Water Benefits Calculator

Technical Guidance Document

Prepared for Catholic Relief Services

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LimnoTech
Water Environment | Scientists Engineers

Contents

1 Purpose of the WBC tool

The Water Benefits Calculator (WBC) is a web-based tool developed by Catholic Relief Services with support from the Inter-American Development Bank (IDB). The WBC can be used to simulate water runoff and sediment washoff for coffeeland farms in Central America and to compare the relative benefits of implementing one or more management interventions on a farm relative to a pre-management reference condition. Pre- and post-management conditions can be represented via the use of transects that represent the different crop and landscape configurations and patterns for a field area of interest. Results reported by the tool include seasonal and annual runoff, evapotranspiration, recharge, and sediment washoff rate at the farm or field scale.

2 Framework

The WBC tool framework is based on configuring a set of transects that represent the unique combination of topographic features in a coffee farm. A transect defines the representation of topographic features and land use / land cover along the slope length of the farm or field area of interest. Within each transect, spatial patterns in land use are segmented as "cells." Each transect requires specification of appropriate land use segments (i.e., cells), fixed cell width (i.e., the lateral spacing), and the cell length (i.e., the vertical spacing) for each land use segment. Within a transect, the cell length can be varied to configure the vertical spacing of the topographic features. In order to facilitate configuration of spatial patterns, the cells are enabled with a dropdown menu containing a list of relevant land uses. A sufficient number of transects must be configured so that the "transect-set" can be reproduced/extrapolated along the lateral length and vertical length (i.e., slope length) of the farm.

3 Hydrological Simulation Program

The *Hydrologic Simulation Program - FORTRAN* (HSPF) model is a U.S. EPA program for simulation of watershed hydrology and water quality. There have been hundreds of applications of HSPF all over the world. The HSPF model uses information such as the time history of rainfall and potential evapotranspiration; land surface characteristics such as land-use patterns; and land management practices to simulate the processes that occur in a watershed. The result of this simulation is a time history of the quantity and quality of simulated runoff from pervious and impervious land surfaces.

The HSPF model consists of a set of modules arranged in a hierarchical structure, which support the continuous simulation of a comprehensive range of hydrologic and water-quality processes. A more detailed description of process representation in HSPF is provided in Bicknell et al. (2005).

The "PERLND" module of HSPF simulates the water quantity and quality processes that occur on pervious land areas. The "PERLND" module is implemented in the WBC tool for hydrology and sediment erosion/washoff (nutrients and pesticides are excluded). The WBC implementation of the "PERLND" module tracks at an hourly timestep the movement of water along three flow output paths: overland flow, interflow, and groundwater flow. A variety of storage zones are used to represent the processes that occur on the land surface and in the soil horizons. A schematic of the hydrologic processes represented in HSPF is shown in Figure 1.

The WBC tool generates uncalibrated model simulations of hydrology and sediment loss from coffeeland farms. Results from the current tool are well suited for evaluating relative changes between pre- and post-management conditions, and therefore the relative benefits of various management approaches; however, the absolute values should be considered uncertain and used with caution.

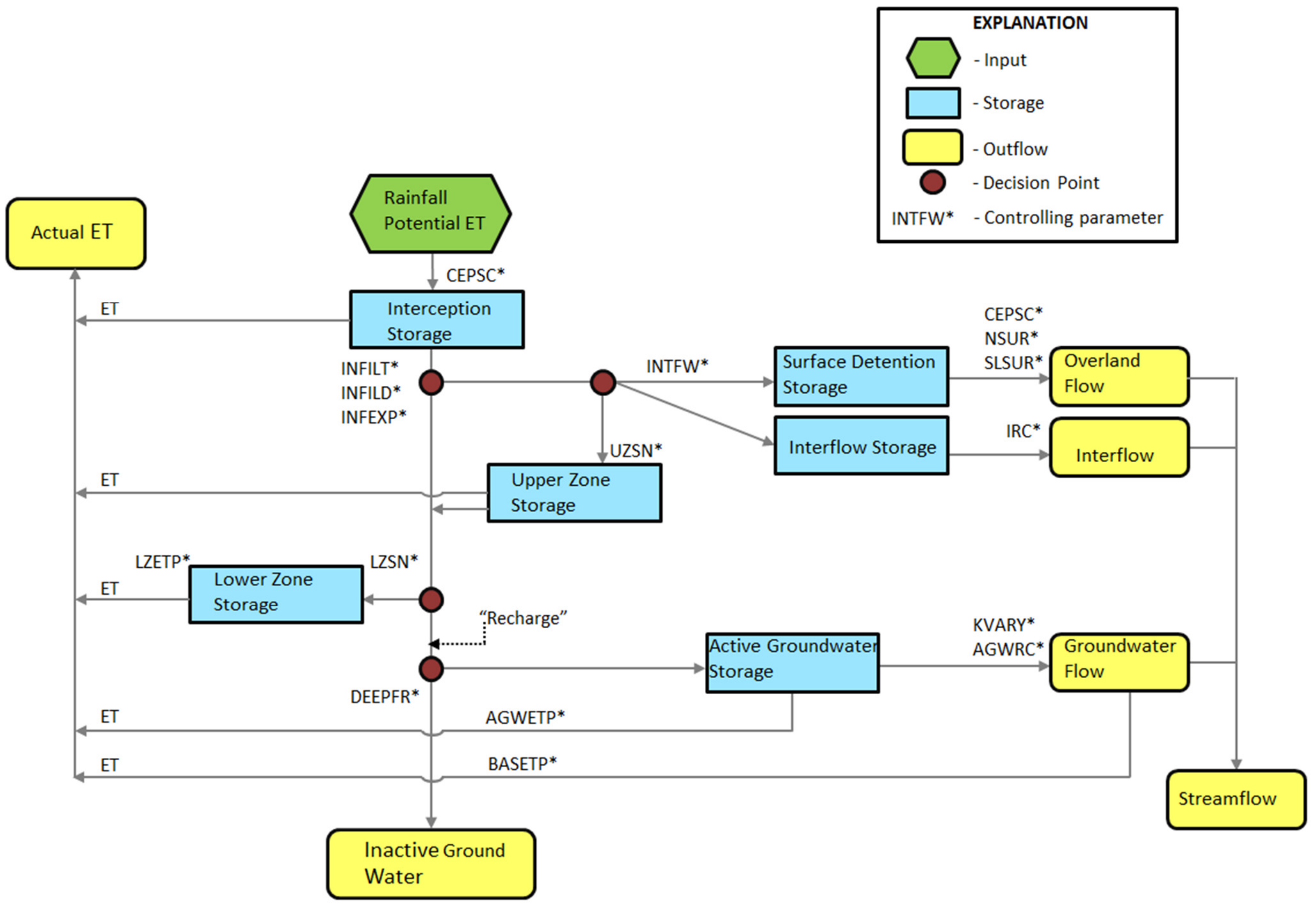


Figure 1. Hydrologic cycle as modeled in HSPF

4 Key Methods and Assumptions

Key methods and assumptions employed in the WBC are summarized below:

- A daily precipitation time series is required as input, and this series is disaggregated to hourly values by the WBC. The hourly distribution is assumed to follow a triangular distribution with peak rainfall occurring at midday.
- A daily potential evapotranspiration (PET) time series is required as input, and this series is disaggregated to hourly values by the WBC. The hourly distribution is assumed to follow a normal distribution centered on midday. Information on average daylight hours per day was used to define the duration of non-zero PET within a day. The average daylight hours per day for each month for various locations across the globe is available from [http://www.climatemps.com/.](http://www.climatemps.com/)

- Water is assumed to only flow downstream in the WBC. Therefore, no interaction is assumed between transects (i.e., "cross slope," along the lateral dimension of the farm).
- Within each transect, water and sediment fluxes from an upstream cell are linked, as appropriate, to the downstream or receiving cell. The following assumptions apply for upstream to downstream cell linkage:
    - Surface runoff and interflow from an upstream cell are routed to the receiving cell. The receiving cell, in addition to generating surface runoff from rainfall within its own domain, also receives upstream surface runoff as an external input. Similarly, interflow from upstream enters the upper soil zone of the receiving cell.
    - Water entering the lower soil zone and the resulting groundwater (GW) flows are tracked by individual cells (i.e., there is no linkage of GW flows to other receiving cells). The groundwater flow output reported for the simulated farm or field area reflects the sum of the GW flows generated from each cell.
- Infiltration pits and ditches, which are generally referred to as "features" below, are simulated based on the following methods and assumptions:
    - Inflows to the infiltration pits/ditches include: 1) direct rainfall to the feature itself, and 2) surface runoff and interflow entering from the upstream cell.
    - Overflow occurs when actual water storage volume in a pit/ditch exceeds the total capture capacity of that pit/ditch.
    - The volume of water infiltrating from a pit or ditch is routed to the lower soil zone of the (downstream) receiving cell.
    - All sediment routed to an infiltration pit/ditch via surface runoff from the adjacent upstream cell (if any) will be assumed to deposit in that pit/ditch. As a result, the pit/ditch will gradually fill in with sediment over time, and the total available water capacity of the pit/ditch will decrease. The rate of in-filling for each pit/ditch feature included in the simulation is reported by the tool as described below in the "WBC Results Dashboard" section.
- The WBC tool assumes steady-state conditions with respect to plant growth. Seasonal and annual changes in vegetative growth stages are not considered in the current version of the WBC tool.
- Deep groundwater losses (inactive groundwater in Figure 1), which represent groundwater lost from the basin due to deep percolation (and flows into an adjacent basin), are assumed to be zero.

5 Land Types Simulated in the WBC

This section provides a description of the various types of land use / land cover (LU/LC) currently represented in the CRS WBC tool. Note that any of the LU/LC types discussed below can be assigned to a given segment represented within a user-specified WBC transect.

Hillslope

Hillslope represents the "patch" of open space, devoid of overstory vegetation, between coffee plants (Figure 2). Hillslope may contain herbaceous understory vegetation that provides various levels of ground cover (GC). Hillslope areas are assumed to follow the general slope characteristic of the coffee farm.

Figure 2. Hillslope areas

A total of 11 hillslope types were included in the WBC. These include "Hillslope (Bare soil)" to represent bare soil conditions (i.e., no herbaceous ground cover) and other (partially vegetated) hillslope types, with herbaceous cover increasing in increments of 10%, to represent various levels of percent ground cover.

Hillslope+Coffee (no Terracette)

This LU/LC type refers to a healthy coffee plant located on a hillslope, with coffee plants located in rows at regular spacing.

Hillslope+RustCoffee (no Terracette)

This LU/LC type refers to coffee leaf rust-affected coffee located on a hillslope. Coffee leaf rust is a fungal disease that affects susceptible coffee plantations. Rusted leaves drop so that affected trees are virtually denuded, thus reducing the canopy cover provided by affected coffee plants.

Terracette+RustCoffee

This LU/LC type refers to coffee leaf rust-affected coffee located on a terracette. Coffee leaf rust is a fungal disease that affects susceptible coffee plantations. A terracette is a step-like microtopographic feature that is created on a hillslope around individual coffee plants. Terracette microtopographic features exhibit a vertical drop and a horizontal platform (Figure 3). Terracette is a type of best management practice implemented to attenuate surface runoff, enhance infiltration and improve soil moisture.

Terracette+Coffee

This LU/LC type refers to a healthy coffee plant located on a terracette. A terracette is a step-like microtopographic feature that is created on a hillslope around individual coffee plants. Terracette microtopographic features exhibit a vertical drop and a horizontal platform (Figure 3). Terracette is a type of best management practice implemented to attenuate surface runoff, enhance infiltration and improve soil moisture.

Figure 3. Coffee plant on terracette

Basic Grains

Land use that represents general basic grain crops that are common in Central America (e.g., maize, rice and beans) (Figure 4).

Figure 4. Typical field growing basic grains

Cacao
Cacao is a small (4 - 8 m tall) evergreen tree native to the tropical regions of Central and South America (Figure 5).

Figure 5. Cacao

Terracette+Cacao
This LU/LC type refers to Cacao located on a terracette. Cacao is a small (4 - 8 m tall) evergreen tree native to the tropical regions of Central and South America (Figure 5). A terracette is a step-like microtopographic feature that is created on a hillslope around individual coffee plants. Terracette microtopographic features exhibit a vertical drop and a horizontal platform (Figure 3). Terracette is a type of best management practice implemented to attenuate surface runoff, enhance infiltration and improve soil moisture.

Shade Species (< 2.5 meters)
Shade species are trees that are incorporated into the coffee farms as part of the production system. “Shade Species (< 2.5 meters)” refers to shade species on a hillslope that are less than 2.5 m in height. Examples of trees in this category include Higuera, Gandul, and Tephrosia. Shade species provide many environmental benefits that include providing shade to the coffee growing system.

Shade Species (< 2.5 meters) + Terracette
This LU/LC type refers to a shade species (< 2.5 meters) located on a terracette. Examples of trees in this category include Higuera, Gandul, and Tephrosia.

Shade Species (2.5 - 6 meters)
“Shade Species (2.5 - 6 meters)” refers to shade species that can grow up to 2.6 - 6 m in height on a hillslope. Examples of trees in this category include Plantain, Orange, Tangerine, Lemon, and Grapefruit. Shade species provide many environmental benefits that include providing shade to the coffee-growing system and enhancing biodiversity.

Shade Species (2.5 - 6 meters) + Terracette
This LU/LC type refers to a shade species (2.5 - 6 meters) located on a terracette. Examples of trees in this category include Plantain, Orange, Tangerine, Lemon, and Grapefruit.

Shade Species (> 6 meters)
“Shade Species (> 6 meters)” refers to shade species that are > 6 m located on a hillslope (Figure 6). Examples of trees in this category include Pine, Zapote, Mampas, Cedro Rojo, Guava, Espavel, Cuajiniquil, Gravilea, Laurel, and Nogal. Shade species provide many environmental benefits that include providing shade to the coffee-growing system and enhancing biodiversity.

Figure 6. Shade species (> 6 m)

Shade Species (> 6 meters) + Terracette

This LU/LC type refers to a shade species (> 6 meters) located on a terracette. Examples of trees in this category include Pine, Zapote, Mampas, Cedro Rojo, Guava, Espavel, Cuajiniquil, Gravilea, Laurel, and Nogal.

Live Barrier (Izote)

A live barrier consists of rows of dense plants used to prevent soil erosion. Live barriers are planted along an elevation contour of a hillslope between rows of coffee plants. This live barrier category represents woody stemmed, medium height perennial plants that are similar to Izote (Figure 7). Note that Izote is generally similar in appearance but smaller than Espadilla, which is another live barrier type included in the WBC (see below).

Figure 7. Live Barrier (Izote)

Live Barrier (Espadilla)

This live barrier category represents woody stemmed, medium height perennial plants that are similar to Espadilla (Figure 8). Note that Espadilla tend to grow much thicker and bigger than Izote, which is another live barrier type included in the WBC (see above).

Figure 8. Live Barrier (Espadilla)

Dead Barrier (Stone walls)

Dead barriers are stone walls or stone lines that are built along a contour to control soil erosion. The stone lines are arranged along the contour to act as a permeable barrier that slows down the movement of water and soil, improves infiltration, and mitigates landslides and traps sediment, thereby reducing the extent of erosion (Figure 9).

Figure 9. Dead barrier (stone walls)

Dead Vegetative Cover

Dead vegetative cover includes soil cover provided by dead plant material and leftovers from pruning (Figure 10). Soil cover protects the soil from rain and wind, prevents erosion, suppresses weeds, and increases soil fertility and soil moisture.

Figure 10. Dead vegetative cover

Infiltration Pit

The “infiltration pit” type refers to an excavated hole in the hillslope (Figure 11). An infiltration pit is a type of best management practice implemented to capture surface runoff and sediments, allow infiltration, and improve soil moisture. Typical dimensions of infiltration trenches are 1 m x 1 m x 1.8 m (L x W x D).

Figure 11. Infiltration pit feature

Infiltration Ditch

The “Infiltration ditch” type refers to horizontal excavation along the contour of the hillslope (Figure 12). An infiltration ditch is a type of best management practice implemented to capture surface runoff and sediments, allow infiltration, and improve soil moisture. Typical dimensions of an infiltration ditch are 3.7 m x 0.7 m x 0.75 m (L x W x D).

Figure 12. Infiltration ditch feature

6 Instructions for Using the WBC

The following sections provide descriptions of the various WBC functionalities and complete instructions on how to interact with the WBC, including accessing the WBC, creating projects, configuring farm inputs, setting up and executing simulations, and evaluating results.

Create User Account

The first step in using the WBC is creating a user account. Click on “Request Account” at the top right of the web page to begin this process.

Enter all information and click the “Submit Request” button. Following this step, the user will receive an automated email containing a link to confirm their account request. After confirming the account request, the user will have access to the WBC tool.

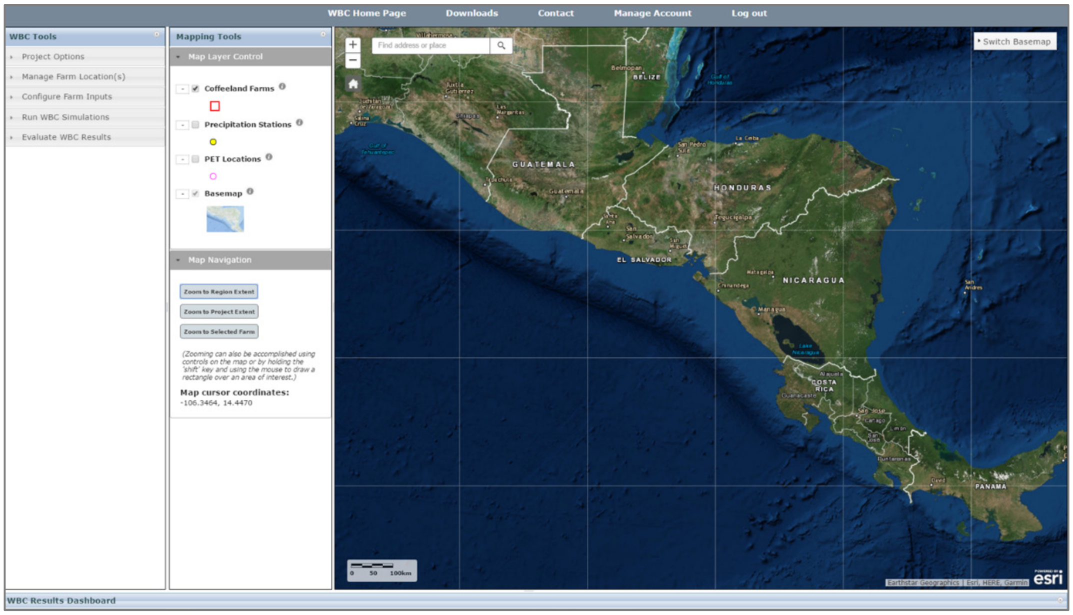
Creating a user account allows the user to “Log In” and create, manage and save projects in the WBC.

Log in

The "Log In" page requires an email address and password, and provides an option to reset your password if forgotten. Following “Log In,” a pop-up window will appear containing a brief description of the WBC tool and a "User Agreement." The user must click "I Agree" to access the WBC interface.

WBC Interface

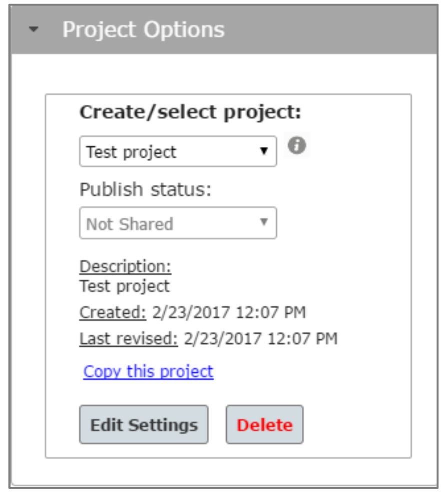
The WBC interface consist of three main panels, including the "WBC Tools" panel, the "Mapping Tools" panel, and the map panel.



The map panel contains a basemap and displays the farms that are added to the WBC project. The search feature in the map panel can be used to navigate to a specific longitude/latitude coordinate or to find a specific place. Coordinates need to be specified as longitude, then a comma, then latitude (e.g., -89.55, 15.44). The “Mapping Tools” provide control to turn on/off display of the project coffee farms added to the WBC and the various built-in WBC data layers, and zoom to various map extent. Zooming can also be accomplished using controls on the map or by holding the 'shift' key and using the mouse to draw a rectangle over an area of interest.

The “WBC Tools” section contains a menu of steps to guide the user through developing the project, managing farm locations, configuring inputs, running WBC simulations, and viewing results in a dashboard.

Project Options

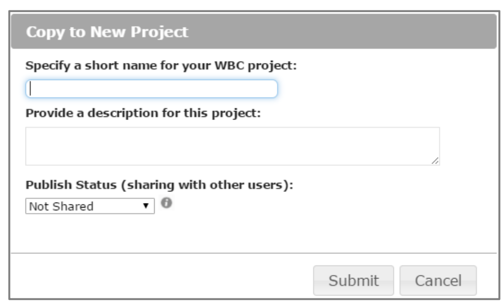


The “Project Options” panel provides options for creating a new scenario or selecting an existing scenario. The dropdown menu located below the “Create/select project” title will contain any projects created by the current user or shared by other users. Any of these projects can be selected and then viewed and modified (with the exception of shared “Read-Only Access” projects – see below).

For setting up a new project, select “Create new…” from the dropdown menu and click “Create Project.” A new window will appear. Specify a short name for the project. Optionally, a short description of the project can be included. The desired level of “Publish Status” (i.e., “Not Shared”, “Read-Only Access”, “Read/Write Access”) can then be selected. Finally, click “Submit” and proceed to the next steps.

The "Not Shared" option can be selected if the user does not wish to share the project with other WBC users. The "Read-Only Access" option will allow any other WBC user to view any results for this project; however, other users will not be able to edit any of the farm locations or inputs associated with the project or run any simulations. Selecting the "Read/Write Access" option will enable other WBC users to view and modify farm locations and inputs, as well as run WBC simulations for the project.

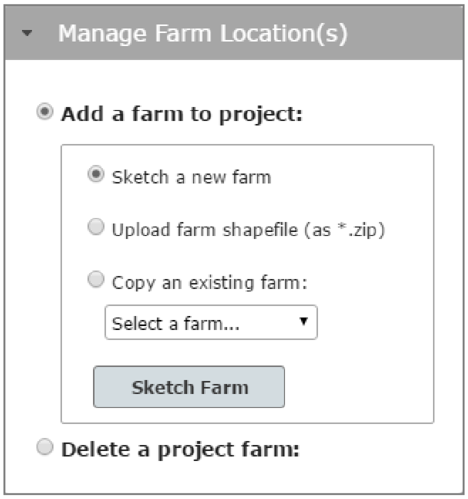
Projects shared by other WBC users will be included on the drop-down list of available projects, and these projects are denoted with a hash symbol (#). Keep in mind that the user will only be able to edit projects shared by others if they selected the "Read/Write Access" option when publishing the project.

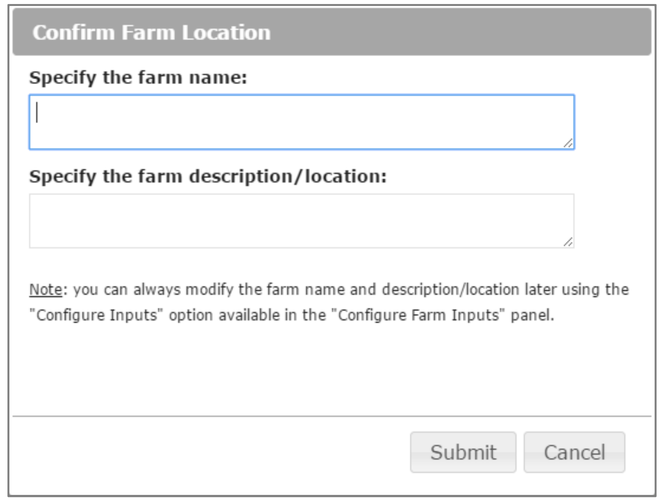


The “Copy this project” option can be used to copy an existing project to a new project. All existing projects created by the user and projects shared by other users with “Read/Write Access” status can be copied to a new project. Select the project to be copied from the drop-down menu and click “Copy this project.” Specify the name, description, publish status and click “Submit.” The selected project will be successfully cloned to a new project, including all farm location and input information associated with the original project. Please note that no WBC simulation results will be copied from the original project.

Manage Farm Locations

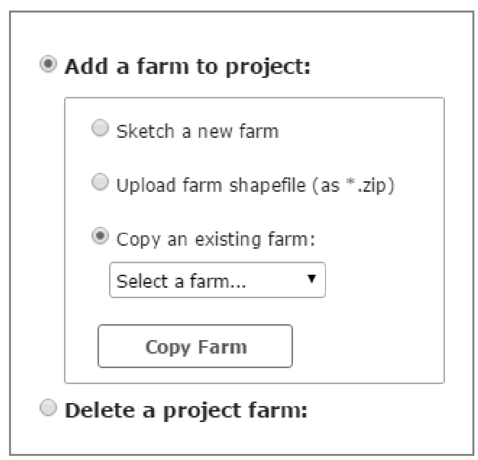
The next step is to add a farm to the project. There are three options to add a farm, which are described below.

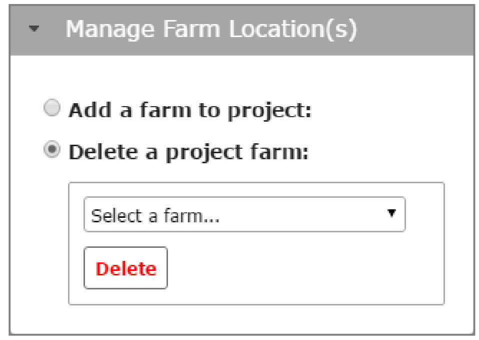




The “Sketch a new farm” option allows the user to draw and delineate the farm directly on the map. To use this option, select "Sketch a new farm," zoom to the farm location on the map, and then click the “Sketch Farm” button. A sketch tool will appear on the map. Sketch the farm boundary and click “OK.” A new window will appear prompting the user to “Specify the farm name” and “Specify the farm description/location. Enter this information and click “Submit.” The new farm will be added to the project. By following this procedure, multiple farms can be added to a project.

Farm(s) can also be added to the project using an external shapefile. To use this option, click “Upload from shapefile” and then click the “Upload Farm(s)” button to upload the shapefile.

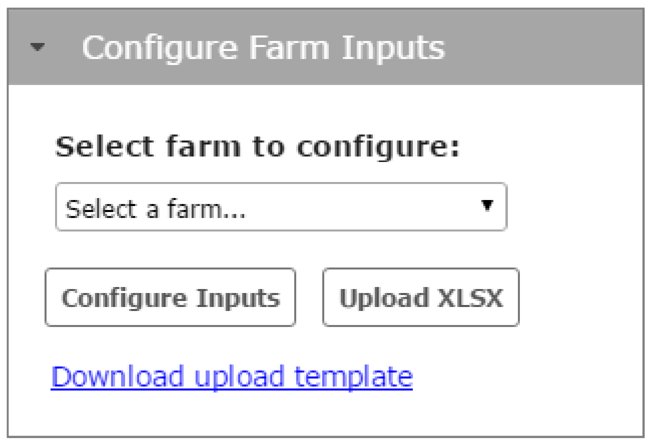




The “Copy an existing farm” option is available for copying a farm from any of the user’s existing projects, including the currently selected project. This option is ideal in situations where the user wishes to perform sensitivity simulations or modify inputs on farms available from existing projects. The drop-down list will display available farms from all the existing projects created by the user. The user can select the desired farm to copy and click the "Copy Farm" button. The farm polygon and all the associated information will be copied to the current project. The copied farm can be named as appropriate.

The “Delete a project farm” option can be used to permanently delete a farm from the project. The drop-down list will display available farms from all the existing projects created by the user. The user can then select the desired farm to delete and click the "Delete" button. Please note that this process will permanently delete a farm from the WBC database, and it will not be possible to recover any information for a deleted farm.

Configure Farm Inputs

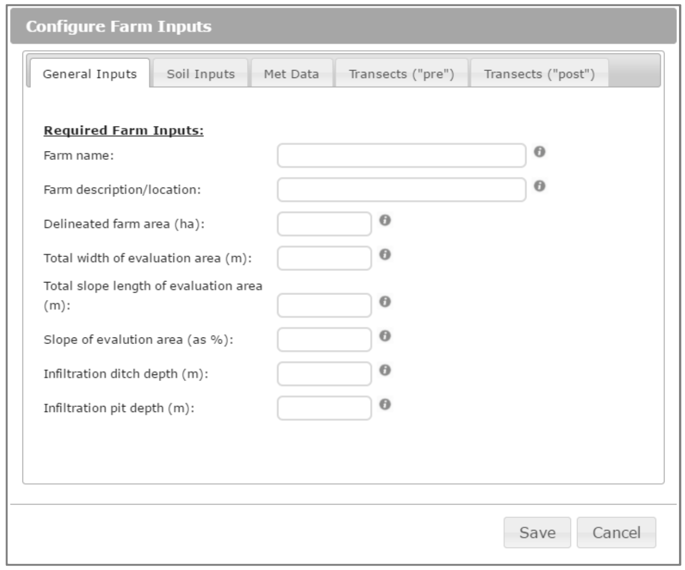


In this step the user completes farm configuration for both pre- and post-intervention conditions.

There are two options to specify the farm configuration: 1) specify the farm inputs using the WBC interface, or 2) use a Microsoft Excel spreadsheet template outside the WBC interface to specify the farm inputs. For the latter option, a template spreadsheet can be downloaded by clicking the “Download upload template” button. The farm inputs can be entered into the spreadsheet and then uploaded to the WBC.

To configure farm inputs within the WBC interface, click the “Configure Inputs” button. A new window will appear with multiple tabbed sections for specifying various inputs.

The following are the inputs in the “**General Inputs**” section.



Farm Name: A brief description or name of the farm must be provided here.

Farm Description/Location: Optionally, a brief description of the farm location can be provided here.

Delineated Farm Area: The total delineated area of the coffee field (specified in ha). The area for a farm is calculated based on the polygon that was sketched, imported from a shapefile, or copied from an existing farm and generally should not need to be changed. Please note that the actual evaluation area simulated by the WBC is not based on this value, but rather is based on the total width multiplied by the total slope length of the evaluation area specified by the user.

Total width of evaluation area (m): The total/average lateral width of the evaluation area (specified in meters).

Total slope length of evaluation area (m): The total/average downslope length of the evaluation area (specified in meters).

Slope of the evaluation area (as %). The average slope of the evaluation area (as %).

Infiltration ditch depth (m): Initial depth (in meters) of any and all infiltration ditches specified within transects for this farm. This input must be provided even if no infiltration ditches are specified in the transects for this farm; however, in that case, the value may be set to zero or -999.

Infiltration pit depth (m): Initial depth (in meters) of any and all infiltration pits specified within transects for this farm. This input must be provided even if no infiltration pits are specified in the transects for this farm; however, in that case, the value may be set to zero or -999.

The following are the inputs in the "**Soil Inputs**" section.

Soil texture: Soil texture indicates the relative amount of sand, silt, and clay particles in a soil sample. The proportions of these three particle sizes influence several soil properties, including water infiltration, percolation, soil aeration, moisture holding capacity, and others. The user can select a soil type that is appropriate for the farm.

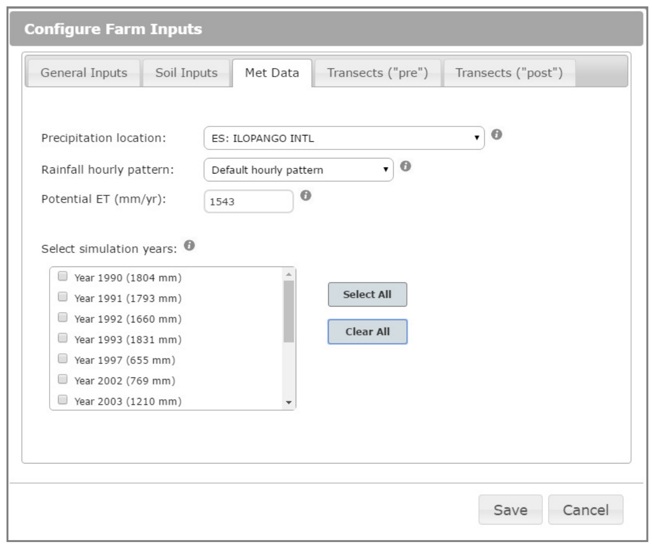
Bulk density (g/cm3): The soil dry bulk density must be specified as the weight of dry soil per unit of volume expressed in grams/cm^3 (or g/ml). Note that selecting a soil texture from the list will automatically assign a soil dry bulk density. However, the user can overwrite the default value and enter a preferred value for bulk density.

Soil Depth (cm): The soil depth input (specified in cm) represents the depth of the soil profile from the surface to the parent material, bedrock, or the layer of obstacles for roots. It differs significantly for different soil types, and it is one of the basic criteria used in soil classification. Soils can be very shallow (less than 25 cm), shallow (25 cm-50 cm), moderately deep (50 cm-90 cm), deep (90cm-150 cm), and very deep (more than 150 cm).

Infiltration rate (mm/hr): Infiltration is the downward entry of water into the soil. The velocity at which water enters the soil is the infiltration rate, expressed in mm/hr. This is an optional input that will not have any impact on WBC simulations.

Organic matter content (as %): Organic matter content is the fraction of the soil that consists of plant residues, soil microorganism, and decomposing and stable organic matter. This is an optional input that will not have any impact on WBC simulations.

The following are the inputs in the "**Met Data**" section, which include meteorological inputs and simulation time period.



Precipitation: By default, the WBC will select the precipitation station closest to the farm location when the farm location is created (i.e., via sketch or upload). However, the user may select an alternate precipitation location from the drop-down menu. The years for which precipitation data are available and the annual total precipitation for the selected station will be displayed. The user can select the years to include in the WBC simulation.

Rainfall hourly pattern: Running a WBC simulation for this farm requires that daily precipitation data be disaggregated to hourly precipitation inputs (e.g., mm/hr). Currently, this is the only disaggregation scheme available in the WBC, and this scheme distributes precipitation as a triangular distribution centered on noon. More daily-to-hourly disaggregation options may be added to the WBC in the future.

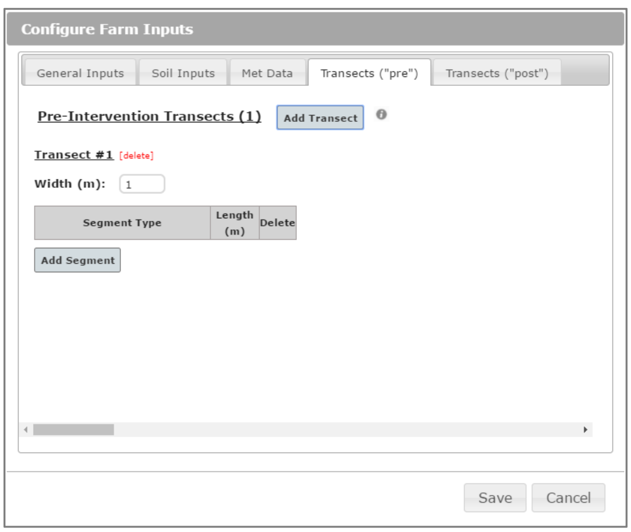
Potential Evapotranspiration (PET): By default, the WBC will assign a default PET location based on proximity to the farm location. The annual PET total for the selected data point will be displayed. The option to change the assigned PET location is not available in the current version of the WBC tool.

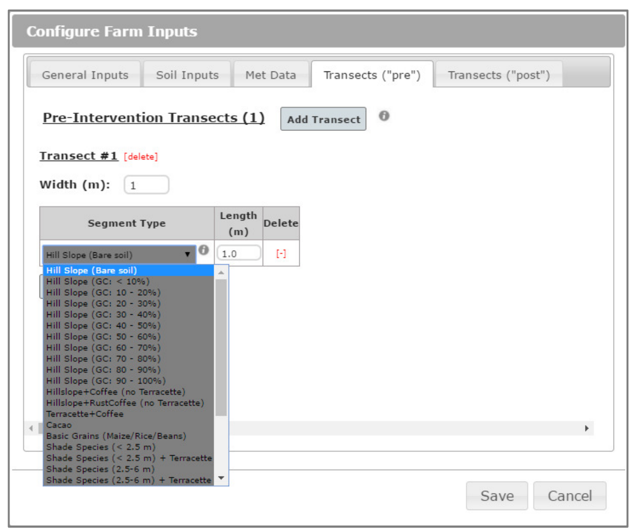
Following the specification of the farm, soil, and meteorological inputs, the next step is creating a representation of the farm configuration using transects. The WBC framework is based on configuring a set of transects that represent the unique combination of topographic features in a coffee farm. A transect defines the representation of topographic features and land use / land cover along the slope length of the farm. Within each transect, spatial patterns in land use are segmented as "cells." Each transect requires specification of appropriate land use segments (i.e., cells), cell width (i.e., the lateral spacing), and the cell length (i.e., the vertical spacing) for each land use segment. All cells within a given transect are assumed to have the same width, and so the width is assigned to the transect itself. Within a transect, the cell length can be varied to configure the vertical spacing of the topographic features. In order to facilitate configuration spatial patterns, the cells are enabled with a dropdown menu containing a list of relevant land uses. A sufficient number of transects must be configured so that the "transect-set" can be reproduced/extrapolated along the lateral length and vertical length (i.e., slope length) of the farm.

Instructions for completing the "Transects ("pre")" and "Transects ("post")" in the WBC interface are provided below.

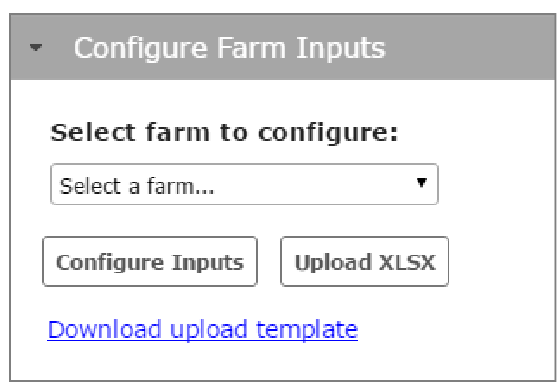
Click on the "Transects ("pre")" tab to configure the pre-intervention transects for the farm. Clicking on the "Add Transect" button will display the first transect (Transect #1) and enable the user to "Add Segment" (i.e., cells), and specify cell width (fixed for a given transect) and cell length (can be varied within a transect). The user can access the land uses included in the WBC by clicking "Add Segment" and then selecting the appropriate land use. The desired number of land uses can be added to a transect using the "Add Segment" button. Using the "Add Transect" button, any number of transects can be added to complete the pre-intervention farm configuration.

The next step, after completing the pre-intervention transect, is to complete the post-intervention farm configuration in the "Transects ("post")" tab by following the same instructions above.





The "Upload XLSX" button provides another option that can be used to complete farm configuration. The Microsoft Excel template spreadsheet can be downloaded by clicking the "Download upload template" link. The entire farm configuration, including all inputs (with the exception of meteorological data) and transects, must be entered into the spreadsheet and saved on the local drive of the computer. The "ReadMe" tab in the upload template contains instructions for specifying the farm inputs in the "Farm Upload" worksheet. Click on the "Upload XLSX" button, and navigate to the local drive to upload the completed

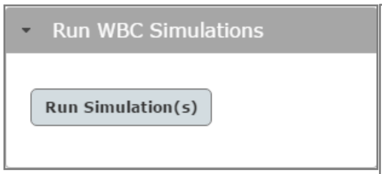


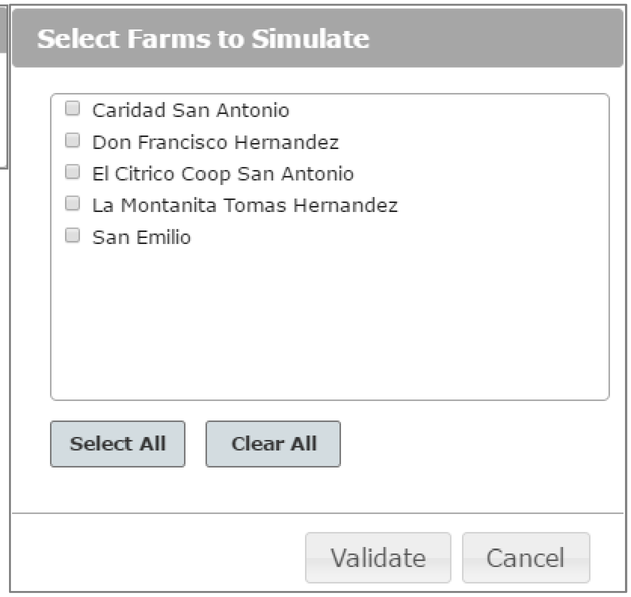
template. The WBC upload utility will copy all the inputs and transect information from the template spreadsheet into the WBC database. All the uploaded farm inputs can be reviewed and edited by clicking the "Configure Inputs" button.

It is important to note that the upload template does not include any information related to precipitation or PET location assignments or simulation time. This is by design, as the WBC is designed to assign precipitation and PET locations to the farm location when it is created (i.e., via the sketch or upload tools). However, the user may need or want to navigate to the "Met Data" tab in the farm input dialog to modify the assigned precipitation location and/or the years to be simulated by the WBC.

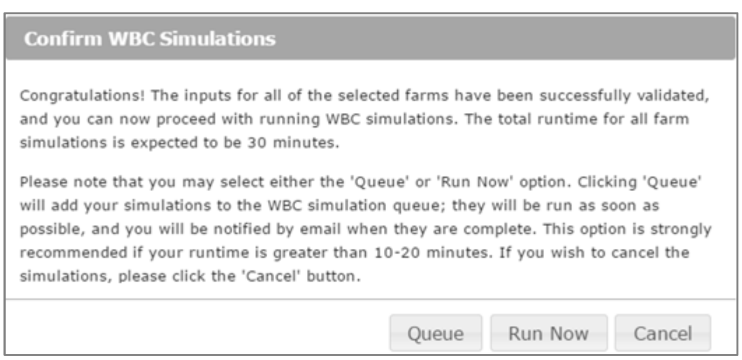
Run WBC Simulation

A WBC simulation can be run after completing the farm configuration by clicking the "Run Simulation(s)" button.

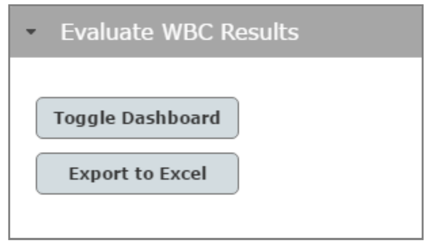




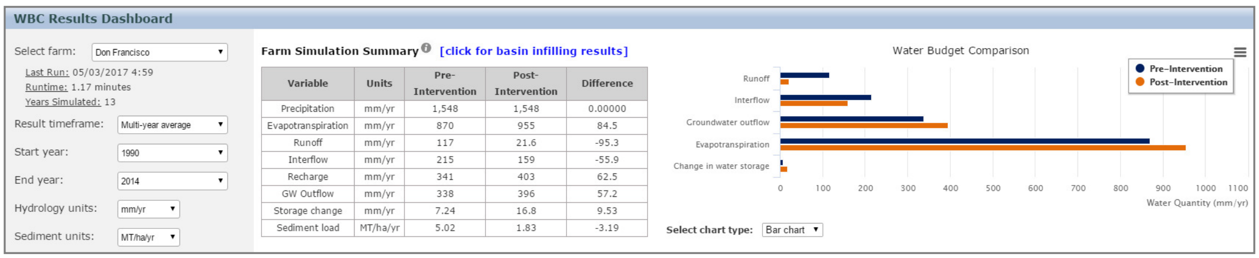
Upon clicking this button, all farms that are in a current project are displayed. The user can select a particular farm or multiple farms to simulate. After selecting the farms to simulate, the next step is to click the "Validate" button. The WBC will perform validation of the inputs and check for any potential errors. Any errors detected during the validation checking will be displayed to the user. If no input errors are found, the WBC will display two options to perform the simulation: "Queue" and "Run Now." Clicking the "Queue" option will add the simulations to the WBC simulation queue on the server. The simulations will be run as soon as possible, and the user will receive email notification when the simulations are complete and the results are ready for viewing. Clicking the "Run Now" button will begin the simulation(s) immediately, and the user will be required to wait for the simulation(s) to complete. Note that the user will not receive any email notification if the "Run Now" option was selected, and no work on the project or farms can be conducted in the tool while the simulation(s) are running (i.e., the tool will be in a "wait" mode).

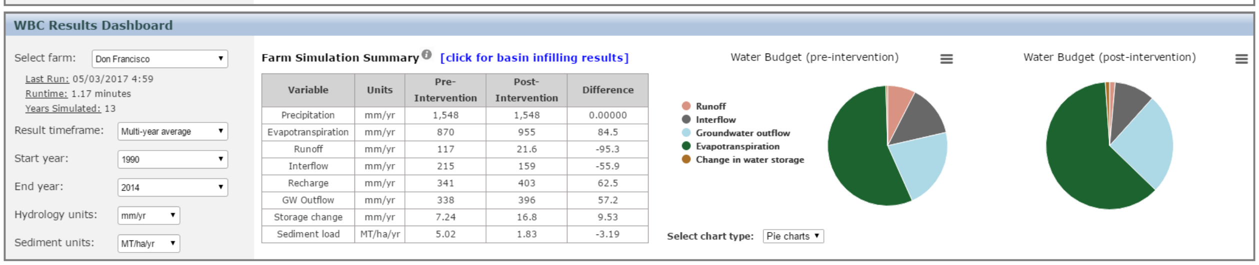


Evaluate WBC Results



The WBC interface includes a *WBC Results Dashboard* to display hydrology and sediment results for the pre- and post-intervention farm configurations. There are various options to display and evaluate the results in the WBC Results Dashboard. The “Toggle Dashboard” button can be clicked to view or hide the WBC Results Dashboard. The WBC results can also be exported to a Microsoft Excel workbook using the “Export to Excel” option, which is explained later in this section. The results can be reviewed in the WBC Results Dashboard using the following steps: 1) specify a farm using the “Select farm” dropdown menu; 2) specify “Result timeframe”; 3) specify “Start year”; 4) specify “End Year”; 5) specify “Hydrology units”; and 6) specify “Sediment units.” After all of the necessary selections have been made, results are displayed in tabular and graphical formats within the Dashboard.





As noted above, the “Select farm” menu contains a drop-down list of farms included in the project. Farms for which simulation results are not available can be selected, but no results will be shown for the farm.

The “Results timeframe” provides different options for processing the results including “Multi-year average,” “Seasonal period” and “Custom period.” The “Multi-year average” will display annual average results for the entire simulation period or for a subset of years (as specified using the “Start year” and “End year” options). Average monthly results for the entire simulation period can be viewed by selecting “Seasonal period” in the “Results timeframe,” and then specifying the start and end months in the “Start month” and “End month” menus, respectively. Note that the current version of the WBC only allows reporting of seasonal results for months within a calendar year (i.e., the start month must always be earlier than the end month). The “Custom period” option allows the user to specify the desired start and end periods, on a monthly basis, over the entire simulation period (i.e., using the “Start month/year” and “End month/year” options).

The user can select the hydrology units from four different options: “mm/yr,” “mm,” “m3/yr,” and “m3.” Similarly, four different options are provided for sediment reporting units: “MT/ha/yr,” “MT/ha,” “MT/yr,” and “MT.”

A breakdown of the hydrology components and sediment erosion results for the pre- and post-interventions and the differences are provided in a summary table. The hydrology results are also displayed in pie and bar charts. The “Select chart type” option can be used to toggle between pie and bar charts.

If the farm simulations include infiltration pits and/or ditches, the infilling results can be viewed by clicking the “click for basin infilling results” link located above the summary table. For every infiltration pit/ditch simulated by the WBC, the following results are reported: the “Initial Depth” at the beginning of the simulation, the “Final Depth” at the end of the simulation to reflect sediment filling, and the annual “Infilling Rate.” It is important to keep in mind that more infiltration pits/ditches may be reported for a given transect than were actually specified by the user for that transect. This is because the cells in the transect will be repeated “downslope” as many time as is necessary to represent the total slope length.

The WBC includes an “Export to Excel” option that can be used to export results to a Microsoft Excel spreadsheet. To use this option, the user must first specify the desired “Results Timeframe,” “Start year,” “End year,” “Hydrology units,” and “Sediment units.” Next, click on the “Export to Excel” button. A new window will appear displaying all the farms associated with the current project. The user can select a single farm or multiple farms to export and then click the “Export” button to initiate the export process. The WBC will produce a *.zip file and prompt the user to save the file to their local hard drive or local area network. The *.zip file must be unzipped/decompressed to access the Excel file(s) containing the results. If multiple farms are exported, then one spreadsheet will be exported for each farm.

Explanation of terms of the WBC results.

Evapotranspiration: Quantity of water lost through the combination of evaporation from the soil surface and transpiration through plant respiration. Evaporation + transpiration = evapotranspiration. The WBC breaks down evapotranspiration into *Interception ET (leaves)* and *Soil ET.* “Interception ET” represents the contribution of canopy interception storage to total ET, and “Soil ET” represents ET losses from the soil.

Runoff: Water that immediately runs off the soil surface during a precipitation event and is not used by plants or absorbed into the soil.

Interflow: Water that flows downslope within the upper soil zone (usually the top 10 cm or so).

Recharge: Represents the quantity of water entering the shallow groundwater storage.

Groundwater Outflow: This is water that has percolated into the groundwater storage and then discharged into downstream rivers and springs.

Change in water storage: Represents the overall change across all water storage compartments (i.e., final storages relative to initial storages at the beginning of the simulation or the start of a user-selected reporting period).

Water budget check: It is a diagnostic output and should be reported as zero. It represents the water balance as follows:

$$\text{Precipitation} = \text{ET} + \text{Runoff} + \text{Interflow} + \text{Groundwater outflow} \pm \text{change in storage}$$

Sediment Load: Represents landscape sediment erosion.

7 References

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