Exercise C5 – Modeling Climate Change Impacts Using SWAT and the Climate Assessment Tool



In this exercise, we will use the Climate Assessment Tool (CAT) with an established SWAT simulation to explore a given area's response to climate change.

Questions addressed in this exercise:

- 1) How do I set up CAT to work with an existing SWAT project?
- 2) How do I create a series of climate change scenarios and choose endpoints?
- 3) How do I conduct batch SWAT simulations for climate change scenarios?

A. Setting Up CAT To Work With An Existing SWAT Project

QUESTION ANSWERED:

1) How do I set up CAT to work with an existing SWAT project?

1. Turn on the Climate Assessment Tool (CAT) plug-in and subsequently activate it from the 'Analysis' menu option as shown in CAT Exercise C1. The initial CAT form is shown below.



2. From the **File** menu, select the option **Open SWAT scenario** as shown below:

🛃 Climate Assessment Tool	
File Edit Options Help	
Open HSPF scenario	
Open SWAT scenario	pad results using the File menu
Load Climate and Endpoints	au rocano aoniguio rino rino ria
Save Climate and Endpoints	
Load Results	
Save Results	
Save Pivot	

3. Locate the Access *mdb* file for the project, the weather data, and output files for the **base** scenario using the following open file dialog windows as shown below. It is important to know that the base scenario needs to be run prior to any CAT analysis.



The required files and their designated locations are as follows (these files need to be placed as directed below before any CAT analysis):

Project Access mdb file	< <i>CAT DIRECTORY</i> >\ <i>Patuxent.mdb</i>
Base run I/O files	<cat directory="">\Scenarios\base\TxtInOut</cat>
Base weather data	< <i>CAT DIRECTORY</i> >\ <i>Scenarios</i> \ <i>met</i> \ <i>met.wdm</i>
Base run <i>fig.fig</i>	<cat directory="">\Scenarios\fig.fig</cat>
SWAT Executable	<cat directory="">\Scenarios\swat2005.exe</cat>
SWAT mdb	<cat directory="">\Scenarios\SWAT2005.mdb</cat>
SWAT soil <i>mdb</i>	<cat directory="">\Scenarios\SWAT_US_Soils.mdb</cat>

4. Once the required files are located, the initial CAT page will appear as shown below.

🦉 Climate Assessment Tool								
File Edit Options Help								
Climate Data Assessment Endpoints Results Table Pivot Table	Climate Data Assessment Endpoints Results Table Pivot Table							
Base Scenario G:\SWATCAT\Patuxent.mdb								
New Scenario Modified								
Add Remove Edit View Prepared	v ^							
Start	Plot							

Leave the 'New Scenario' name to read 'Modified'.

B. Construct Climate Change Scenarios

QUESTION ANSWERED:

2) How do I create a series of climate change scenarios and choose endpoints?

1. Click the 'Add' button on the 'Climate Data' Tab to bring up the 'Modify Existing Data' dialog window and specify all required information as shown below:

Modify Exis	ting Da	ta 📃 🗖 🔀
Modification Na	me:	Prec Grad
Existing Data to	Modify:	OBSERVED MD180465 PREC View
- Compute PET:	-	<click pet="" replace="" specify="" to=""> View</click>
How to Modify:		Multiply Existing Values by a Number
⊖Number to mu	ltiply existir	ng data by
🔘 Single Cha	inge 📀	Iterate Changes
Minimum	0.5	multiplication factor
Maximum:	1.5	multiplication factor
Increment:	0.5	Increase this much each iteration from Minimum
Seasons Varu onlu in	selected	Month
Jan Jun Feb Jul Mar Aug Apr Sep May Oct	Nov Dec	
All		None
		Ok Cancel

- 2. Click 'Ok' button to save this climate change definition for later use.
- 3. Click 'Add' button again to initiate the definition of another climate change scenario for temperature. Specify all information as shown below:

Modify Existing D	ata	
Modification Name:	Temp grad	
Existing Data to Modifu:	OBSEBVED MD180465 ATEM	View
Carranda DET.	(aliak to apapity PET to rapises)	
How to Modify:	Change Lemperature	*
Degrees to add to eac	h existing temperature value	
	Viterate Changes	
Minimum -2	degrees	
Maximum: 2	degrees	
Increment: 1	Increase this much each itera	tion from Minimum
Events		
Vary precipitation of	nly in the following Events	
Seasons		
Vary only in selected	d Month	~
Jan Jun Nov	/	
Mar Aug		
Apr Sep May Oct		
All		None
	Ok	Cancel

4. Click the 'Ok' button to save this definition for later use.

At this point you have defined two gradient change schemes for both precipitation and temperature, as shown below:

🏭 Climate Ass					
File Edit Option	s Help				
Climate Data As	sessment Endpoints 🛛 f	Results Table	Pivot Table		
Base Scenario	G:\SWATCAT\Patu	xent.mdb			
New Scenario	Modified				
Add Rem	Add Remove Edit View Prepared				
✓ Prec Grad M ✓ Temp grad A	ultiply from 0.5 to 1.5 s dd from -2 to 2 step 1	step 0.5 Month Month: Jul Au	r: Jun Jul Aug g Sep		
Start Fini	shed runs			Plot	

Now we are to define the endpoints to be examined with climate changes.

5. Navigate to the 'Assessment Endpoints' tab and click on the 'Add' button to bring up the data selection window. Select the 'FLOW_OUT' constituent as shown below:

💐 Select data for endpoint								
File Attributes Select Help Select Attribute Values to Filer Auslighte Data								
טו	~	Location	~	Lonstituent	~	Description		
1	^	AGRR 46	^	DISOX_IN	<u>^</u>	Hourly Air Temperature in+		
2		AGRR 47	_	DISOX_OUT		Hourly Cloud Cover in Te+		
3		AGRR 48		ET		Hourly Dewpoint Tempera		
4		AGRR 49		EVAP		Hourly Potential ET in Inc+		
5		AGRR 50		FLOW_IN	_	Hourly Precip in Inches		
6	~	AGRR 51	~	FLOW_OUT	~	Hourly Solar Radiation in +		
Matching Data (2 of 9	23)							
3		REACH 1		FLOW_OUT				
56		REACH 2		FLOW_OUT				
Selected Data (1 of 9	923) —							
56 REACH 2 FLOW_OUT								
Dates to Include								
All	Comr	non	_					
Start 1991/12/31	1991/1	2/31	199	91/12/31				
End 1995/12/31	1995/1	2/31	199	95/12/31	0	k Cancel		

- 6. Click the 'Ok' button to save this selection for later use.
- 7. Click on the 'Add' button again to select another endpoint, 'SED_OUT', as shown below.

🐉 Select data fo	r end	point						\mathbf{x}
File Attributes Select Help								
Select Attribute Values to Filter Available Data								
ID 🔽 Location 🔽 Constituent 🔽 Description							~	
1	~	AGRR 46	~	REACTPST	~	Hourly Dewpoin	t Tempera-	~
2		AGRR 47	=	RESUSP_PST		Hourly Potential	ET in Inc+	
3		AGRR 48		SEDCONC		Hourly Precip in	Inches	
4		AGRR 49		SEDP		Hourly Solar Ra	diation in +	=
5		AGRR 50		SED_IN	-	Hourly Wind Sp	eed in MPł	
6	~	AGRR 51	~	SED_OUT	~	~Missing~		~
Matching Data (2 of 9	923)							
7		REACH 1		SED_OUT				
60		REACH 2		SED_OUT				
 Selected Data (1 of a co 	923)	DEACH 2		SED OUT				
00		HEACH 2		360_001				
Dates to Include All Start 1991/12/31 End 1995/12/31	Com 1991/1 1995/1	non 2/31 2/31	199 199	91/12/31 95/12/31	0	k C	Cancel)

8. Click the 'Ok' button to save this selection for later use.

Now you have two endpoints defined as shown below:

💐 Climate Assessment Tool	
File Edit Options Help	
Climate Data Assessment Endpoints Results Table Pivot Table	
 Save All Results Show Progress of Each Run Add Remove Edit Copy Flow Mean Sed Mean 	Top îv Bottom
Start Total iterations selected = 1 (0:33)	Plot

C. Define Endpoints for the CAT analysis

QUESTION ANSWERED:

3) How do I conduct batch SWAT simulations for climate change scenarios?

1. Click the 'Start' button to initiate the batch simulation process and wait for results as shown below. Once the simulations begins, the 'Start' button changes to 'Stop' and the run status is shown as text next to it.

ile E	Edit Options Help				
Climat	e Data 🛛 Assessment E	ndpoints Results Table	Pivot Table		
Run	Prec Grad	Temp grad	Flow	Sed 🔷	
	Multiply	Add	Mean	Mean	
	Current Value	Current Value	base REACH 2 FLOW_OUT	base REACH	
	Month (Jun Jul Aug.)	Month (Jul Aug Sep)			
1	0.5	-2	39.027	57,304	
2	0.5	-1	38.762	57,297	
3	0.5	0	38.514	57,298	
4	0.5	1	38.156	58,869	
5	0.5	2	38.094	59,223	
6	1	-2	48.132	67,644	
<	1	-	47 702	C7 500	

The whole simulation process is done when the 'Finish runs' text is shown at the bottom of the CAT window, near the 'Start' button as shown below.

🌌 CI	💐 Climate Assessment Tool							
File	File Edit Options Help							
Clima	Climate Data Assessment Endpoints Results Table Pivot Table							
Bun	Prec Grad	Temp grad	Flow	Sed				
1154.1	Multiply	Add	Mean	Mean				
	Current Value	Current Value	base REACH 2 FLOW_OUT	base REACH 2 SED_OUT				
	Month (Jun Jul Aug.)	Month (Jul Aug Sep)						
1	0.5	-2	39.027	57,304				
2	0.5	-1	38.762	57,297				
3	0.5	0	38.514	57,298				
4	0.5	1	38.156	58,869				
5	0.5	2	38.094	59,223				
6	1	-2	48.132	67,644				
7	1	-1	47.782	67,508				
8	1	0	47.328	67,282				
9	1	1	46.664	68,493				
10	1	2	46.42	68,875				
11	1.5	-2	60.434	83,484				
12	1.5	-1	59.678	82,848				
13	1.5	0	59.01	82,364				
14	1.5	1	58.136	83,530				
15	1.5	2	57.69	83,564				
<				>				
	itart Finished runs			Plot				

- 2. The resulting endpoints are shown in a grid in the 'Results Table' for all the combination of the gradients for the two climate changes defined during step 2.
- 3. Now, navigate to the 'Pivot Table' tab to examine the outputs in a common pivot table format. The results are shown below.

🗱 Climate Assessment Tool								
File Edit Options Help								
Climate Data Assessment Endpoints Results Table Pivot Table								
Rows	Rows Prec Grad Multiply Current Value							
Columns	Temp grad Add	Current Value				*		
Cells	Cells Flow Mean base REACH 2 FLOW_OUT							
	-2	-1	0	1	2			
0.5	39.027	38.762	38.514	38.156	38.094			
1	48.132	47.782	47.328	46.664	46.42			
1.5	60.434	59.678	59.01	58.136	57.69			
Start Finis	Start Finished runs Plot							

🦉 Climate Assessment Tool 📃 🗖 🔀							
File Edit Options Help							
Climate Data Assessment Endpoints Results Table Pivot Table							
Rows Prec Grad Multiply Current Value							
Columns	Columns Temp grad Add Current Value						
Cells Sed Mean base REACH 2 SED_OUT							
	-2	-1	0	1	2		
0.5	57,304	57,297	57,298	58,869	59,223		
1	67,644	67,508	67,282	68,493	68,875		
1.5	83,484	82,848	82,364	83,530	83,564		
Start Finished runs Plot							

To save the climate variations as we have defined, go to the **File** menu and select **Save Climate and Endpoints**. Select the location and file name for the setting file to be saved as shown below.

Save Variation	s as XML Text		? 🗙
Save jn:	C SWATCAT	 3 Ø Ø 🗇 🖽• 	
📁 Recent	met Scenarios Watershed CAT_Tong.xml		
Desktop			
My Documents			
My Computer			
	File <u>n</u> ame:	CAT_Tong.xml	<u>S</u> ave
My Network	Save as <u>type</u> :	XML files (*.xml)	Cancel