RECWET SEMINAR

Part 4

Analytical Tools- SWAT, DSSAT, WEAP Models and DSS Platform: *Application and Some Results*

Research Center for Water Environment Technology
School of Engineering, The University of Tokyo
LECTURE SERIES NUMBER 33, December 14, 2018

SWAT Soil & Water Assessment Tool

WEAP Water Evaluation And Planning System

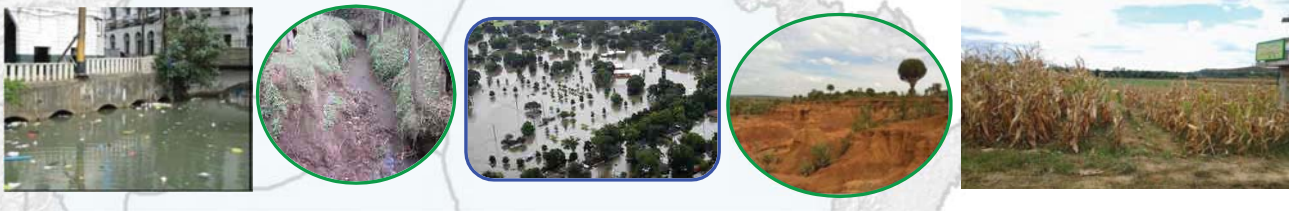
DSSAT V4.5 DECISION SUPPORT SYSTEM FOR AGROTECHNOLOGY TRANSFER

R&D STUDIES UNDERTAKEN and SOME RESULTS:

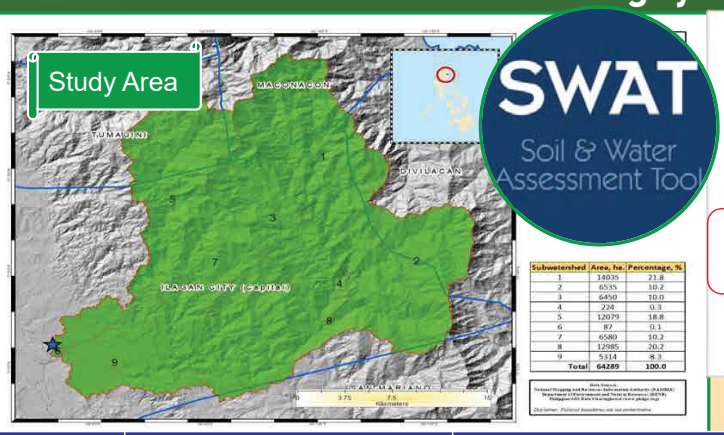
1)Land Use and Climate Change Impact on Hydrology and Erosion Hazard in Abuan Watershed of Cagayan River Basin using SWAT Model;

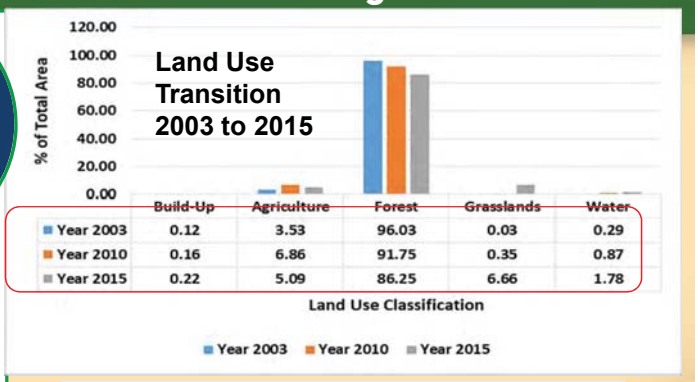
2) Water Security in Cagayan River Basin*: Assesment of Impact of Climate and Socio- Economic Changes using WEAP Model;*

3) Agricultural Modeling of Major Crops for Local Climate Adaptation in Cagayan Valley using DSSAT



1) Land Use and Climate Change Impact on Hydrology and Erosion Hazard in Abuan Watershed of Cagayan River Basin using SWAT Model





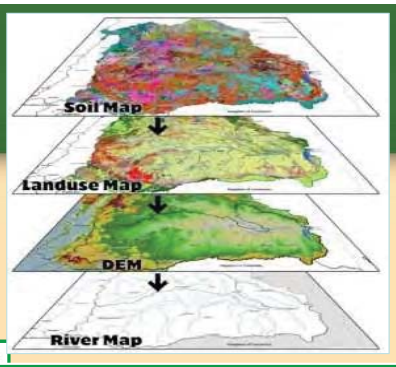
	Build-Up	Agriculture	Forest	Grasslands	Water
Year 2003	0.12	3.53	96.03	0.03	0.29
Year 2010	0.16	6.86	91.75	0.35	0.87
Year 2015	0.22	5.09	86.25	6.66	1.78

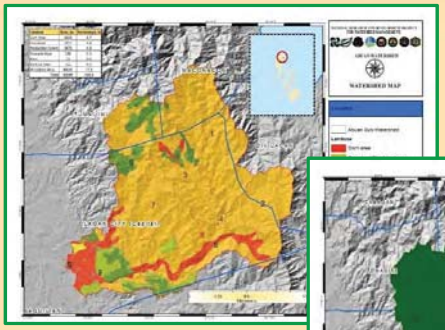
Time Frame	Temperature Increase (°C)				Rainfall Change (%)			
	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
2050	2.0	2.1	1.6	1.9	25.1	-29.2	8.7	1.7

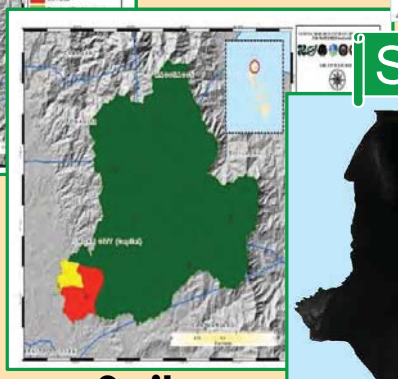
Land Use Change Scenario

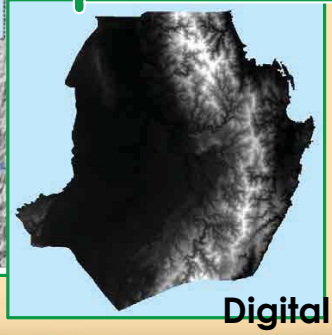
1	No Change
2	50% of Agriculture to Urbanization; 25% of Grassland to Urbanization - TREND
3	50% of Agriculture Converted to Forest(Agro-forestry); 100% of Grasslands to Forest- GOVT TARGET

Methodology









SWAT Model Inputs

Weather Data

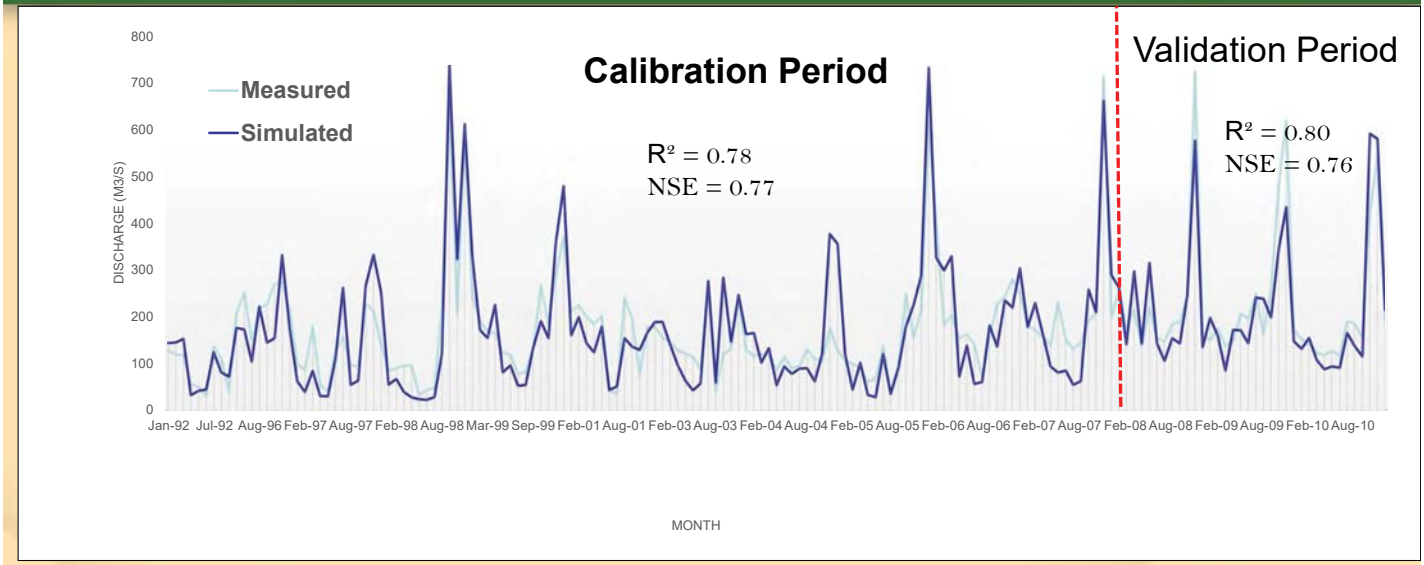
Streamflow Data

Landuse

Soil

Digital Elevation Model

Model Parameters and Prediction of Streamflow

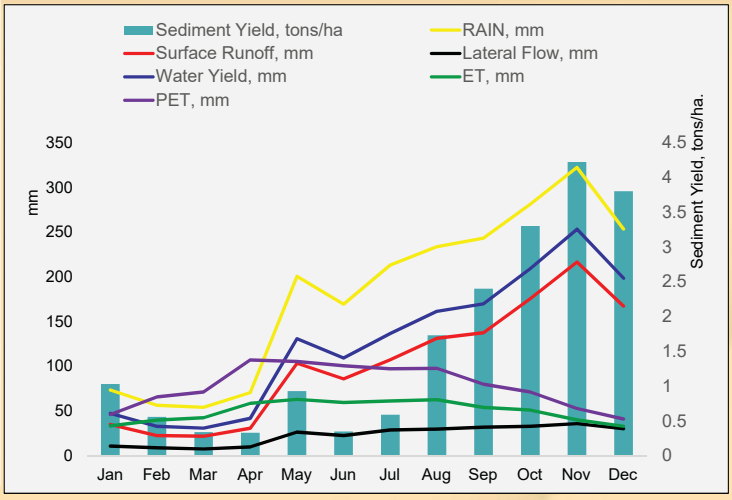


Monthly observed and simulated streamflow in the study area.

Simulated Hydrological Processes

PARAMETERS	AMOUNT (mm)	PERCENT OF RAINFALL
Rainfall	2169.1	
Surface Runoff	1233.9	56.9
Shallow Groundwater Recharge	9.46	0.4
Deep Aquifer Recharge	1.23	0.1
Total Aquifer Recharge	61.41	2.8
Total Water Yield (Streamflow)	1520.47	70.1
Percolation	61.46	2.8
Potential Evapotranspiration	934.3	43.1
Evapotranspiration	597.8	27.6

Annual Water Balance in Abuan Watershed



Average monthly values and sediment yield in tons/ha

Simulation of Hydrologic Impacts of Land use and Climatic Change Scenarios

Parameters	Baseline		Scenario 1		Scenario 2		Scenario 3	
	Amount mm	Percent of Rainfall	Amount mm	Percent of Rainfall	Amount mm	Percent of Rainfall	Amount mm	Percent of Rainfall
Rainfall	2169.10		2238.00		2238.00		2238.00	
Surface Runoff	1233.90	56.89	1296.75	57.94	1299.62	57.94	1230.79	57.94
Shallow Groundwater Recharge	9.46	0.44	10.74	0.48	10.74	0.48	10.74	0.48
Deep Aquifer Recharge	1.23	0.06	1.31	0.06	1.31	0.06	1.31	0.06
Total Aquifer Recharge	61.41	2.83	65.64	2.93	65.37	2.92	65.51	2.93
Total Water Yield (Streamflow)	1520.47	70.10	1588.29	70.97	1588.21	70.97	1588.32	70.97
Percolation	61.46	2.83	65.72	2.94	65.47	2.93	65.60	2.93
Potential Evapotranspiration	934.30	43.07	934.30	41.75	934.30	41.75	934.30	41.75
Evapotranspiration	597.80	27.56	596.00	26.63	596.30	26.64	596.00	26.64

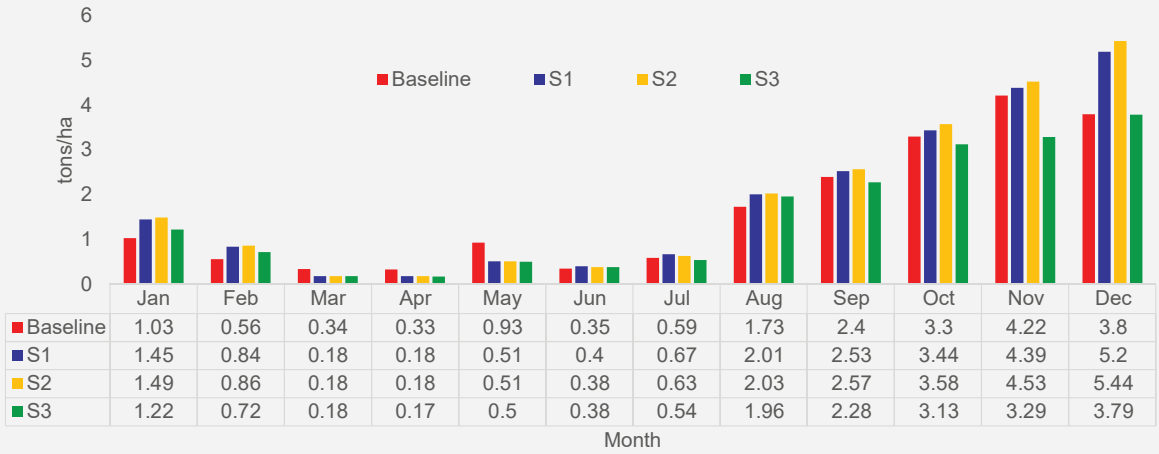
Simulated annual water balance of the different scenarios in Abuan watershed

Simulation of Hydrologic Impacts of Land-use and Climatic Change Scenarios

MONTH	Baseline			2050			% Increase		
	Surface Runoff, mm	Water Yield, mm	Sediment Yield, tons/ha	Surface Runoff, mm	Water Yield, mm	Sediment Yield, tons/ha	Surface Runoff, mm	Water Yield, mm	Sediment Yield, tons/ha
January	35.16	47.44	1.03	48.64	62.96	1.45	38	33	41
February	22.53	32.85	0.56	32.37	44.44	0.84	44	35	50
March	21.83	30.84	0.34	12.43	19.84	0.18	-43	-36	-47
April	30.75	41.80	0.33	17.70	26.53	0.18	-42	-37	-45
May	103.49	130.84	0.93	59.44	82.07	0.51	-43	-37	-45
June	85.95	109.10	0.35	94.73	119.44	0.40	10	9	14
July	107.17	136.44	0.59	120.01	151.29	0.67	12	11	14
August	131.15	161.49	1.73	147.54	179.43	2.01	12	11	16
September	137.38	169.82	2.40	141.10	173.87	2.53	3	2	5
October	175.41	209.01	3.30	179.75	213.63	3.44	2	2	4
November	216.46	253.19	4.22	221.55	258.55	4.39	2	2	4
December	167.19	198.48	3.80	222.33	257.37	5.20	33	30	37
TOTAL	1234.47	1521.30	19.58	1297.59	1589.42	21.80	5	4	11

Simulated monthly baseline and 2050 percent increase of surface runoff and water yield in Abuan watershed

Simulation of Hydrologic Impacts of Land use and Climatic Change Scenarios to Sediment Yield



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline	1.03	0.56	0.34	0.33	0.93	0.35	0.59	1.73	2.4	3.3	4.22	3.8
S1	1.45	0.84	0.18	0.18	0.51	0.4	0.67	2.01	2.53	3.44	4.39	5.2
S2	1.49	0.86	0.18	0.18	0.51	0.38	0.63	2.03	2.57	3.58	4.53	5.44
S3	1.22	0.72	0.18	0.17	0.5	0.38	0.54	1.96	2.28	3.13	3.29	3.79

Month

S3 results to significant reduction of erosion in 2050 by 6%, 21.3% and 24.6% against baseline, scenario1 and scenario2, respectively from July-Dec

Simulated baseline sediment yield and across scenarios.

2) Water Security in Cagayan River Basin: *Assesment of Impact of Climate and Socio-Economic Changes using WEAP Model*

Objectives

1.Establish a benchmark of existing water use, water balance, water technologies use, water policies and governance in the basin;

2.Assess future water resources and demands considering socio-economic, technological and climate changes using the WEAP model;

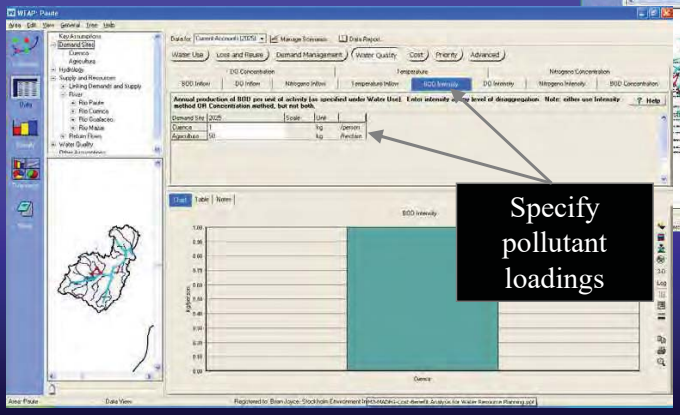
3.Develop a water security index as tools for planning and policy decision making.

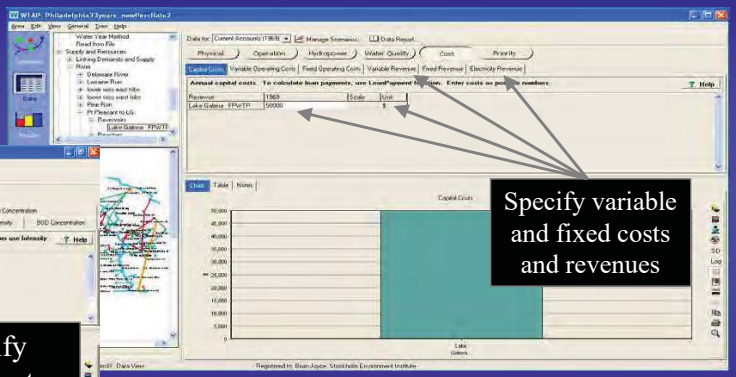
WEAP Highlights

- **Integrated water resources planning system**
- GIS-based, graphical drag and drop interface
- Basic Methodology: physical simulation of demands and supplies
- **Scenario management capabilities**
- Dynamic links to spreadsheets & other models

Other Features

Water Quality



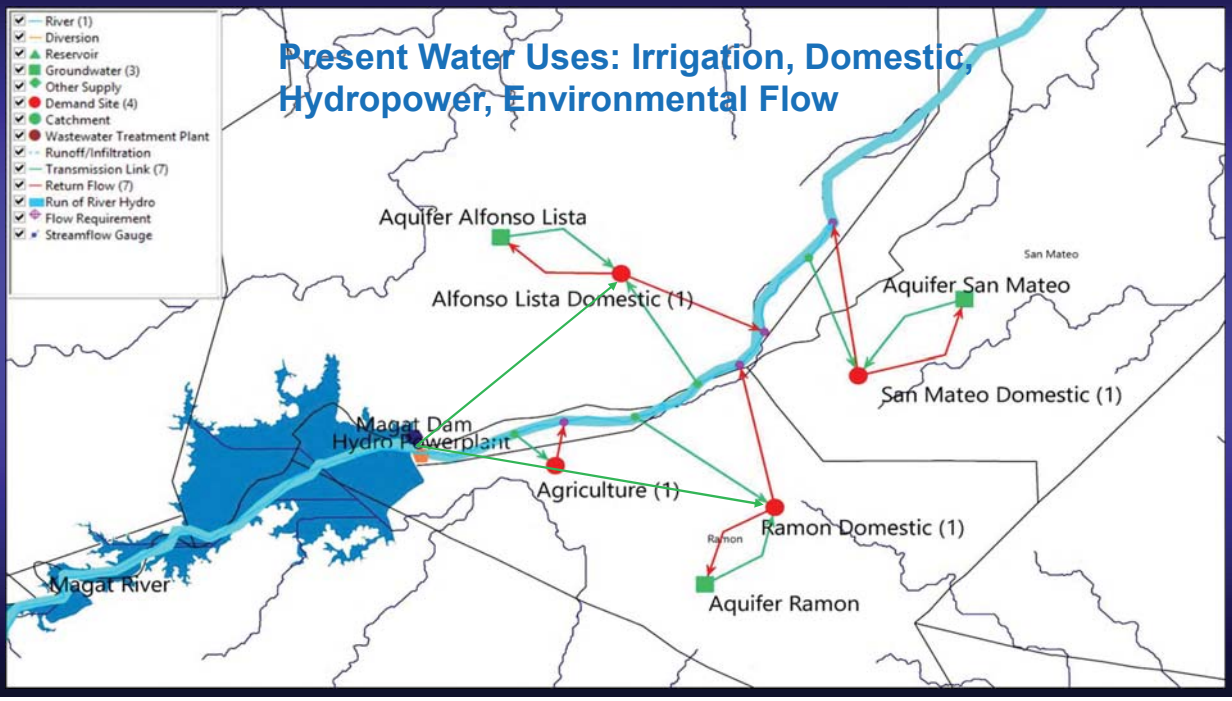


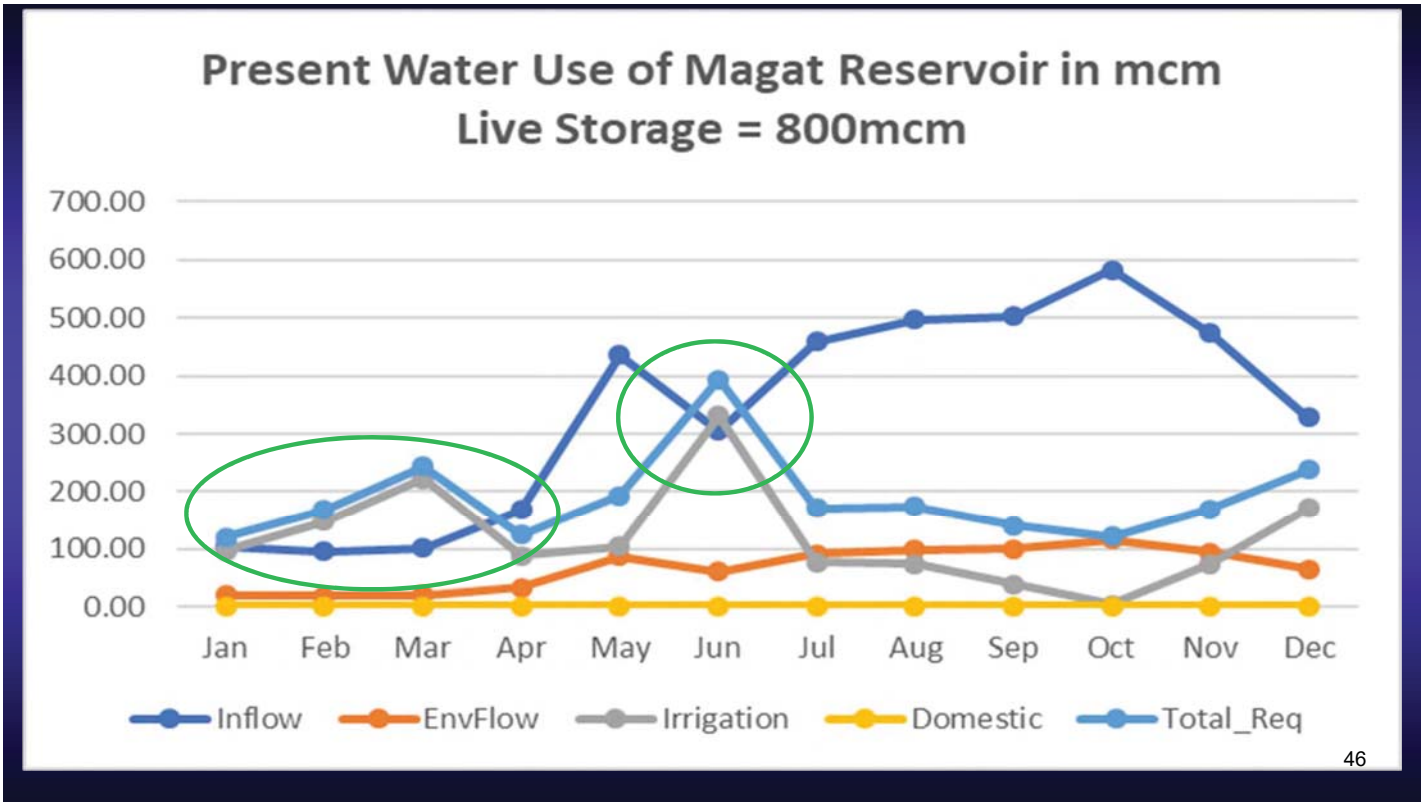
Financial Analysis

Expected Output

- Water use benchmarks and inventory of water users, existing policies, water balance, water quality and productivity, future development plans;
- Developed local WEAP model for analysis of present and future water resources and demands considering socio-economic, technological and climate changes;
- A water security index as tools for planning and policy decision making (i.e water availability, productivity, hazards, governance, watershed health);

Some Results: The Magat WEAP Schematic

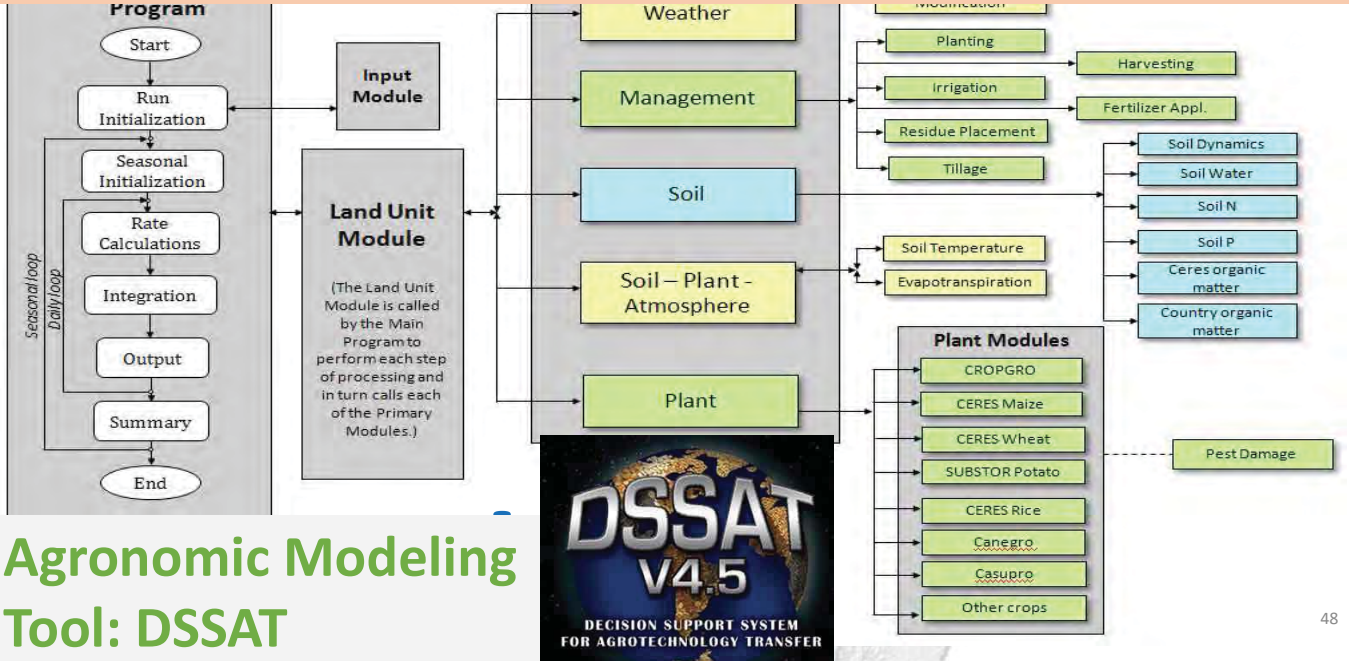




Simulation of Future Scenarios

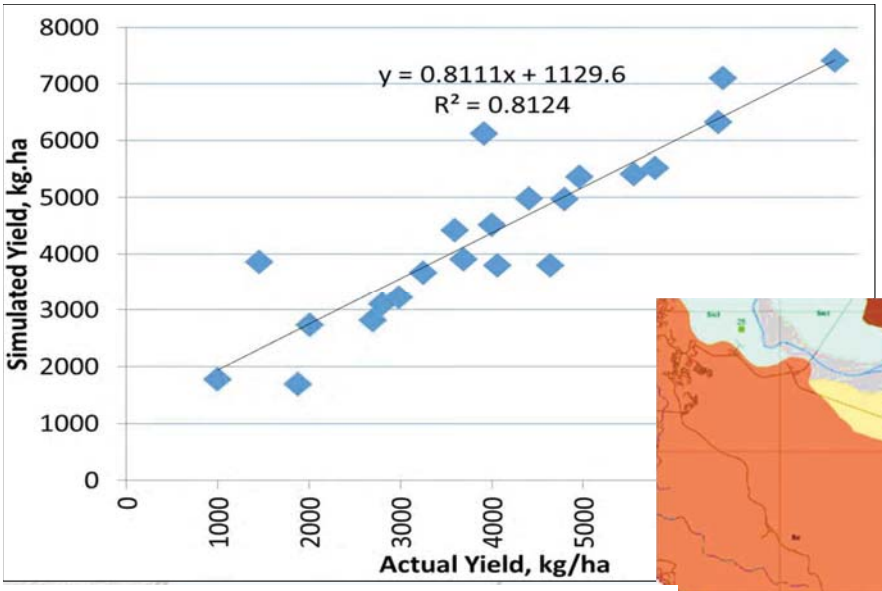
- Changes in water/ irrigation technologies
- Changes in agriculture development
- Changes in climate
- Changes in domestic and industrial demand
- Increase in population and water use per capita
- Expansion/Modernization of infrastructure for water supply system

3) Agricultural Modeling of Major Crops for Local Climate Adaptation in Cagayan Valley using DSSAT

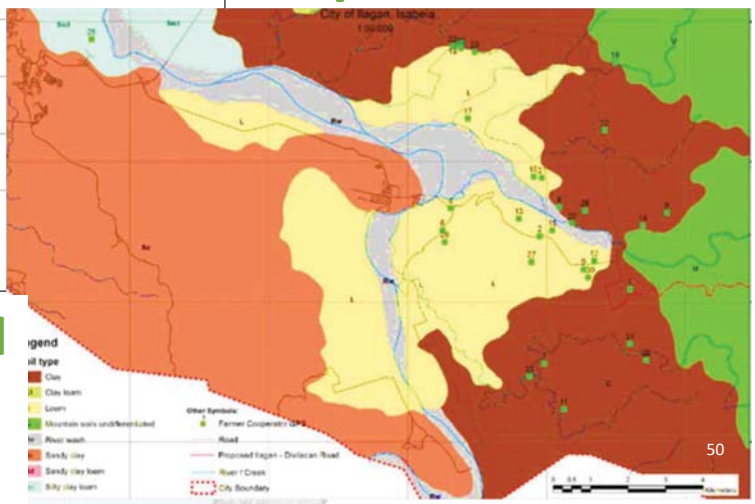


Agronomic Modeling Tool: DSSAT

DSSAT Localized model development, calibration and validation flow chart



Simulated vs actual yield of farmer cooperators

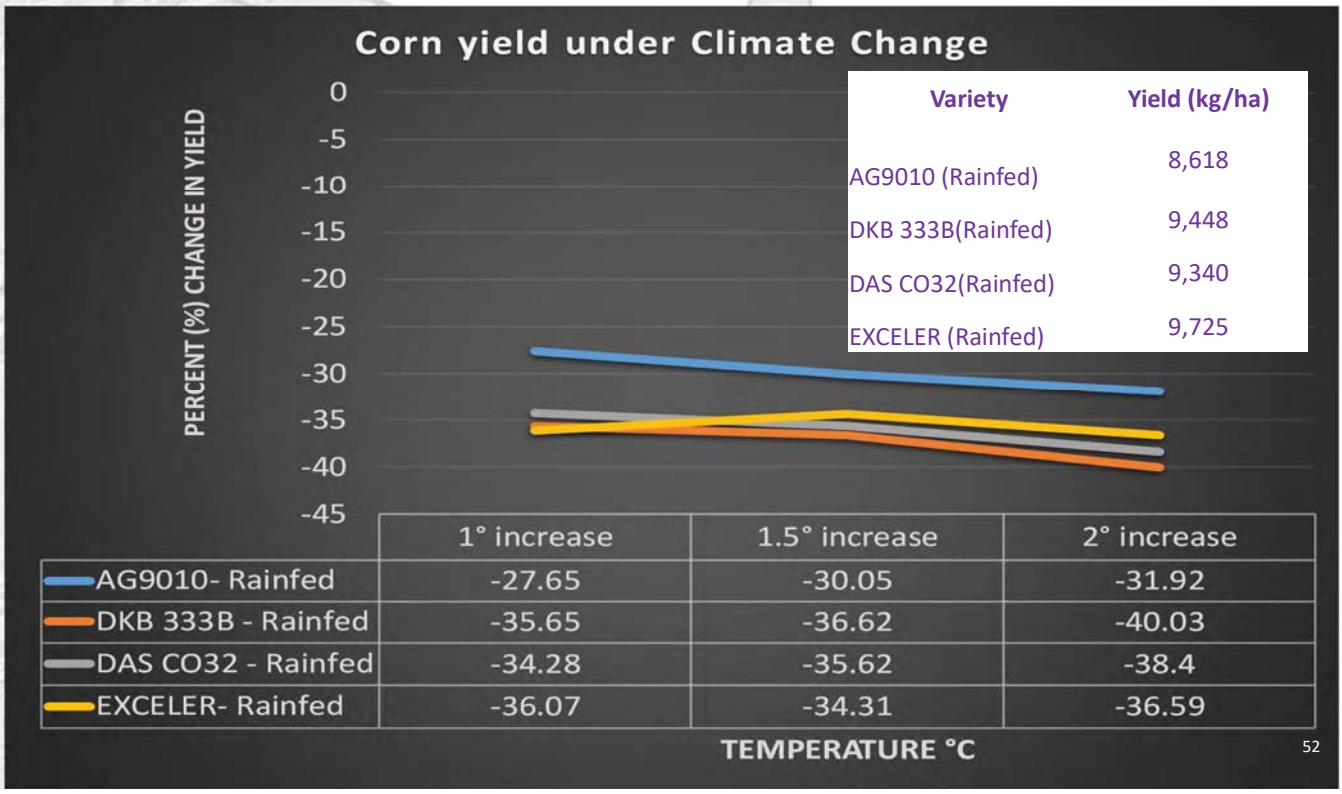


Location of farms for model validation under various ecosystem and soil type

Impact of Climate Change on Corn Yields and Adaptation Options

Baseline (1987-2014)		Value
Growing days, d		110
Tx, mm		125
Wet yield, tons/ha		6.78
Dry yield, tons/ha		7.711
Mean yield, tons/ha		7.25

2050s	Best Case, RCP2.6		Worst Case, RCP8.5	
	% change		% change	
Growing days, d	103	-7%	101	-8%
Tx, mm	183	46%	175	40%
Wet yield, tons/ha	6.06	-11%	5.96	-12%
Dry yield, tons/ha	3.47	-55%	2.64	-66%
Mean yield, tons/ha	4.77	-34%	4.30	-41%
% mean yield loss/deg		-25%		-23%
Oct 15 planting date, yield	**6.94**	**-10%**	**6.24**	**-19%**
With irrigation, yield	**7.60**	**-1%**	**7.27**	**-6%**



Variety	Yield (kg/ha)
AG9010 (Rainfed)	8,618
DKB 333B(Rainfed)	9,448
DAS CO32(Rainfed)	9,340
EXCELER (Rainfed)	9,725

	1° increase	1.5° increase	2° increase
AG9010- Rainfed	-27.65	-30.05	-31.92
DKB 333B - Rainfed	-35.65	-36.62	-40.03
DAS CO32 - Rainfed	-34.28	-35.62	-38.4
EXCELER- Rainfed	-36.07	-34.31	-36.59

Productivity Mapping of Groundnut in Cagayan River Basin using DSSAT for Dry and Wet Season