

# Agricultural Policy / Environmental eXtender

## A Watershed & Land Management Simulation Model

APEX, Agricultural Policy/Environmental eXtender model, was developed to extend EPIC's capabilities of simulating management and land use impacts for whole farms and small watersheds. EPIC (Environmental Policy Integrated Climate model) is a cropping systems model that was developed to estimate soil productivity as affected by erosion. APEX was constructed to evaluate various land management strategies considering sustainability, erosion (wind, sheet, and channel), economics, water supply and quality, soil quality, plant competition, weather, and pests.



## Capabilities

APEX functions on a daily time step and can simulate hundreds of years for approximately one hundred different crops. It can be configured for land management strategies such as irrigation, drainage, furrow diking, buffer strips, terraces, waterways, fertilization, manure management, lagoons, reservoirs, crop rotation and selection, pesticide application, grazing, and tillage. The routing of water, sediment, nutrient, and pesticide capabilities are some of the most comprehensive available in current landscape-scale models and can be simulated between subareas and channel systems within the model.

## APEX Components

### Climate Inputs

- precipitation, minimum/maximum temperatures, solar radiation, wind speed/direction, and relative humidity
- can be measured or simulated

### Hydrologic Balance

- encompasses all of the key processes that occur in the hydrologic cycle: incoming precipitation, surface runoff volume/rate, subsurface flow, percolation, and potential evaporation

### Crop Growth and Competition

- simulates potential daily growth of annual/perennial crops, trees, and other plants (up to ten plants in a mixed stand)
- simulates actual growth constrained by stresses (water, temperature, nutrients, and aeration)

### Livestock Grazing Inputs

- confined area feeding, intensive rotational grazing, and/or cropland grazing after harvest
- herd attributes: forage intake rate, grazing efficiency, urine/manure production rates

### Phosphorous (P) Cycling and Losses

- estimates soluble P runoff, leaching, mineralization, and immobilization of P, and crop uptake of P

### Water and Wind Erosion

- calculates water-induced erosion in response to rainfall, snowmelt, and irrigation runoff events
- calculates wind-induced erosion based on soil properties, surface roughness, vegetation cover, and wind direction

### Carbon Cycling Routine

- estimates soil changes as a function of climatic conditions, soil properties, and management practices
- simulates storage and transfer of carbon and nitrogen among pools

### Manure Management Inputs

- manure production and ingredient inputs can be solid or liquid form for a variety of livestock, swine, and poultry

### Manure Erosion

- measures organic nutrient and carbon losses from feedlots and manure application

### Nitrogen (N) Cycling and Losses

- simulates the complete nitrogen cycle: atmospheric N inputs, fertilizer/manure N applications, crop N uptake, mineralization, immobilization, nitrification, denitrification, ammonia volatilization, organic N transport on sediment, and nitrate-nitrogen losses in leaching, surface runoff, lateral subsurface flow, and tile flow

### Feedlot Dust

- measures dust emissions and distribution

### Routing Component

- routes water through channels or flood plains to simulate long-term water, sediment, nutrient, and pesticide yields from whole farms and small watersheds

### Reservoir Component

- determines amount of flood storage

### Economics Component

- simulates cost and income accounting





## APEX Interfaces:

Several interfaces and other tools have been developed to support APEX applications since the first versions of the model were released:

### Interactive APEX (i\_APEX)

- Performs automatic input of data, execution of each APEX run, and storage of selected model outputs using a single database to manage both the input and output data of all of the required APEX simulations.

### Windows APEX (WinAPEX)

- A Windows interface for the APEX model that allows for the same functionality as the stand-alone APEX model with the output in Microsoft Access database format.

### Windows APEX – Geographic Information System (WinAPEX-GIS)

- Builds the input files to execute APEX version 0806 for the Bosque River Watershed application requiring over 15,000 sub-watersheds.

### SWAT-APEX (SWAPP)

- Provides an automated method for performing nested APEX simulations on the field, whole-farm, or small watershed scale within a SWAT (Soil and Water Assessment Tool) watershed application.

### ArcGIS APEX (ArcAPEX)

- Takes advantage of improved options included in the ArcGIS (a geographic information system) platform which provides mapping and analysis of geographic data for watershed and regional analyses while being coupled to APEX allowing for analysis of small watershed hydrology, cropping system, and carbon related issues. Also allows for integration of APEX small watershed data into SWAT (Soil and Water Assessment Tool) river basin analyses.

## Various APEX Applications:

APEX can perform long-term continuous simulations for modeling the impacts of different nutrient management practices, tillage operations, conservation practices, alternative cropping systems, and other management practices on surface runoff and losses of sediment, nutrients, and other pollutant indicators. Example applications include:

- evaluate effects of global climate and carbon dioxide changes on crop yields
- assess alternative manure applications and other management scenarios
- design biomass production for energy
- demonstrate hydrologic balance components and pollutant transport for different cropping and forestry production systems
- simulate intensive rotational grazing scenarios depicting movement of livestock between paddocks
- evaluate the effects of different tree harvesting treatments on forested watersheds
- analyze the potential benefits of “woody draws” (relatively small, natural drainage areas covered by trees or shrubs in agricultural landscapes)
- determine cropping and conservation practice effects on lake systems
- simulate landscape management decisions such as harvest unit size, total area harvested, and rotation length
- assess environmental impact of pollutants into lakes
- evaluate effects of buffer strips
- simulate nonpoint-source pollution impacts from cultivated cropland
- design economical and environmentally safe landfill sites

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