that the first table in the window contains the list of all indicators by category. The indicators with an activated check in the "Results Available" column correspond to those that have been calculated and have results available to be incorporated into the report. It is likely that not all calculated indicators will be required to be contained in the report. The

"Include in report" column allows you to enable or disable, through a Check Box, the indicators that you want to include in the report.

If you want the report to contain The Nature Conservancy's metrics and areas of importance for biodiversity, click on the respective Check Boxes and enable the options.

Figure 3-24. ***Location of the Open option in VWBA Tool***



Freshwater metrics are calculated using the global databases recommended by the TNC Freshwater Metrics Guide for the 2030 Goals. For rivers, the HydroSHEDS database is used, while for wetlands, the Global Lakes and Wetlands database. The metrics for rivers and wetlands are proportional to the land intervention area entered by the user in this window. The previous area corresponds to the sums of the areas of the activities in the Agricultural Practices and Land Conservation and Restoration category.

On the other hand, the total number of beneficiaries is calculated as the relationship between the volume of recharged water (which is estimated using method A-15 of the volumetric benefits guide) and the global average endowment volume estimated at 150 liters per person and day.

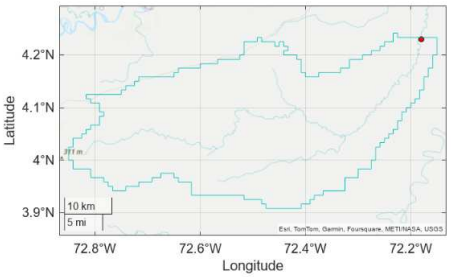
Regarding the areas of importance for biodiversity, they are estimated using the data generated by Jung et al. (2020). The categories are defined by five regular intervals. The proportion of the hydrographic basin area that corresponds to each category is consolidated in the table.

Once you have indicated the information you want to include in the report, click on the button **Create**. The tool will estimate the portfolio of entered area and the volume of recharged water. Subsequently, it will display an HTML file that corresponds to the report. This report contains the information that the user entered when configuring the project, an image of the analysis basin, tables with data on volumetric benefits, metrics and areas of importance for biodiversity. Each section contains descriptive summaries that facilitate the interpretation and communication of the results to different audiences, from decision makers to technicians and other stakeholders (see Figure 3-25).

Figure 3-25. *Report format*

Tester_Project

Tester



Volumetric Water Benefit

Volumetric benefits are estimated using the methods described in the Volumetric Water Benefit Accounting (VWBA): A Method for Implementing and Valuing Water Stewardship Activities guide and the Volumetric Water Benefit Accounting 2.0 – Installment 4 Updated VWB Calculation Methods guide.

Activity	Indicator	Objetive	VWB (m^3)	Method
Agricultural practices	Reduced runoff	Improved water quality through nonpoint source pollution reduction	149702.55	A-1
Agricultural practices	Volume captured	Improved water balance through increased supply	0.00	A-14
Agricultural practices	Volume improved	Improved water quality through nonpoint source pollution reduction	1762701133.17	A-13

Metrics

Freshwater metrics are estimated using the global databases recommended by TNC's Freshwater Metrics Guide for the 2030 Goals. For rivers, the HydroSHEDS Database is utilized, while for wetlands, the Global Lakes and Wetlands Database is employed. The metrics for rivers and wetlands are proportional to the intervention area. The total number of beneficiaries is calculated as the ratio between the volume of recharged water (see A-15) and the global average endowment volume estimated as 150 liters per person per day.

Metrics	Value
Basin area (ha)	175228.81
Terrestrial intervention area (ha)	200.00
Total length of rivers in the basin (km)	748.26
Total area of wetlands in the basin (ha)	10354.50
Estimated total number of people in the basin (people)	11990
Estimated length of rivers benefited (km)	0.85
Estimated area of wetlands benefited (ha)	11.82
Maximum potential number of people benefited downstream (people)	163293.00

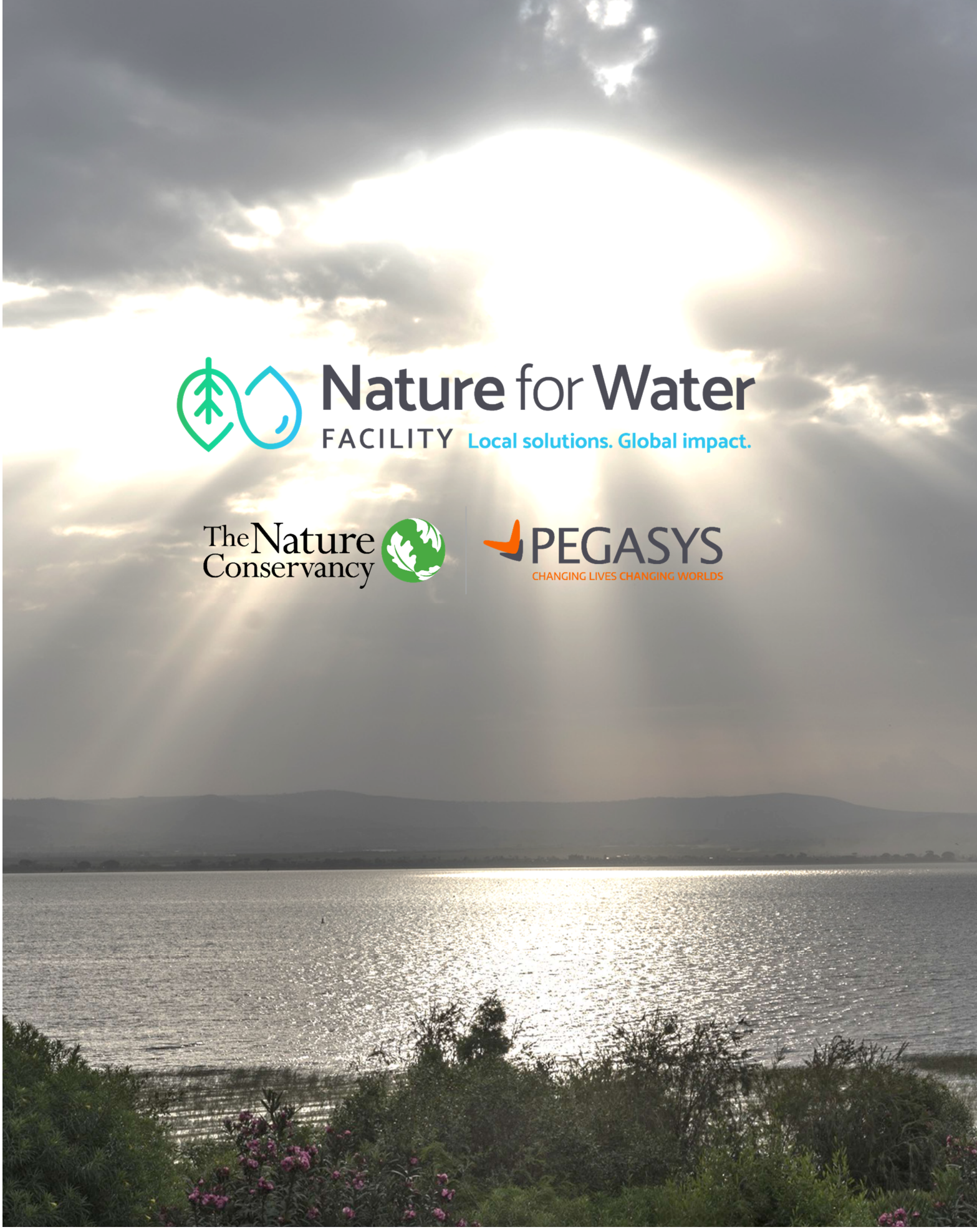
Distribution of areas by importance for biodiversity

Areas of importance for biodiversity are estimated using data generated by Jung et al. (2020). The categories are defined by five regular intervals. The proportion of watershed area falling into each category is consolidated in the table.

Category	Area (ha)	Area (Percentage)
Very high	24205.27	13.81
High	113272.37	64.64
Medium	26912.56	15.36
Low	1216.87	0.69
Very Low	9621.74	5.49

Nature for Water - Facility

Nature for Water FACILITY Local solutions. Global impact. The Nature Conservancy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