
WEAP

Water Evaluation And Planning System

Incorporating Gender Aspects

A TUTORIAL ON

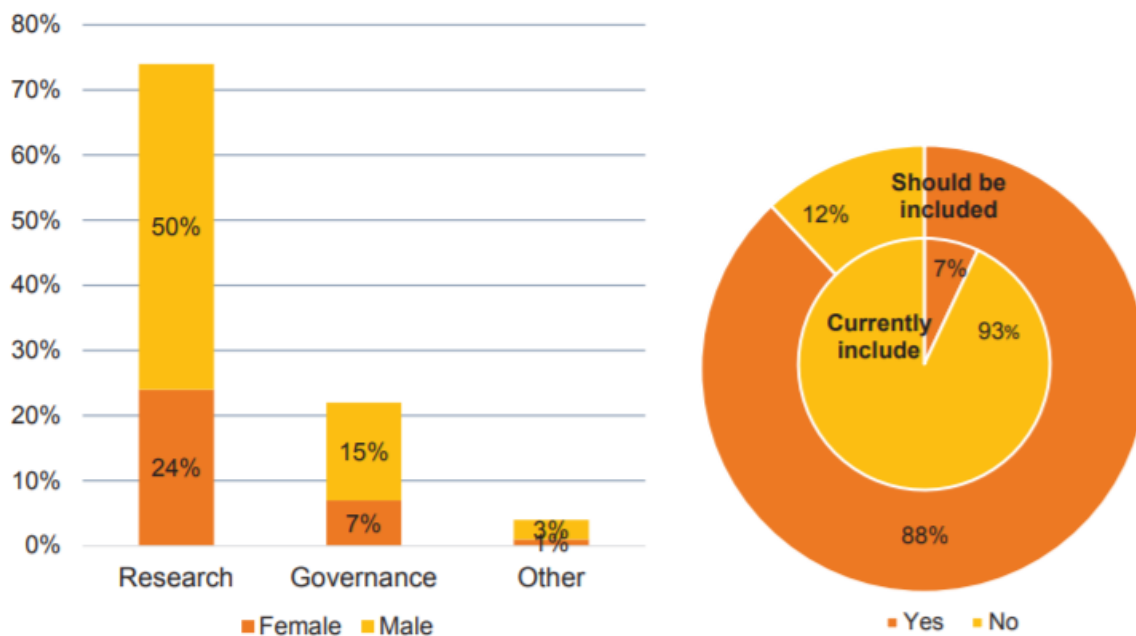
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1. Understanding Gender Challenges

As part of the Gender and Social Equality (GSE) program, WEAP modelers from the SEI-US Water Group are examining how to incorporate GSE aspects in WEAP. This process began with the development of a guidance document, called “Guidance Materials for Mainstreaming Gender Perspectives into Model-based Policy Analysis” (Escobar et al., 2017).¹ This guidance document describes the challenges in including GSE considerations in a technical analysis. The identified challenges are: i) lack of recognition of GSE issues, ii) low prioritization or interest, iii) lack of convincing scientific evidence, iv) lack of quantitative data, and v) lack of analytical tools. In addition, a survey done to WEAP and LEAP users shows that modelers think that GSE considerations should be included in the analysis (Figure 1). This tutorial aims to address the fifth challenge on the *lack of analytical tools* and respond to our user community by showing how WEAP can be used to model Gender issues related to water collection labor, which affects many women and children in various parts of the world.



Right: Institutional affiliations and gender of survey respondents. Left: Responses regarding the inclusion of gender and social equality considerations in modelling activities. Source: (Escobar et al., 2017)

¹ Escobar, M., Forni, L., Ghosh, E., Davis, M., 2017. Guidance Materials for Mainstreaming Gender Perspectives into Model-based Policy Analysis. Stockholm Environment Institute - U.S. Center, Davis, CA. <https://www.sei.org/mediamanager/documents/Publications/SEI-2017-Gender-guidance-for-modelling-studies.pdf>

For this module you will need to have completed the previous modules (“WEAP in One Hour, Basic Tools, and Scenarios) or have a fair knowledge of WEAP (data structure, Key Assumptions, Expression Builder, creating scenarios). To begin this module, go to the Main Menu, select “Revert to Version” and choose the version named “Starting Point for all modules after ‘Scenarios’ module.”

2. Representing Water Collection Labor

Gender differences in water collection labor is analyzed by incorporating the amount of time required to collect water for rural residences. This information is often obtained by surveys, for example, the Demographic Health Survey (DHS)² and the Multiple Indicator Cluster Survey (MICS)³ that contain information about water collection labor for women and children. This section of the tutorial focuses on creating a user-defined variables that estimate the effort required to collect water from women and children based on the analysis of these survey data published in Graham et al., 2016⁴.

In this section we will model a small city where some households have water in their premises, Water in Premises (WIP), and other households do not have water in their premises, No Water In Premises (NWIP). Some of the households that do not have water in the premises have been surveyed about who is the primary water collector, either Adult female or child (<15 years of age), and with more than 30 minute water collection.

2.1. *Create a new demand*

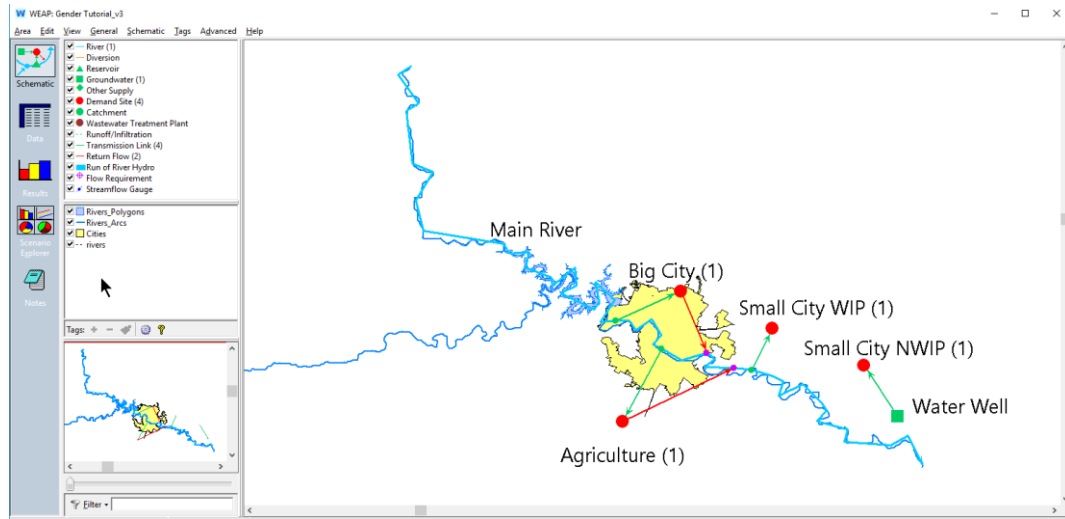
In the WEAP schematic, create two new demand sites downstream of Big City to simulate a smaller city. One of the nodes is called “Small City WIP”. Give a *Demand Priority = 1* to the node. Provide a Transmission Link from the Main River positioned downstream of both the Big City and Agriculture Return Flows. *The Supply Preference should be set to 1*. The other node is called “Small City NWIP”. Give a *Demand Priority = 1* to this node. The “Small City NWIP” node extracts water from a water well. Therefore, include a groundwater object called “Water Well” from the object menu and locate next to the “Small City NWIP” node. Provide a Transmission

² <http://dhsprogram.com/data/available-datasets.cfm>

³ <http://mics.unicef.org/surveys>

⁴ Graham, J.P., Hirai, M., Kim, S.-S., 2016. An Analysis of Water Collection Labor among Women and Children in 24 Sub-Saharan African Countries. PLOS ONE 11, e0155981. <https://doi.org/10.1371/journal.pone.0155981>
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4889070/>

Link from the groundwater node to the demand. *The Supply Preference should be set to 1.* Your area should now look as follows:



2.2. Create the Data Structure for “Small City” demand nodes

Time per trip to collect water will be assumed as 30 minutes. In addition, based on average estimates, the carry capacity of each collector, Adult female or child, will be assumed as 20 Liters of water per trip and the average water use for drinking, cooking and personal hygiene in any household is at least 15 liters per person per day⁵.

The water use data included in the model as this part of the tutorial is described in the table below:

WEAP Node	Variable	Data
Small City WIP	Population with Water In Premises (1990)	27,488
	Water use (liters per capita/day)	75
Small City NWIP	Population with No Water In Premises with at least 30 min per trip in water collection time (1990)	58,412
	Adult female primary collector, proportion of households which reported ADULT FEMALE as the primary water collector of Small City NWIP (%)	90%
	Child primary collector, proportion of households which reported CHILDREN as the primary water collector of Small City NWIP (%)	6%
	Water use (liters per capita/day)	15
	Carry capacity of each collector (liters) (Adult Female and Child)	20
	Time per trip to collect water (hours) (Adult Female and Child)	0.5

⁵ http://ec.europa.eu/echo/files/evaluation/watsan2005/annex_files/Sphere/SPHERE2%20-%20chapter%20%20-%20Min%20standards%20in%20water,%20sanitation%20and%20hygiene%20prom.pdf

Remember that the “Primary collector Child PCT” and “Primary collector Adult Female PCT” data are the proportion in percentage of households which reported ADULT FEMALE or CHILD as the primary water collector in the city that does not have water in their premises. These data IS NOT equal to proportion in percentage of the total female population or total child population in a city.

In order to create a data structure, right-click on Key assumptions and add the following tree starting with “Collector Data” (do not enter any data yet):

The screenshot shows a software interface with a tree view on the left and a table on the right. The tree view shows a hierarchy starting with 'Key Assumptions', followed by 'Collector Data', and then several sub-branches: 'Capacity per trip Adult Female L', 'Capacity per trip Child L', 'Primary collector Child PCT', 'Primary collector Adult Female PCT', 'Time per trip Adult Female h', and 'Time per trip Child h'. The table on the right, titled 'Key Assumptions', lists these variables with their values for the year 2000, their scale, and their unit.

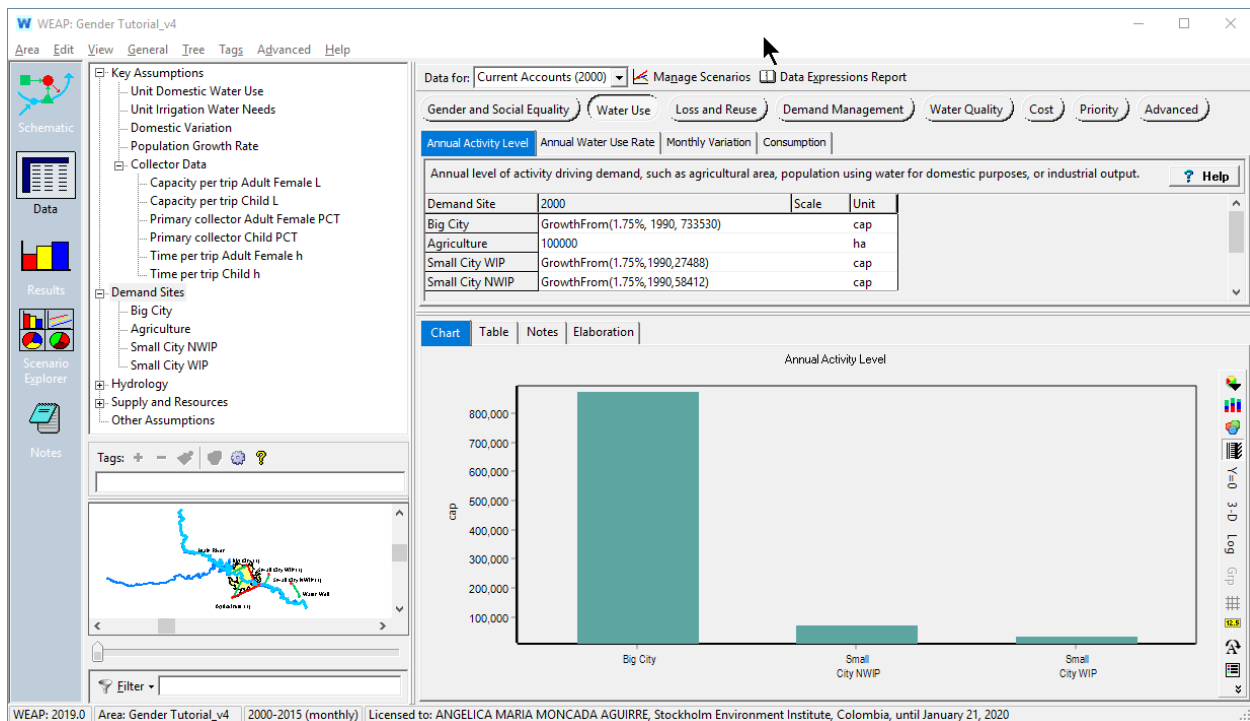
Key Assumption	2000	Scale	Unit
Collector Data	0		
Capacity per trip Adult Female L	0		L
Capacity per trip Child L	0		L
Primary collector Child PCT	0	Percent	share
Primary collector Adult Female PCT	0	Percent	share
Time per trip Adult Female h	0		hr
Time per trip Child h	0		hr

Note that “Time per trip Child h”, “Time per trip Adult Female h”, “Primary collector Child PCT”, “Primary collector Adult Female PCT”, “Capacity per trip Child L”, and “Capacity per trip Adult Female L” are added as sub-branches below “Collector Data”.

Set the corresponding unit for each key assumption (see image above) and enter the information. Make sure that the unit of “Collector Data” is “No Unit”

Key Assumption	2000	Scale	Unit
Collector Data	0		
Capacity per trip Adult Female L	20		L
Capacity per trip Child L	20		L
Primary collector Child PCT	90	Percent	share
Primary collector Adult Female PCT	6	Percent	share
Time per trip Adult Female h	0.5		hr
Time per trip Child h	0.5		hr

Click on Demand Sites in the data tree and select the category Annual Activity. For “Small City WIP” and “Small City NWIP”, enter units of “people” (cap). For “Small City WIP” and “Small City NWIP”, use the GrowthFrom function to extrapolate the 1990 population data shown in the above table for the year 2000 using a growth rate of 1.75%, as for “Big City.”

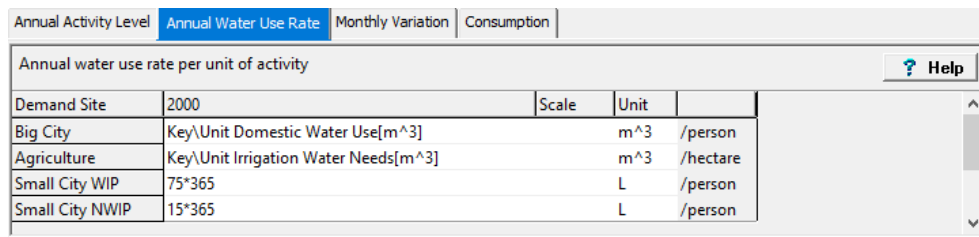


2.3. Enter the Annual Water Use Rate data

For the “Small City WIP” and “Small City NWIP” demand sites, enter the following data under the “Annual Water Use Rate” tab.

	Water use	Per capita/Day
Demand WIP	Population with Water In Premises	75 L
Demand NWIP	Population with No Water In Premises	15 L

Note that in order to format this data for WEAP annual’s demand format, the daily consumption data must be multiplied by 365. **Make sure that the unit of both “Small City WIP” and “Small City NWIP” has been set in liters “L”.**



3. Creating “User Defined Variables”

To create a new variable in WEAP:

- Right click on one of the data tabs. In this case, right click on “Annual Activity Level” and select “Create”.
- In the section “Category” select “<Add New Category>”.

You should have the following view:

- The name of the new category is “Gender and Social Equality” and click OK.
- Then fill out that “Name” as “Trips Children”
- Change the first drop down menu under “Scope” to “Annual.” And the last one to “Lowest Level Only”.
- Make sure the “Result Variable” box is checked.
- It is also good practice to enter a short description of your new variable. In this case the description “This variable will estimate the number of trips per year that children will need to make to collect water” can be added.

Edit Variable

Name Unit

Category Result Variable

Comment

Scope

Values (Optional)

Minimum Value

Maximum Value

Sum Across Branches

Allow Missing Value (-9999)

Default Value or Expression

Current Accounts

Scenarios

Read Only (User cannot override Default Value or Expression)

- Click Save.

Using the same process, create a second variable in the category Gender and Social Equality for “Trips Adult females”.

The calculation in the new variables would estimate the number of trips by dividing the ratio water demand by women or children and the capacity per trip of the Small City NWIP population.

In the Gender and Social Equality category for the Small City NWIP demand site, enter the following equations:

- **“Trips Adult females”, number of trips equal to:**

Annual Activity Level[cap]*Annual Water Use Rate[L]*Key\Collector Data \Primary collector Adult Female PCT [% share]/100/Key\Collector Data\Capacity per trip Adult Female L [L]

Gender and Social Equality		Water Use	Loss and Reuse	Demand Management	Water Quality	Cost	Priority	Advanced	
Trips Adult Female Trips Children MOCT Adult Female MOCT Child									
User-defined variable: This variable will estimate the number of trips per year that adult female will need to make to collect water.									
Demand Site	2000						Scale	Unit	
Big City	0								
Agriculture	0								
Small City WIP	0								
Small City NWIP	Annual Activity Level[cap]*Annual Water Use Rate[L]*Key\Collector Data\Primary collector Adult Female PCT[% share]/100/Key\Collector Data\Capacity per trip Adult Female L [L]								

- “Trips Children”, number of trips equal to:

$$\text{Annual Activity Level}[\text{cap}] * \text{Annual Water Use Rate}[\text{L}] * \text{Key} \backslash \text{Collector Data} \backslash \text{Primary collector Child PCT} [\% \text{ share}] / 100 / \text{Key} \backslash \text{Collector Data} \backslash \text{Capacity per trip Child L} [\text{L}]$$

The screenshot shows a software interface with several tabs: Gender and Social Equality, Water Use, Loss and Reuse, Demand Management, Water Quality, Cost, Priority, and Advanced. The 'Water Use' tab is active, and the 'Trips Children' variable is selected. Below the tabs, there is a text box with the user-defined variable: 'This variable will estimate the number of trips per year that children will need to make to collect water.' Below this is a table with columns for 'Demand Site', 'Scale', and 'Unit'. The 'Demand Site' column has a value of '2000'. The 'Scale' and 'Unit' columns are empty.

Demand Site	Scale	Unit
2000		
Big City		
Agriculture		
Small City WIP		
Small City NWIP		

4. Estimating Minimum Opportunity Cost on collection Time

The adult female and child represented in this exercise of the tutorial corresponds to the individuals that spend at least 30 min per trip collecting water in 20 Liter containers. Unfortunately, we don't have the data to know the exact amount of time spent collecting water. Therefore, we can estimate the **minimum** amount of time spent collecting water that can be used for other productive activities or education. This time is considered the **Minimum Opportunity Cost on collecting Time (MOCT)** for Small City NWIP. To represent that, two new variables are created “MOCT Child” and “MOCT” Adult Female.

Below is the variable for “MOCT Adult Females”. Set the unit to “hours”, make sure the “Result Variable” box is checked. Change the first drop down menu under “Scope” to “Annual.” And the last one to “Lowest Level Only”.

Using the same process, create a second variable in the category Gender and Social Equality for “MOCT Children”.

Edit Variable

Name: Unit:

Category: Result Variable:

Comment:

Scope:

Values (Optional):
 Minimum Value:
 Maximum Value:
 Sum Across Branches
 Allow Missing Value (-9999)

Default Value or Expression:
 Current Accounts:
 Scenarios:
 Read Only (User cannot override Default Value or Expression)

In the Gender and Social Equality category for the Small City NWIP demand site, enter the following equations:

- **“MOCT Adult Females”, equal to:**

Trips Adult female*Key\Collector Data\Time per trip Adult Female h[hr]

User-defined variable			
Demand Site	Value	Scale	Unit
Big City	0		hr
Agriculture	0		hr
Small City WIP	0		hr
Small City NWIP	Trips Adult female*Key\Collector Data\Time per trip Adult Female h[hr]		hr

- **“MOCT Children”, equal to:**

Trips Children*Key\Collector Data\Time per trip Child h[hr]

User-defined variable			
Demand Site		Scale	Unit
Big City	2000		hr
Agriculture	0		hr
Small City WIP	0		hr
Small City NWIP	Trips Children*Key\Collector Data\Time per trip Child h[hr]		hr

5. Using the plugin “Gender and Social Equality”

Section “2.2 Create the Data Structure for “Small City” demand nodes”, “3 Creating “User Defined Variables””, and “4 Estimating Minimum Opportunity Cost on collection Time” can be skipped by downloading the **WEAP plugin “Gender and Social Equality”**

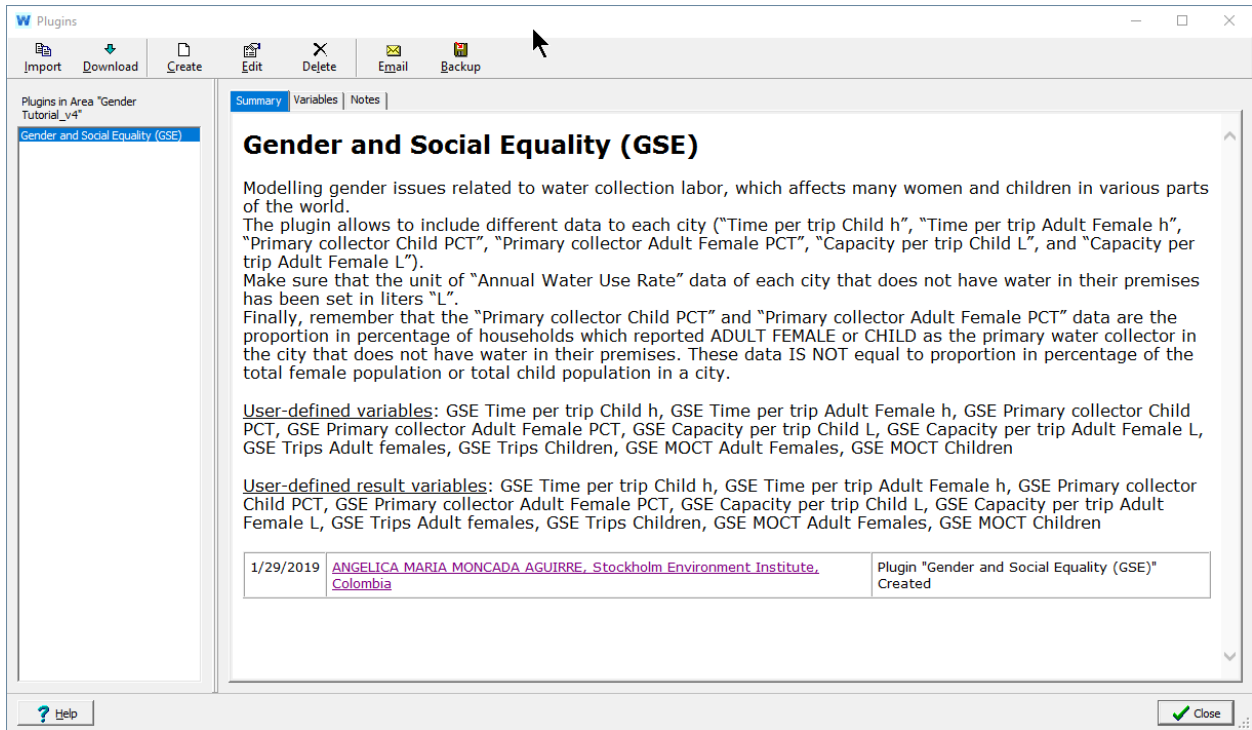
It is highly recommended to use the WEAP plugin “Gender and Social Equality” when more than one city that does not have water in their premises is going to be modelled. The plugin allows to include different data to each city (“Time per trip Child h”, “Time per trip Adult Female h”, “Primary collector Child PCT”, “Primary collector Adult Female PCT”, “Capacity per trip Child L”, and “Capacity per trip Adult Female L”). Using key assumptions these data will be assumed equal in all the cities that do not have water in their premises.

Make sure that the unit of “Annual Water Use Rate” data of each city that does not have water in their premises has been set in liters “L”.

Finally, remember that the “Primary collector Child PCT” and “Primary collector Adult Female PCT” data are the proportion in percentage of households which reported ADULT FEMALE or CHILD as the primary water collector in the city that does not have water in their premises. These data IS NOT equal to proportion in percentage of the total female population or total child population in a city.

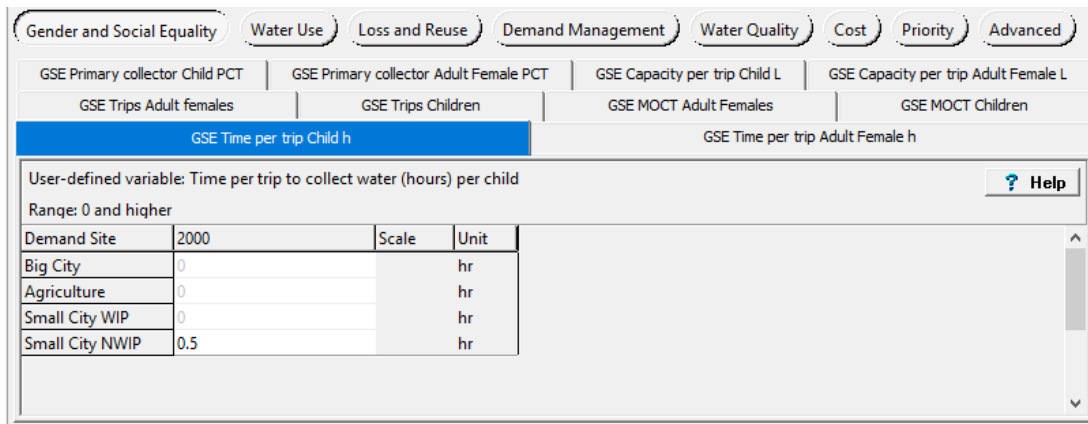
To download it, go to Advanced/Plugins (must have the WEAP 2018 version or later) and click “Download.”

In the window “Select plugin to download, open the “Gender and Social Equality” plugin from the dropdown menu.



The difference between the plugin and all which was done above is that the variables “Time per trip Child h”, “Time per trip Adult Female h”, “Primary collector Child PCT”, “Primary collector Adult Female PCT”, “Capacity per trip Child L”, and “Capacity per trip Adult Female L” are now User-Defined Variables. Using the plugin, the data of these variables need to be included under the category “Gender and Social Equality”, none of the “key assumptions” need to be created.

The data only need to be added to the city that does not have water in their premises, the data of the other demand sites need to be left blank.



Gender and Social Equality | Water Use | Loss and Reuse | Demand Management | Water Quality | Cost | Priority | Advanced

GSE Primary collector Child PCT | GSE Primary collector Adult Female PCT | GSE Capacity per trip Child L | GSE Capacity per trip Adult Female L

GSE Trips Adult females | GSE Trips Children | GSE MOCT Adult Females | GSE MOCT Children

GSE Time per trip Child h | GSE Time per trip Adult Female h

User-defined variable: Time per trip to collect water (hours) per adult female [? Help](#)

Range: 0 and higher

Demand Site	2000	Scale	Unit
Big City	0		hr
Agriculture	0		hr
Small City WIP	0		hr
Small City NWIP	0.5		hr

Gender and Social Equality | Water Use | Loss and Reuse | Demand Management | Water Quality | Cost | Priority | Advanced

GSE Time per trip Child h | GSE Time per trip Adult Female h

GSE Trips Adult females | GSE Trips Children | GSE MOCT Adult Females | GSE MOCT Children

GSE Primary collector Child PCT | GSE Primary collector Adult Female PCT | GSE Capacity per trip Child L | GSE Capacity per trip Adult Female L

User-defined variable: Adult female primary collector, proportion of households which reported ADULT FEMALE as the primary water collector of the City with No Water In Premises (NWIP) (%) [? Help](#)

Range: 0 and higher

Demand Site	2000	Scale	Unit
Big City	0	Percent	share
Agriculture	0	Percent	share
Small City WIP	0	Percent	share
Small City NWIP	6	Percent	share

Gender and Social Equality | Water Use | Loss and Reuse | Demand Management | Water Quality | Cost | Priority | Advanced

GSE Time per trip Child h | GSE Time per trip Adult Female h

GSE Trips Adult females | GSE Trips Children | GSE MOCT Adult Females | GSE MOCT Children

GSE Primary collector Child PCT | GSE Primary collector Adult Female PCT | GSE Capacity per trip Child L | GSE Capacity per trip Adult Female L

User-defined variable: Child primary collector, proportion of households which reported CHILD as the primary water collector of the City with No Water In Premises (NWIP) (%) [? Help](#)

Range: 0 and higher

Demand Site	2000	Scale	Unit
Big City	0	Percent	share
Agriculture	0	Percent	share
Small City WIP	0	Percent	share
Small City NWIP	90	Percent	share

Gender and Social Equality | Water Use | Loss and Reuse | Demand Management | Water Quality | Cost | Priority | Advanced

GSE Time per trip Child h | GSE Time per trip Adult Female h

GSE Trips Adult females | GSE Trips Children | GSE MOCT Adult Females | GSE MOCT Children

GSE Primary collector Child PCT | GSE Primary collector Adult Female PCT | GSE Capacity per trip Child L | GSE Capacity per trip Adult Female L

User-defined variable: Average carry capacity of child collector (liters) [? Help](#)

Range: 0 and higher

Demand Site	2000	Scale	Unit
Big City	0		L
Agriculture	0		L
Small City WIP	0		L
Small City NWIP	20		L

Gender and Social Equality | Water Use | Loss and Reuse | Demand Management | Water Quality | Cost | Priority | Advanced

GSE Time per trip Child h | GSE Time per trip Adult Female h

GSE Trips Adult females | GSE Trips Children | GSE MOCT Adult Females | GSE MOCT Children

GSE Primary collector Child PCT | GSE Primary collector Adult Female PCT | GSE Capacity per trip Child L | **GSE Capacity per trip Adult Female L**

User-defined variable: Average carry capacity of adult female collector (liters) ? Help

Range: 0 and higher

Demand Site		Scale	Unit
Big City	0		L
Agriculture	0		L
Small City WIP	0		L
Small City NWIP	20		L

The variables name has the prefix “GSE”, it was included to identified each variable in the results.

Demand Site GSE Capacity per trip Adult Female L (Cubic Meter) Comparison

- Water Demand
- Supply Requirement
- Supply Delivered
- Unmet Demand
- Coverage
- Reliability
- Demand Site Inflows and Outflows
- Instream Flow Requirement
- Instream Flow Requirement Delivered
- Unmet Instream Flow Requirement
- Instream Flow Requirement Coverage
- Flow Requirement Reliability
- Total Node Inflow
- GSE Capacity per trip Adult Female L
- GSE Capacity per trip Child L
- GSE MOCT Adult Females
- GSE MOCT Children
- GSE Primary collector Adult Female PCT
- GSE Primary collector Child PCT
- GSE Time per trip Adult Female h
- GSE Time per trip Child h
- GSE Trips Adult females
- GSE Trips Children
- Demand >
- Supply and Resources >
- Water Quality >
- Financial >
- Input Data >

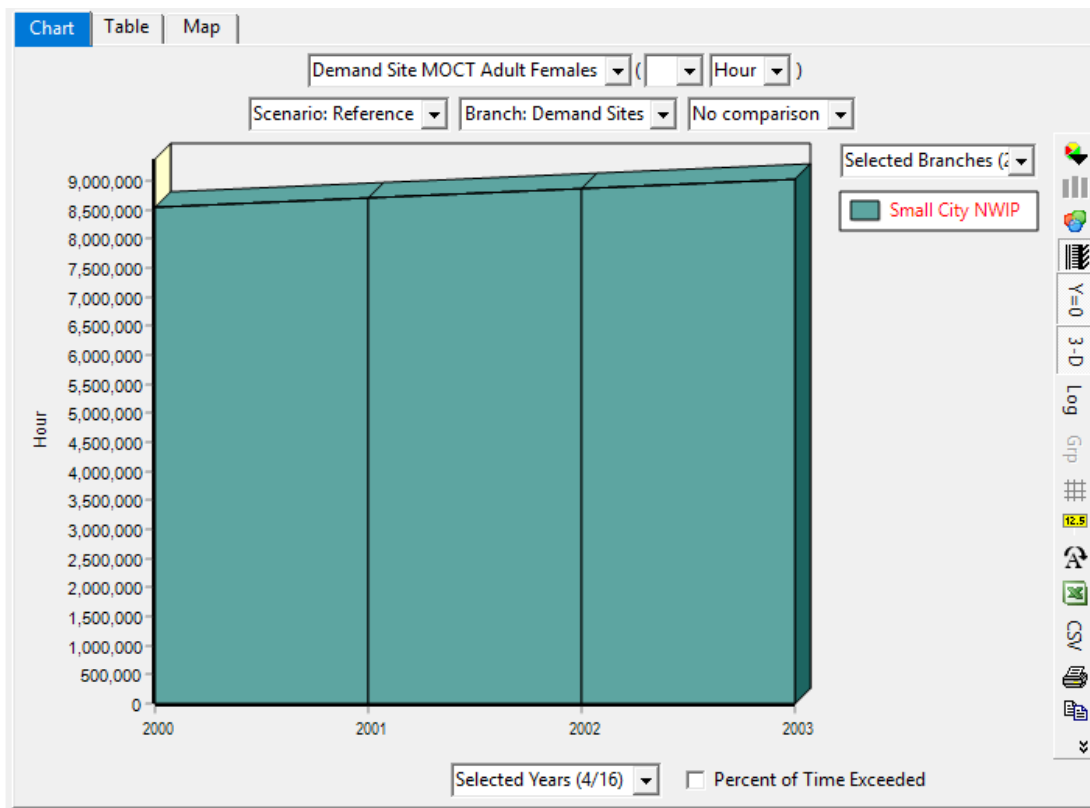
6. Evaluating Results

Recalculate your results. In the Results view, choose “Trips Adult Females” under “Demand” to see the number of trips that Adult female take each year to supply the domestic water demand for the Small City NWIP residents. You can select the “Area”

graph on the top icon on the right toolbar. Selecting the “Trips Children” variable shows the estimated number of trips that children take.

By selecting the “MOCT Adult Females” variable, we can see that all the women of “Small City NWIP” spend at least 8,558,800 hours collecting water per year. **This is the equivalent of 1 year of work of over 4114 adult female water collectors of Small City NWIP** (2080 hours per year considering 52 weeks per year and 40 hours of work per week).

	2000	2001	2002	2003	Sum
Small City NWIP	8,558,800.377	8,708,579.384	8,860,979.523	9,016,046.664	35,144,405.948



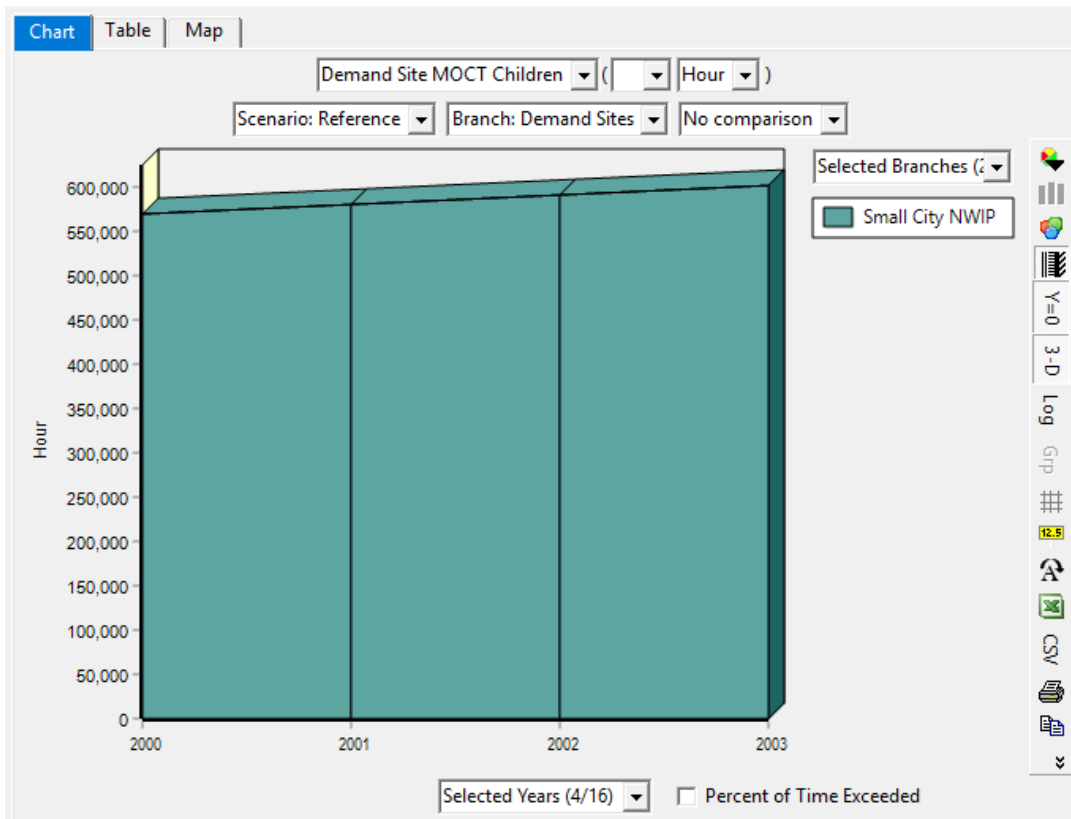
By selecting “MOCT Children” the model shows that children spend at least 570,587 hours per year collecting water. **This is the equivalent of over 1 year of school time of 570 children water collectors of Small City NWIP** (1000 hours per year assuming 15 hours a day, 5 days a week and 4 weeks per month in school 10 months a year).

Chart Table Map

Demand Site MOCT Children (Thousand Hour)

Scenario: Reference Selected Branches (2/5) Branch: Demand Sites No comparison

	2000	2001	2002	2003	Sum
Small City NWIP	570.587	580.572	590.732	601.070	2,342.960



Concluding Remarks

When water sources are not on the community premises, water needs to be collected, and women and children (mostly girls) are paying with their time, spending more than 15 min collecting water⁶. In some countries, the time spent collecting water may even be higher. Spending time collecting water is a disadvantage that women and children have when compared with those families who have water in their premises. More importantly, lacking access to water in household's premises creates inequalities in society. The time women spend collecting water could be spent in education, income-producing activities, or spent supporting their families. The time children spend collecting water may prevent them from accessing education or even attending school altogether. The absence of water in premises also affects people's health beyond the opportunity cost of time. This tutorial provides the basic building blocks to support decision-makers to start incorporating the burden of lack of water access in technical analysis on water management. Addressing these challenges can provide the means to improve education levels, human health, and the economy of the region.

Acknowledgments

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⁶ Graham, J.P., Hirai, M., Kim, S.-S., 2016. An Analysis of Water Collection Labor among Women and Children in 24 Sub-Saharan African Countries. PLOS ONE 11, e0155981. <https://doi.org/10.1371/journal.pone.0155981>
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4889070/>