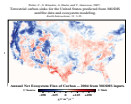
# Remote Sensing and Modeling of Carbon and Hydrologic Fluxes in Northern California Watersheds

*Christopher Potter[1], David Bubenheim[1], Steven Klooster [1,2], Seth Hiatt[2]*

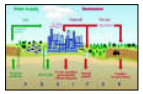
*1 – NASA Ames Research Center, Moffett Field, CA  2 – California State University Monterey Bay, Seaside, CA  Contact: chris.potter@nasa.gov*

**Purpose/Objective:** To develop a comprehensive ecosystem carbon and water cycle modeling approach using remote sensing products for watershed management studies

**Abstract/Background:** The NASA-CASA (Carnegie Ames Stanford Approach) simulation model based on satellite observations of monthly vegetation cover from the Landsat sensor was used to estimate biomass production from land cover types across the Northern California. The USDA-ARS SWAT model was applied as well to better understand management options that may improve water quality as a case study in the Laguna de Santa Rosa watershed in Sonoma County, California. Surface water quality in the Laguna watershed has been significantly impaired over recent years, as natural land cover has been urbanized or converted to agricultural uses. We first generated new maps of land cover and major land uses from satellite and airborne imagery for the watershed. SWAT model output was checked against six stream flow gauges in the watershed. Model scenarios are being tested for vegetation filter strips and improved ground cover conditions applied in sub-basins where soil erosion was shown to be elevated in previous simulations.



**Introduction** Many metropolitan areas in California are growing at unprecedented rates, creating extensive urbanized landscapes across former rangelands, wetlands, and woodlands. Sediment runoff from development sites and excess fertilizers, herbicides, and pesticides from mixed croplands, parklands and residential areas are frequently found to be important sources of local water contamination.



**Case Study Area in Sonoma County** Surface water quality in the Laguna de Santa Rosa watershed has been significantly impaired over recent years, as natural land cover has been urbanized and converted to agricultural uses.

**The Laguna de Santa Rosa is listed as impaired under the federal Clean Water Act for sediment, nitrogen, phosphorus, temperature, mercury, and dissolved oxygen, the most of any water body on the Northern Coastal region of California.**

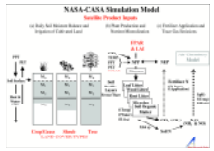

**Carbon Model Inputs**

Climate
Land Cover
Land Use
Soils
Elevation
Management

**Watershed Simulations**

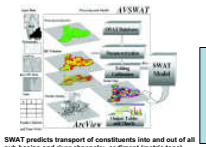
Applications of the USDA-ARS Soil Water Assessment Tools (SWAT model

## CASA Model Overview



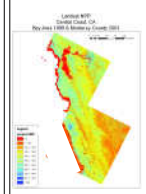

**Net primary production over any region is computed by the NASA-CASA model (Potter et al., 1999) on the basis of monthly vegetation index data sets. Monthly production biomass increment (g C per m$^2$) is estimated as a product of Landsat VI, surface solar irradiance, $S_o$, plus a constant light utilization efficiency term ($e_{max}$) that is modified by stress scalar terms for temperature (T) and moisture (W) effects:**

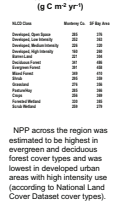
$$NPP = S_o\ EVI\ e_{max}\ T\ W$$




**SWAT predicts transport of constituents into and out of all sub-basins and river channels: sediment (metric tons), organic nitrogen, nitrate, and ammonium (kg N), organic and mineral phosphorus (kg P), chlorophyll-a, algal biomass, carbonaceous biochemical oxygen demand, dissolved oxygen, soluble and sorbed pesticide, and number of persistent bacteria.**

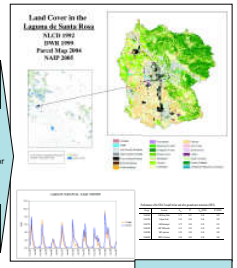
**Mean Annual NPP (g C m$^{-2}$ yr$^{-1}$)**





NPP across the region was estimated to be highest in evergreen and deciduous forest cover types and was lowest in developed urban areas with high intensity use (according to National Land Cover Dataset cover types).

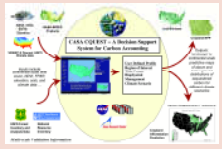
Remote sensing input layers for land cover






Remote Sensing R&A

## CASA - CQUEST: Carbon Query and Evaluation Support Tools




Public users anywhere can use a web browser to log-in and view, query, and download any of our CASA carbon data products at:

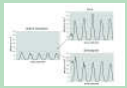
http://geo.arc.nasa.gov/sge/casa/cquestwebsite/

CQUEST is free to the public and entirely web-based. The customized Map Viewer tools are intended to permit users to query and navigate with GIS functionality from any web browser. Numerous carbon sequestration estimates are based on the peer-reviewed NASA-CASA ecosystem model.

## Bonus: Tracking Land Use Conversion to Biofuels

Under a high-price oil scenario, U.S. acreage planted to corn is projected to increase by 44%, from 78 million acres in 2006 to 112 million acres over the next 5-7 years (Source: Iowa State Univ.). Conservation Reserve Program (CRP) grasslands represent the largest available source of tillable acres in the U. S. for conversion to biofuel cropping.

The CASA model predictions at right show the change in growing season greenness profiles that would need to be detected from data mining of MODIS time series to track land use conversion from CRP-like grasslands in Iowa to corn or switchgrass fields. We are in process of analyzing the entire MODIS 250-meter data from 2000-2008 for this regional land use change product (example at lower right).



## Summary of Capabilities

- **Predict the impacts of drought and/or climate warming on surface water yields and demands in (ex-)urban drainage areas.**
- **Predict the effects of land cover and land use change on surface water transport of non-point source pollutants.**
- **Monitor the production levels of ex-urban "ranchland" and the demands for supplemental irrigation water to sustain healthy plant cover, with a focus on new vineyards.**
- **Monitor the effects of invasive (plant) species spread on both small stream flows and regional water yields.**
- **Predict the impacts of biofuel crops and other alternative energy sources on food, fiber, surface water yields and demands in (ex-)urban areas.**

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