Application of the SWAT and APEX Models Using SWAPP (SWAT/APEX Program) for Dynamic Fertilizer Management Application

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Part I
SWAT/APEX (SWAPP) Program

Introduction

- Several processed-based nonpoint source models are used to assess and evaluate various agricultural BMPs (best management practices) at field and watershed levels including:

  - Watershed-scale: Soil Water assessment Tool, SWAT
  - Field-scale: Agricultural Policy/Environmental eXtender, APEX

- SWAT and APEX are daily-time step models
- SWAT was developed to predict the effect of different management scenarios on water quality, sediment yields, and pollutant loading in rural watersheds
- APEX was designed to simulate edge-of-field runoff volume, nutrients and sediment loadings
- SWAT allows data input via Geographical Information System (GIS)
- Output from APEX from each field can be input as a point source into SWAT

Strengths of SWAT and APEX

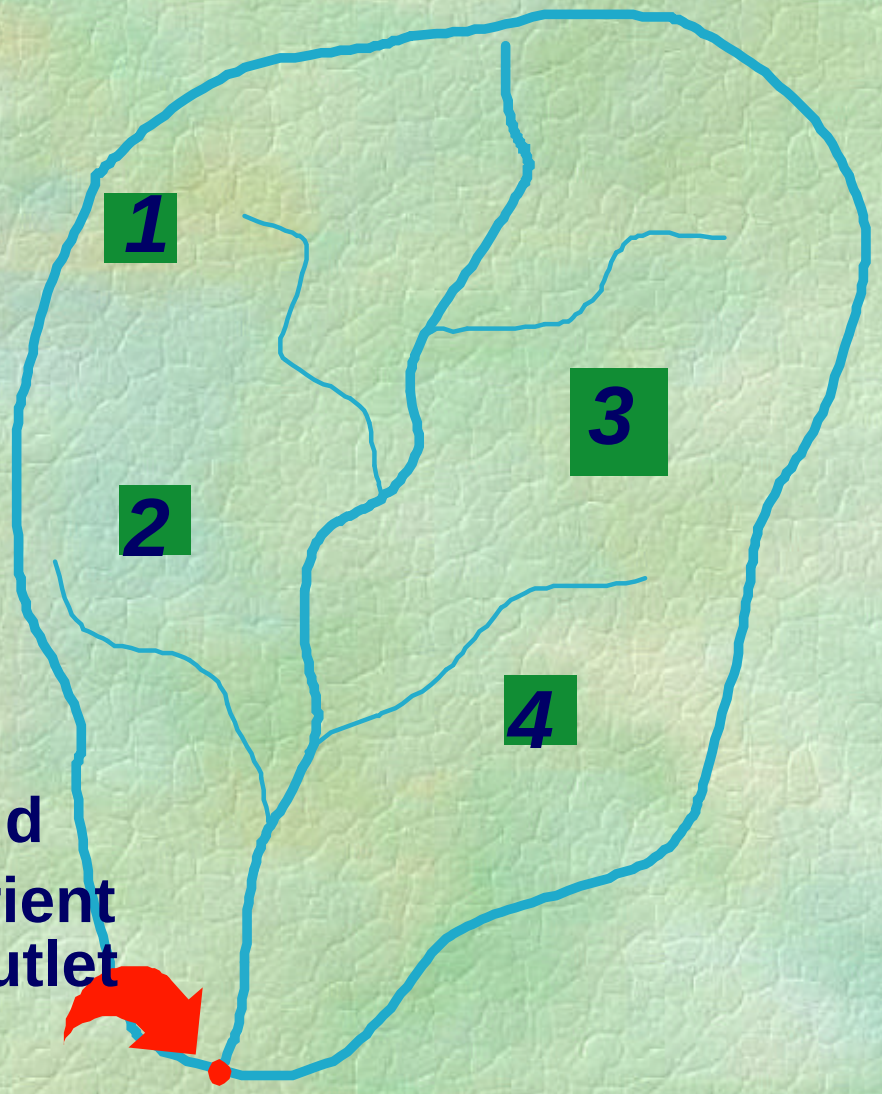
- APEX
  - More precise results at the field level
  - Simulation of more detailed management practices (e.g., double cropping and filter strips, animal feeding operations, etc.)
  - Wind erosion simulation
- SWAT
  - Ability to generate the required data bases efficiently using AVSWAT
  - Routing functions
  - Input from other models and point sources, etc.

Objectives of this study

- Develop an automated program to link and facilitate the simultaneous use of SWAT and APEX
- Modify the APEX program to apply manure dynamically based on the soil extractable P

APEX-SWAT Linkage

- Simulated Landuse by APEX



Input daily APEX edge-of-field flows, and sediment and nutrient loadings at SWAT subbasin outlet

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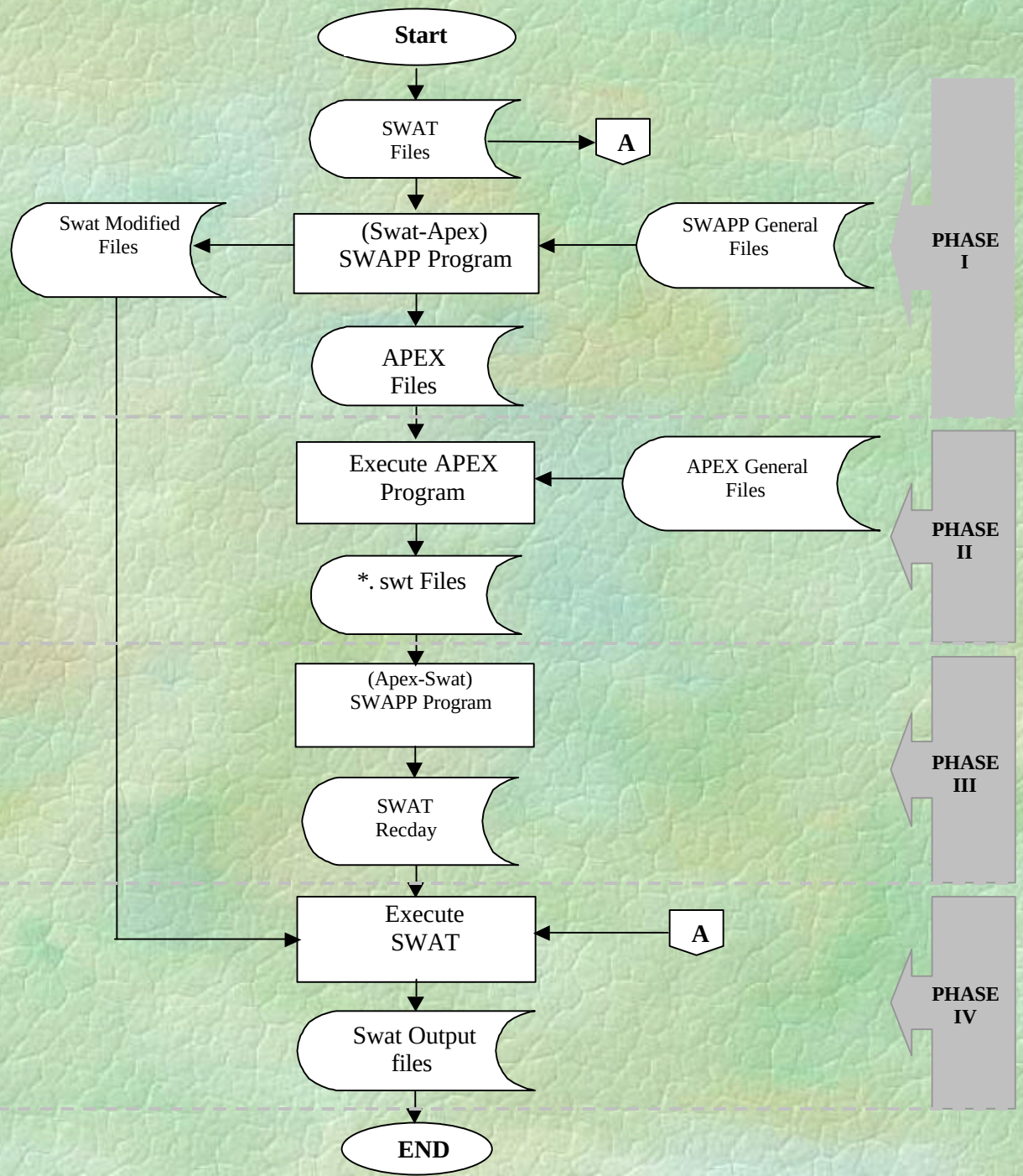
Start
SWAT Files
A
Swat Modified Files
(Swat-Apex) SWAPP Program
SWAPP General Files
PHASE I
APEX Files
Execute APEX Program
APEX General Files
PHASE II
*. swt Files
(Apex-Swat) SWAPP Program
PHASE III
SWAT Recday
Execute SWAT
A
PHASE IV
Swat Output files
END

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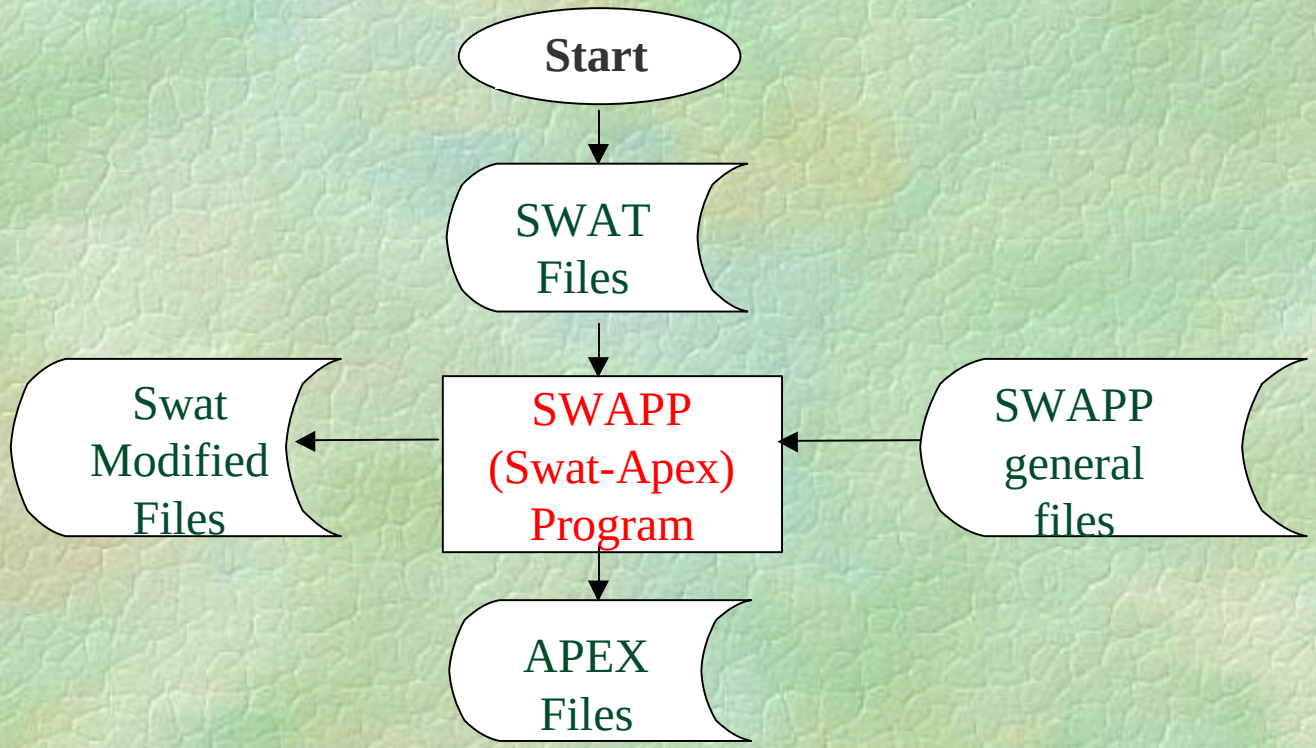
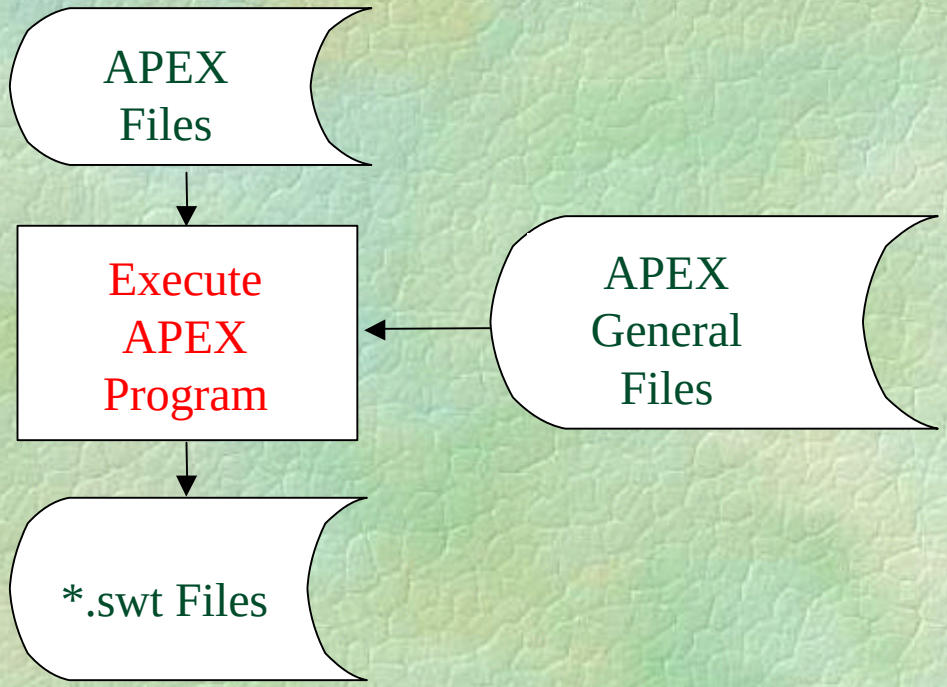
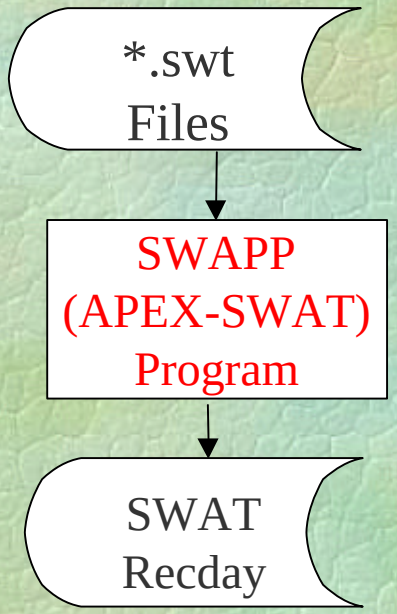
Phase I: SWAT to APEX



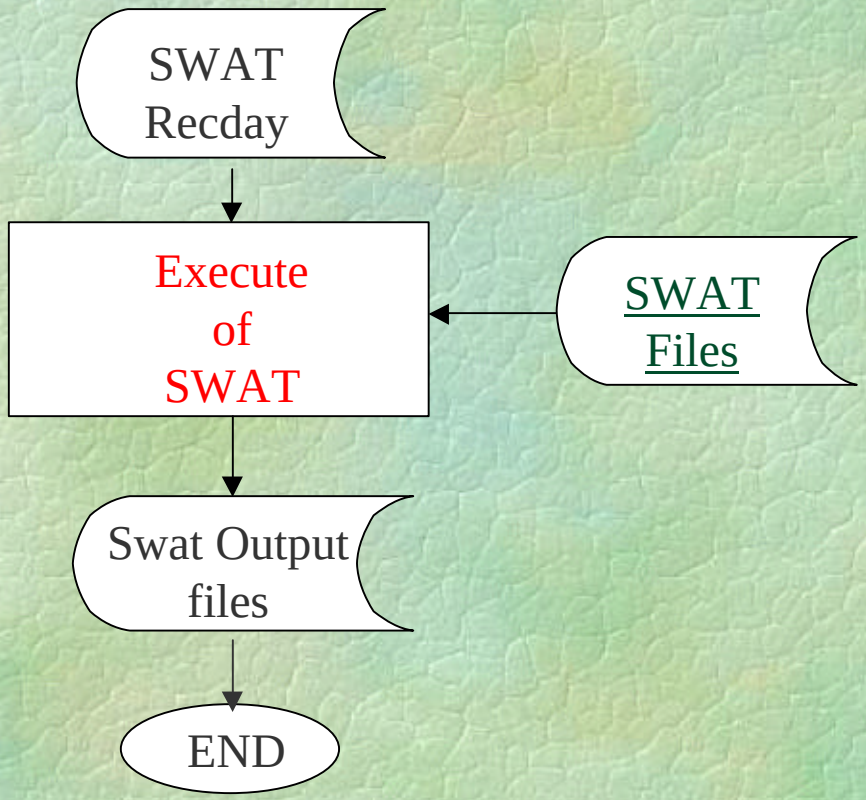
Phase II: APEX Simulation



Phase III: APEX to SWAT



Phase IV: SWAT Simulation



Part I
Summary

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- The SWAPP program transfers SWAT data files generated by the AVSWAT program to APEX data files rapidly and automatically
- It allows the user to evaluate BMPs at the field and watershed scales more precisely
- Results from a previous study (Saleh and Gallego, 2006) have shown that the simulated nutrient loading obtained from SWAT/APEX within SWAPP were closer to measured values as compared to those from SWAT alone

- SWAPP allows the user to simulate management practices, such as multi cropping systems and filter strips (by APEX), both of which are not available in SWAT at this time.
- SWAPP can be used with all current versions of the SWAT and APEX models

Part 2
APEX-DYNAMIC

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APEX-DYNAMIC

- Allows manure application rates based on soil extractable P at user-defined depths
- Allows the automatic expansion of manure application fields based on soil extractable P levels

Baseline and BMP Scenario Simulations

- Simulation period (40 years)
- Manure was produced by 2,000 cows at the rate of 2.92 t/cow/yr
- Crop
  - Coastal bermudagrass
- Two manure application schemes:
  - Case I. Whole field (175 ha)
  - Case II. Divided into five fields (35 ha)

BasScenarios

- soil extractable P < 200 ppm at 15 cm depth : manure application based on N agronomic rate (49 t/ha/yr)
- soil extractable P > 200 ppm at 15 cm depth: manure application based on P agronomic rate (12 t/ha/yr)

BMP Scenario(USDA-NRCS Nutrient Management Code 590)

- soil extractable P < 10 ppm at 15 cm depth: manure application based on N agronomic rate
- soil extractable P > 10 < 41 ppm at 15 cm depth: manure application based on two times P agronomic rate
- soil extractable P > 41 < 61 ppm at 15 cm depth: manure application based on one and a half times P agronomic rate
- soil extractable P > 61 < 200 ppm at 15 cm depth: manure application based on P agronomic rate
- soil extractable P > 200 ppm at 15 cm depth: manure application based on half of P agronomic rate

The need for element N, as commercial fertilizer, was determined based on the crop N stress level

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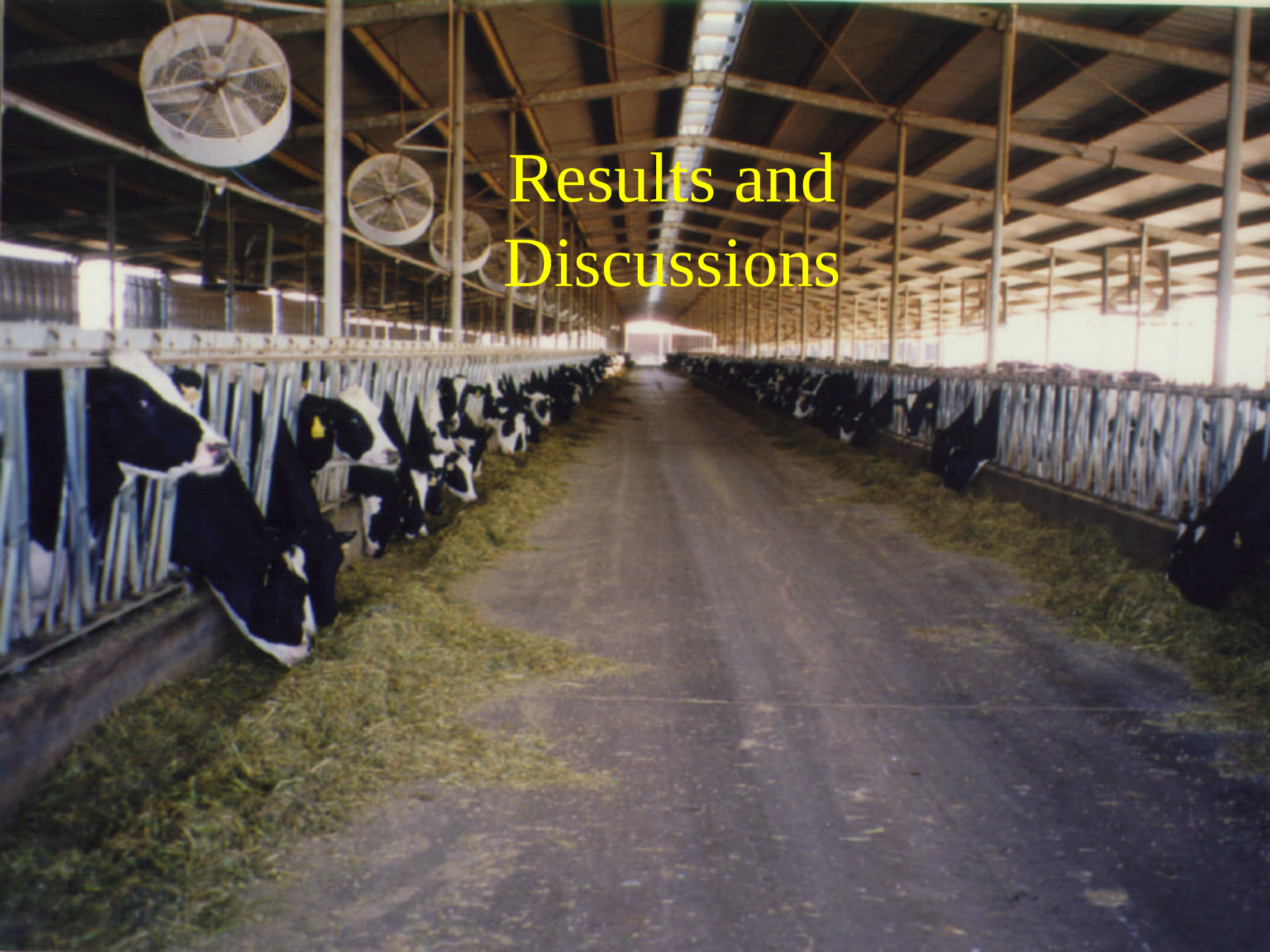

Results and Discussions

Applied manure under baseline and BMP scenarios under case I and II

	CASE I		CASE II	
	Baseline	*BMP*	*Baseline*	*BMP*
Manure Produced (t/yr)	5,913	5,913	5,913	5,913
Manure Applied (t/yr)	5,040	2,336	5,092	2,336
Manure Remaining (t/yr)	873	3,577	821	3,577
Percent Applied	**85**	**40**	**86**	**40**

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Nutrient loadings under baseline and BMP scenarios for cases I and II

	CASE I			CASE II		
	Baseline	*BMP*	*% change*	*Baseline*	*BMP*	*% change*
Sediment (t/ha)	0.09	0.09	0	0.12	0.12	0.0
NO_3 (kg/ha)	2.43	2.46	+1.2	1.89	1.99	+5.3
Organic-N (kg/ha)	1.84	1.54	-16.3	2.8	2.49	-11.1
PO_4-P (kg/ha)	1.78	1.00	-43.8	1.89	0.99	-47.6
Particulate-P (kg/ha)	0.21	0.18	-14.3	0.33	0.32	-3.0

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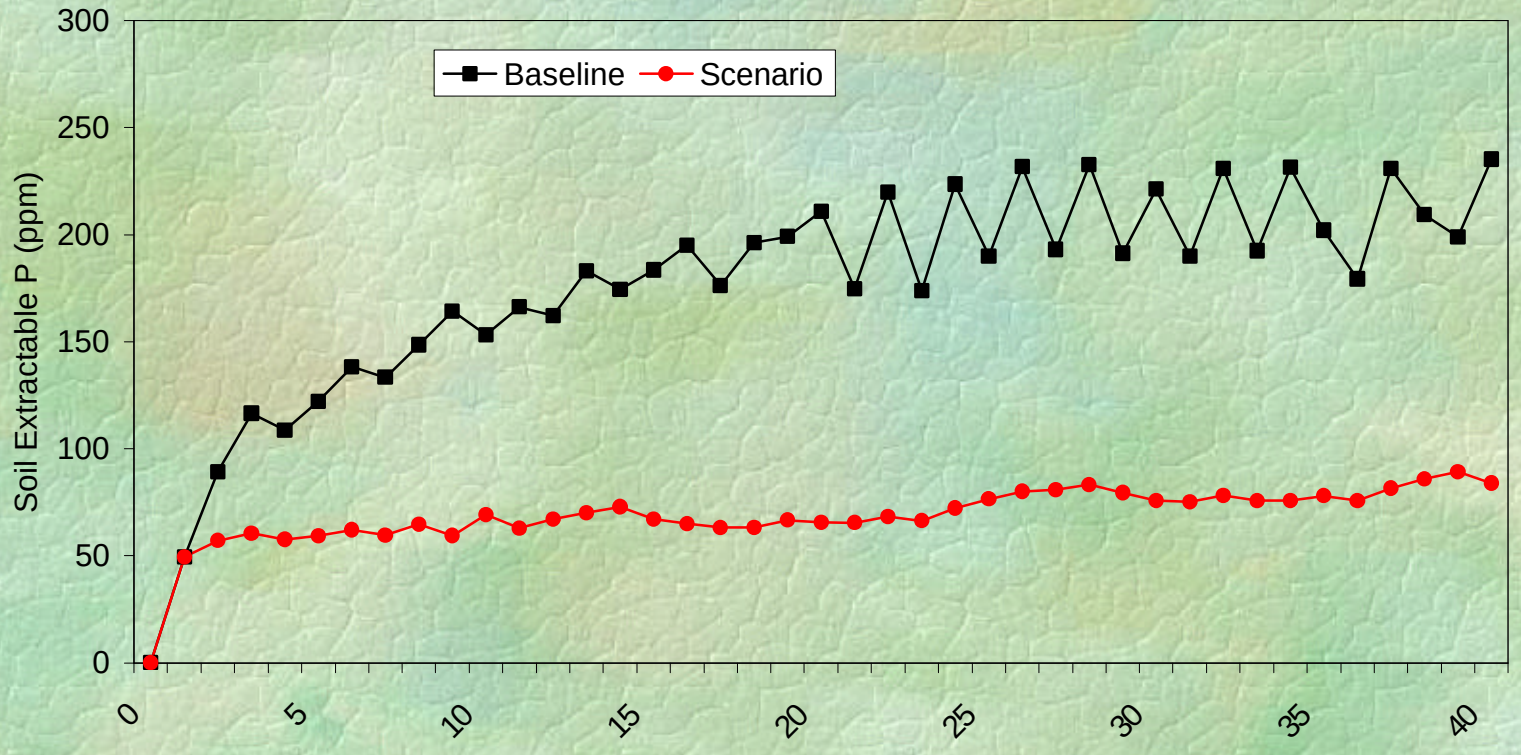
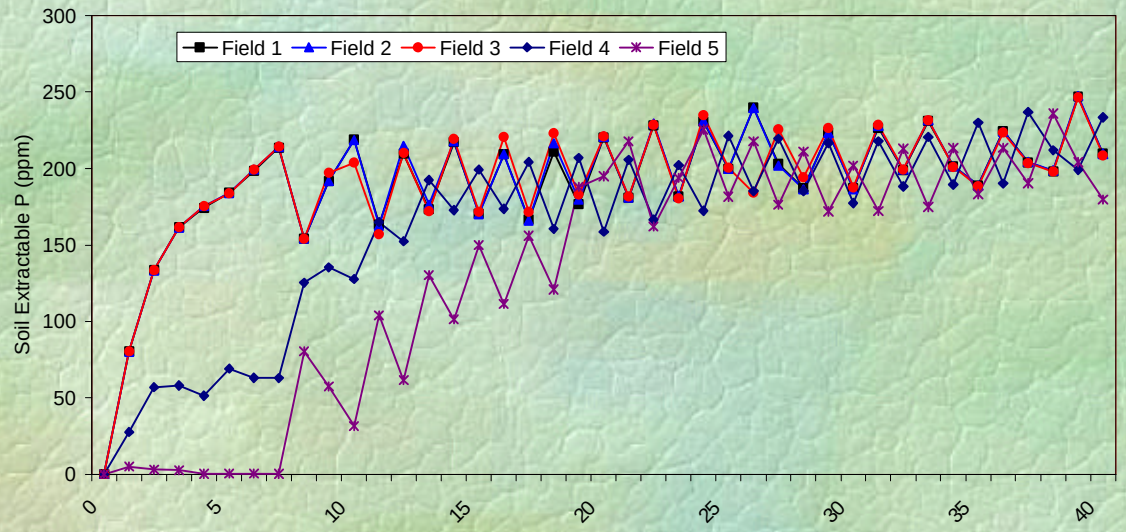
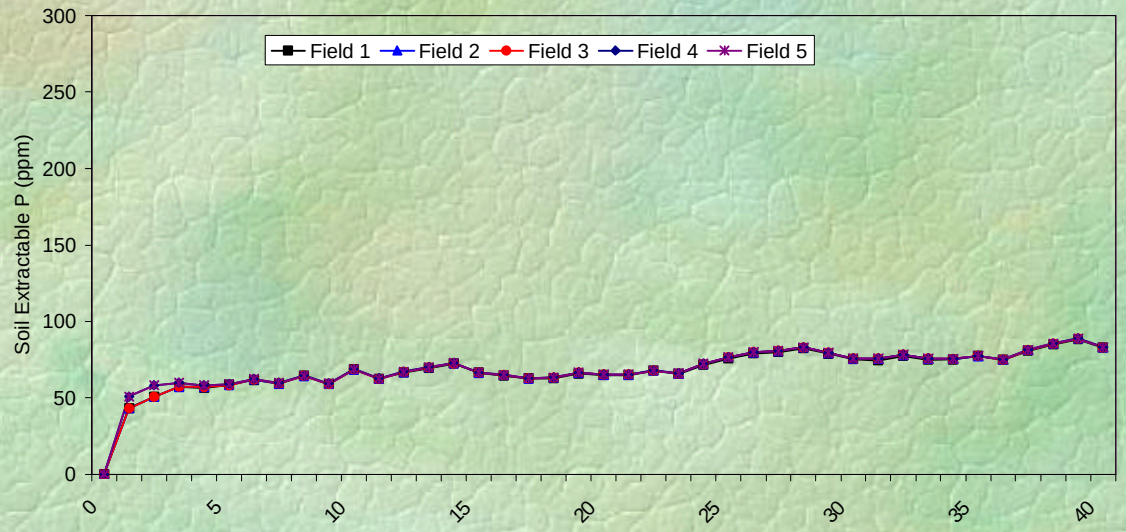
Soil extractable P when manure applied in a 175 ha field (case I) under baseline and BMP scenarios



Soil extractable P when manure applied in five 35-ha fields (case II) under baseline and BMP scenarios





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Part 2
Summary

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- Manure was applied significantly at a higher rate under the baseline compare to the BMP scenario
- The soil profile extractable P and the stream PO_4-P loadings were reduced significantly due to lower manure application rate under the BMP scenario
- APEX-DYNAMIC proved to be an excellent tool for evaluating the effects of various manure management options on agricultural lands and related water quality
- Further evaluation of APEX-DYNAMIC using the measured field or/and watershed data regarding evaluated BMPs is needed
- APEX-DYNAMIC will be evaluated for inclusion of the soil-P Index in near future

Acknowledgement

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THANK YOU