

FAO-MOSAICC Modelling system for Agricultural impacts of climate change

Tutorial: Performing simulations with WABAL

Francois Delobel Draft 20130504

Content

1.	Introduction	1
2.	Uploading input files: administrative units, soil map and crop mask	2
	Defining the crop files	
	Running a simulation	
	Retrieving the outputs	

1. Introduction

This tutorial shows step by step how to perform simulations with WABAL in MOSAICC, in a view of defining yield functions and projecting yields under climate scenarios. The tutorial focuses on case study, the simulation of corn in the province of Nueva Ecija, Philippines.

The following processes are detailed:

- Uploading input files
- Running a simulation, in both points and grid mode.
- Retrieving the outputs: display and download

Climate data are assumed to be already available in the database.

The steps of each process are illustrated with screenshot from MOSAICC. The overall structure of MOSAICC web interfaces is depicted in Figure 1.

FOOD AND AGRICULTURE ORGANIZATION helping to build a world without hung	of THE UNITED NATIONS MC	BAICCPHI,	•.0.1 Main m	enu		about contacts copyrights profile log-out
Home Funct	ions Data	Tools	Documents			
fdelobel My account Log out	MOSAIC		lelling System	for Agriculture of Climat	al Impacts te Change	
	system of models designed to carry out each nal level. on and decision making to improve food foodsec.org.					
Side menu	The project manager ar custom data manage custom module man. run the installed mod geo-processing publish their experim-	ement (upload, de agement (upload lules with the avai	ownload, layout contro and update) lable data for multiple (l and update)	on the following Page boo	

Figure 1 MOSAICC user home page and overall structure

2. Uploading input files: administrative units, soil map and crop mask

Users can upload new datasets to the MOSAICC database through the interface following the path:

- Main menu: Data
- Side menu: Upload (in the section "Geographic data")

The screen below appears (Figure 2):

Home	Functions	Data	Tools	Documents			
eographic Data	CCI	- Data Mng					
Management					Data Upload		
Sources & Referen	ices				Work mode selection		
Upload	The	evetors allows the us	or to unland the da	ta bolonoina ta tha t	was be can manage, that depend on i	he functions available for the role(s) the use	ar bao Ň
limate Data	Edit	system allows the use	аг то цогоац тле ца	la belonging to the t	pes ne carrinanage, that depend on t		s (185, 🛄
Observed Data	. E.Wo	ork Mode(s)					
Stations / Obs. Poi Variables							
			Grid	halaha ang antila taran		the latter de condition ethode come	
ownscaling Porta			i ne inpu	t data are grids, i.e. m	atrix of data regularly distributed along	the latitude and longitude axes	
Data Upload Data Download			This work	mode allows to uplo	ad the following data types:		
	AURELHY distance to the sea					^	
rop Data			• AL	RELHY interpolation r	nask		
Crop Library PET Data			• AU	RELHY principal comp Itivated area raster ma	onent grids		_
PET Data				M	40°		×
upport Files						Start working v	vith Grid 🔶
Management			Points				
fdelobel			The input		not ordered distribution of data record		
My account		•			ad the following data types:		
Log out		•			au trie ioliowing uata types:		
209.000			• AQ	UACROP Crop parame	ters file		
			• Da • Ga	m hydrological observ uging station hydrolog	ations aical observations		
			+ OL	Itlet characteristics file			~
				N JOEGO, J MARANE PEGO.	29896 P. CL1996 P. P. P.	Start working wit	h Deinte 🄶
						Start Working Wit	n Points 🔻
		-	Polygon The inpu		ta, such as polygons, polylines or point:	s, stored in shape files (.shp files).	
			This work	mode allows to uplo	ad the following data types:		
		15					^
				lministrative boundarie Itivated area vector m			
		V	• Riv	er basins	ala		
				rer network Jesse Jes Cose reedal			~

Figure 2 Data upload screen: data format selection

Three different formats can be uploaded to the MOSAICC database: point shapefiles, polygon shapefiles, raster (ArcInfo ASCII or geotiff). To upload new administrative limits, the user must click on: "Start working with Polygons" in the page body and fill in the form displayed (Figure 3):

FOOD AND AGRICULTU helping to build a wi	FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS helping to build a world without furger			MOSAICC ^{PHI, v. 0.1} Home			about contacts i	copyrights profile log		
Home	Function	IS	Data	Tools	Documents					
Geographic Data		CCI - Da	ta Mng							
 Management Sources & Refe Upload 	rences		_			Data Upload Work mode: Polygons				
Climate Data		Data Defir	nition							
Observed Data		Data-set N	lame							
Stations / Obs. Point Variables		Data-set D	Description							
ownscaling Por	tal									
 Data Upload Data Download 										
Crop Data			tion about the	data content						
Crop Library	1	Content	type		DATA T	'PE		~		
PET Data		Data Refi	erence		··· REFER	NCE (SOURCE)		×		
Support Files		Period of	reference: beg	in		0				
Management		Period of	reference: enc	l		(9)				
fdelobel		[Web-GI	s							
My account		Layer usa	age		🔾 Base L	ayer (background) 💿 Data Layer (overlap the backgrou	nd)			
Log out		r Upload r	method							
		ZIP Archi	ive		Choose F	e No file chosen				
		FTP Data	3		FTP File					
					If you sel	ect a FTP file the ZIP Archive will be ignored				
								Upload		

Figure 3 Data upload form

The following filled are to complete:

- Data set name: user defined name for the administrative limits
- Description: a short description of the dataset
- Content type: Administrative boundaries
- Data reference: the reference of the data. If not existing the reference must be first created in the Sources and Reference page (side menu)

The period fields are not relevant for datasets that are not time series.

The layer usage can remain set on Data layer, in order to keep the layer available for display together with other datasets in the visualisation tools throughout the interfaces.

The dataset can be uploaded either through direct upload or through FTP. Direct upload is recommended when the files have relatively small size (up to 5Mb), upload through FTP for bigger ones. For the latter option the file must be uploaded to the FTP repository beforehand. In both cases the dataset must be packed in a ZIP archive.

Here is an example filled form for a shapefile delimiting the province of Nueva Ecija and directly uploaded through the interface (Figure 4):

FOOD AND AGRICULTU helping to build a w	RE ORGANIZATION OF 1 orld without hunger	THE UNITED NATIONS	MOSA Home	LCC ^{PHI, v.}	0.1		about contacts	copyrights	profile	log-out
Home	Function	ns Dat	a	Tools	Documents					
Geographic Data	1	CCI - Data Mn	g							_
 Management Sources & Refe Upload 	rences					Data Upload Work mode: Polygons				
Climate Data		Data Definition								
 Observed Data 		Data-set Name			Nueva Ecij	1				
 Stations / Obs. Variables 	Point	Data-set Descript				extracted from FAQ GAUL 2009				,
Variables Downscaling Portal Data Upload Data Download Crop Data		_ Information abo							/	
 Crop Library 		Content type			~					
 PET Data 		Data Reference GAUL2009 (FAO)							~	
Support Files Management 		Period of refere	Period of reference: end							
fdelobel		Web-GIS								
My account	8	Layer usage			O Base L	yer (background) \odot Data Layer (overlap the backgro	ound)]
Log out		Upload method								
		ZIP Archive			Choose Fi	e Nueva_Ecija.zip]
		FTP Data			··· FTP File				~	
					If you sele	ct a FTP file the ZIP Archive will be ignored]
									Upload	

Figure 4 Filled data upload form for Nueva Ecija

Once uploaded, the file is visible in the Geographic data Management screen (see side menu).

To upload soil maps and crop masks, the procedure is the same. The only difference is that these files are grids, therefore the grid work mode must be selected on the initial upload page. The corresponding data types are "cultivated area raster map" for crop masks and "soil water holding capacity" for soil maps. Soil maps can also be uploaded as polygon shapefiles using the "soil properties for crop models" data type. Instructions for formatting soil maps in vector files are detailed in the manual "MAN_preparation of soil data".

3. Defining the crop files

WABAL simulations are adapted for each crop through the utilization of a number of parameter describing its water requirements over the growing season. These crop specific parameters are saved in MOSAICC in crop files gathered in a Crop Labrary. The crop library is accessible going to "Data" in the main menu and then "Crop library" in the side menu, Crop Data section (Figure 5).

Home	Function	ns l	Data	Tools	Documents	
Geographic Data		CCI - Dat		1003	Docamenta	
Management						
Sources & Refer	rences		Shared Crops	Built-in Crops		
Upload		- NAI				FUNC.
limate Data			uro's Tomato -	2012		8
Observed Data			t_crop rainfed			8
Stations / Obs. Point			t_crop irrigated	1		8
Variables			Corn Francois			N 🗎
ownscaling Por	təl		Palay Francois			8
Data Upload		37 tes	t test test			8
Data Download						🕹 New Crop
rop Data						
Crop Library						
PET Data						
upport Files						
Management						
fdelobel						
My account						
Log out						

Figure 5 Crop library

The list of crops previously defined is available in the body of the page. These crop files can be edited or deleted using the two icons (a page with a pen and a bin) at the right-hand end of the row. New crop files can be created clicking on "New Crop", at the lower right corner of the list. A form appears (Figure 6).

Home Fun	ctions Data	Tools Documents		
eographic Data	CCI - Data Mng			
Management Sources & References Upload	Crop Definition		Crop Name	
limate Data	Crop Name		Crop Name	
Observed Data			WABAL Parameters	
Stations / Obs. Point Variables	Pre-season dekads	3 💌	Pre-season crop coef.	0.5
	Crop factor F1	0.2	Crop factor K1	0.5
ownscaling Portal	Crop factor F2	0.4	Crop factor K2	1.5
Data Upload Data Download	Crop factor F3	0.7	Crop factor K3	1
	Bunding height (mm)	0	R-index	5
Crop Data Crop Library	Stress threshold	0.3	X-Index	5
PET Data	Irrigation mode	Rainfed (none)		×
upport Files			AQUACROP Parameters	
Management	Crop calendar	💿 Days 🔿 G	DD (Growing Degrees)	
Hundgemene	Template crop	TEMPLATE -	•	
fdelobel	Planting Method	 Transplati 	ing O Sowing	
My account	Initial canopy - Plant density		Initial canopy - Cover %	
Log out	Initial canopy - Cover per sidling		Canopy growth coefficient (%/day)	
	Maximum canopy cover (%)		Days to see emergence (JD)	
	Canopy decline coefficient (%/d	lay)	Days to see scenescence (JD)	
	Days to see maturity (JD)		Building up of Harvest Index (days)	
	Days to see flowering (JD)		Duration of flowering (days)	
	Min effective rooting depth (cm	lay)	Days to max rooting depth (JD)	
	Max effective rooting depth (cm	n)	Reference Harvest Index (%)	

Figure 6 Crop parameters

Each crop file is saved under a unique name defined by the user in the first text box ("Crop Name"). Though the crop file can contain both WABAL and AQUACROP parameters, one of the two sets only is strictly required.

4. Running a simulation

The link to the wizard for the definition of WABAL experiment is located in the side-menu ("WABAL") of the "Functions" page. In MOSAICC, WABAL can run either on points, to

simulate for instance yields for given agronomic stations, or grids, to provide results at the level of user-defined administrative units (Figure 7).

Home FL	Inctions	Data	Tools	Documents					
Study area	CCI -	User Functions							
Climate downscaling				WABAL					
PET Hargreaves				Working mode selection					
PCA			alance simulation w	with WABAL the agronomist needs the bio-climatic variables: Prec, PET, GSO and GSL; and soil water holding					
Data Interpolation	capac								
PLD		sk for cultivated are. ne land use map is re		s well, the agronomist must upload it if the layer does not exist in the database yet, Consultation with the hydrologist					
WABAL		,	Commended (DD.						
AQUACROP		rk Mode(s) ——							
STREAM calibration			Grid						
STREAM simulations			The inpu	out data are grids, i.e. matrix of data regularly distributed along the latitude and longitude axes					
fdelobel				This function requires to go trough a 2-steps wizard: 1. PLD Choice					
My account				PLD Choice Period, Provinces and Crop					
Log out									
		1 1 1							
				Start working with Grid 🕈					
				Start working with Gid 💌					
			Points The ippu	s out data are points, i.e. not ordered distribution of data recorded on a specific geographic location.					
		•		uu uata are points, ite, not ordered distribution or data recorded on a specific geographic location.					
		٠	This func	nction requires to go trough a 2-steps wizard: Data type, period and stations					
			 2. Wi 	WABAL parameters					
		-							

Figure 7 WABAL main page and work modes

Grid mode

The wizard to define WABAL experiment has two steps. The first step includes the following fields (Figure 8):

- Data type: to select the nature of the data, which can be observed or simulated (i.e. derived from downscaling)
- Manual set-up of PLD: to choose whether the planting dates come from a PLD experiment ("Yes") or constant values ("No")

Home F	unctions	Data	Tools	Documents		
tudy area	CCI -	User Functions	6			
limate downscaling					WABAL	
ET Hargreaves					Work Mode is Grid	
TA T	PLD C	noice				Step 1 /
ata Interpolation	Data t	ype		Observe	d 🔘 Simulated	
Would you like to manual set-up PLD?				💿 No 🔘 Yi	BS	
D	PLD Si	mulation		··· SIMULATI	DN	×
ABAL	Defaul	t Season's Begin (dekad)			
QUACROP	Defaul	t Season's Length	(dekads)			
TREAM calibration						Show details on the selected PLD
TREAM simulations	Soil lay	er		··· SELECT ···		~
	Admin	istrative layer		··· SELECT ···		
elobel	Filter/f	Aask layer (optiona	n	··· SELECT ···		
ly account						•
og out	Extra	ayer (optional)		··· SELECT ···		~

Figure 8 WABAL grid mode step 1

If the user selects "Yes" in the second field, the user can select the PLD experiment wanted in the following drop down menu ("PLD Simulation"). Instead if the user chooses to work with constants, two drop down menus appear to select the precipitation and the PET grids. Next,

two text fields are displayed: "Default Season's Begin" and "Default Season's Length". These fields accept integers between 0 and 36 as their unit is the dekad. They are used as default values when a PLD experiment is failing, or as actual growing season begin and length if PLD experiments are by-passed. In the second section of the form, a soil layer with water holding capacities in mm in its attributes must be selected, as well as an administrative layer containing the units for which the simulation will be achieved. Loading the administrative units may be a slow process; it is therefore advised to select a layer containing the area of interest only.

On the next step (Figure 9), the experiment is given a name, the years and the areas of simulations are selected and the crop file is chosen. Clicking on "Run >>" launches the simulations.

FOOD AND AGRICULTURE ORGANIZATION OF helping to build a world without hunger	MOSAICC ^{PHI, v. 0.1} Home			about contacts copyrights profile log-ou	
Home Functions	Data	Tools	Documents		
Study area	CCI - User Fun	tions			
Climate downscaling				WABAL	
PET Hargreaves				Work Mode is Grid	
	Period, Provinces a	nd Crop			Step 2 / 2
PCA				Run Name	
Data Interpolation	Name of the run				
PLD	Module to run		WABAL1		
WABAL				WABAL Parameters	
AQUACROP	Begin Period		1979		×
	End Period		2010		
STREAM calibration	Provinces			🗌 Nueva Eci	ita
STREAM simulations	Crop		CROP		ija V
fdelobel	· · · · · · · · · · · · · · · · · · ·		0101		Restart Run >>
My account					
Log out					

Figure 9 WABAL grids mode step 2

Points Mode

In points mode, the wizard is very similar, though it has some simplifications. The first screen (Figure 10) allow the user to choose whether to work with a PLD experiment or without, enter the growing season beginning and length (dekad) default values and to select the soil map.

FOOD AND AGRICULTURE ORGANIZATION O	F THE UNITED NATIONS	MOSAICC	PHI, v. 0.1		about contacts copyr	ights profile log-out
Home Functions	; Data	Tools	Documents			
Study area	CCI - User Fun	ctions				
Climate downscaling				WABAL		
PET Hargreaves				Work Mode is Points		
PCA	Data type, period a	and stations		Step 1 / 2		
	Data type			ved 🔘 Simulated		
Data Interpolation	Would you like to m	-	🔘 No 💿	Yes		
PLD	Season's Begin (dek	ad)				
WABAL	Season's Length (de	ekads)				
AQUACROP		Soil Properties				
STREAM calibration	Soil layer		SELEC	τ		×
	-					Next >>
STREAM simulations						
fdelobel						
My account						
Log out						

In the second step (Figure 11), the first field serves for naming the experiment. The second one, the module to run, is fixed. The data source, i.e. the set of weather observations to be used for the simulation, can then be selected, as well as the beginning and the end years of the time series. Selecting the data source and the time series limits loads the stations from that source available for that whole period. The user can choose which stations to include in the simulation and the crop file to use. As in grids mode clicking on "Run >>" launches the simulations.

FOOD AND AGRICULTURE ORGANIZATION OF 1 helping to build a world without hunger	THE UNITED NATIONS	MOSAICC [®] Home	ΉI, v. 0.1		about	s copyrights	profile log-out
Home Functions	Data	Tools	Documents				
Study area	CCI - User Fund	tions					
Climate downscaling				WABAL			
PET Hargreaves				Work Mode is Points			
	WABAL parameters						Step 2 / 2
PCA				Run Name			
Data Interpolation	Name of the run						
PLD	Module to run		WABAL1				~
WABAL	Data Source		DATA S	OURCE			~
AQUACROP	Begin Period						~
STREAM calibration	End Period						~
STREAM simulations	Stations		stations				
				WABAL Parameters			
fdelobel	Crop		CROP				~
My account						Restart	Run >>
Log out	L						

Figure 11 WABAL points mode step 2

5. Retrieving the outputs

WABAL simulations usually take few seconds to run. When a simulation is done the results can be retrieved by going to "Tools" in the main menu and "Experiments" in the side menu. All experiments carried out by the user are displayed on the screen. Filtering the experiments using the for drop-down menus at the top of the screen helps to isolate specific experiments (Figure 12). Results can be in turn visualised by clicking on the experiment number, on the left end of the row.

helping to build a wo	orld without hunger			Home	LCC ^{PHI, v. 0.1}				
Home	Functions		Data	Tool	s Documents				
vailable Tools		CCI - T	ools						
xperiments asks						Experiment Manager			
lodules					Exp				
Jsers Downscaling DB		Experime	ent's Filter]					
Jser Functions		User Fund	tion	ALL F	UNCTIONS	Module	WABAL1	~	
fdelobel		Work Mod	de	WORK	MODE	💌 Run Time	Yesterday	~	
My account								Apply	
Log out						WABAL			
		WABAL	1						
		# Date		Work Mod	le Name		Generated Data	Finished	Û
		2356 03-0		Points	Test WABAL points 0503		none	03-05-2013 16:56	Û
		16:5	56					10:36	

Figure 12 Experiment list and filter

The results of WABAL experiments are presented in a table, with the values for each output variable for each year of simulation (Figure 13). On table is shown for each administrative

units in grids mode or each station in points mode. The tables can be downloaded directly for statistical processing using the button "Result file" at the bottom of the screen.

Home Funct	ions	Data	а		Tools	5	D	ocum	ients										
ailable Tools		Tool				_													
eriments			-								_								
ks										l	=xper	imen WAF	it Man 3 Al	lager					
dules rs	WABA	u										00774	JAL						WABAL
inscaling DB										tost		RΔI	grids	050	з				
r Functions	·									103			grias	, 050	<u> </u>				
lobel	Files	Results																	
account	Nuev	ra Ecij	ja																
g out	Year	ETAt	ETA1	ETA2	ЕТАЗ	ETA4	DEFt	DEF1	DEF2	DEF3	DEF4	EXCt	EXC1	EXC2	EXC3	EXC4	TWR	WSI (raw)	WSI (corr. for surplus)
g out	1985	i 685	1	330	204	150	0	0	0	0	0	629	66	350	133	81	805	100	10
	1986	600	7	306	138	149	104	0	0	0	104	634	55	322	227	31	778	100	10
	1987	604	13	308	140	143	0	0	0	0	0	812	49	398	243	123	868	100	10
	1988	685	22	329	198	136	17	0	2	0	15	631	16	321	180	114	869	100	10
	1989	691	8	364	153	167	0	0	0	0	0	446	56	139	235	15	817	100	10
	1990		3	318	136	152	13	0	0	0	13	791	64	368	260	100	861	100	10
	1991	. 700	7	346	174	172	0	0	0	0	0	791	56	382	209	143	912	100	10
	1992	659	14	334	148	163	2	0	0	0	2	881	54	427	283	117	978	100	10
	1993	635	1	334	157	144	0	0	0	0	0	924	71	419	264	170	976	100	10
	1994		19	361	141	184	3	3	0	0	0	697	19	330	276	72	925	100	10
	1995		16	322	134	132	0	0	0	0	0	855	44	413	304	95		100	10
	1996		23	317	204	169	0	0	0	0	0	449	5	264	163	17	817	100	10
	1997		5		185	158	144	0	0	0	144	698	62	357	198	81	854	100	10
	1998		0	327	153	143	42	0	0	0	42	850	69	399	277	105	932	100	10
	1999		22	350	234	165	13	1	11	0	0	303	1	178	74	49	800	100	10
	2000	1 724	18	333	220	153	158	0	76	0	83	363	41	112	179	31	810	100	10

Figure 13WABAL output table (grid mode)