Remote Sensing and Modeling of Carbon and Hydrologic Fluxes in Urbanized Watersheds

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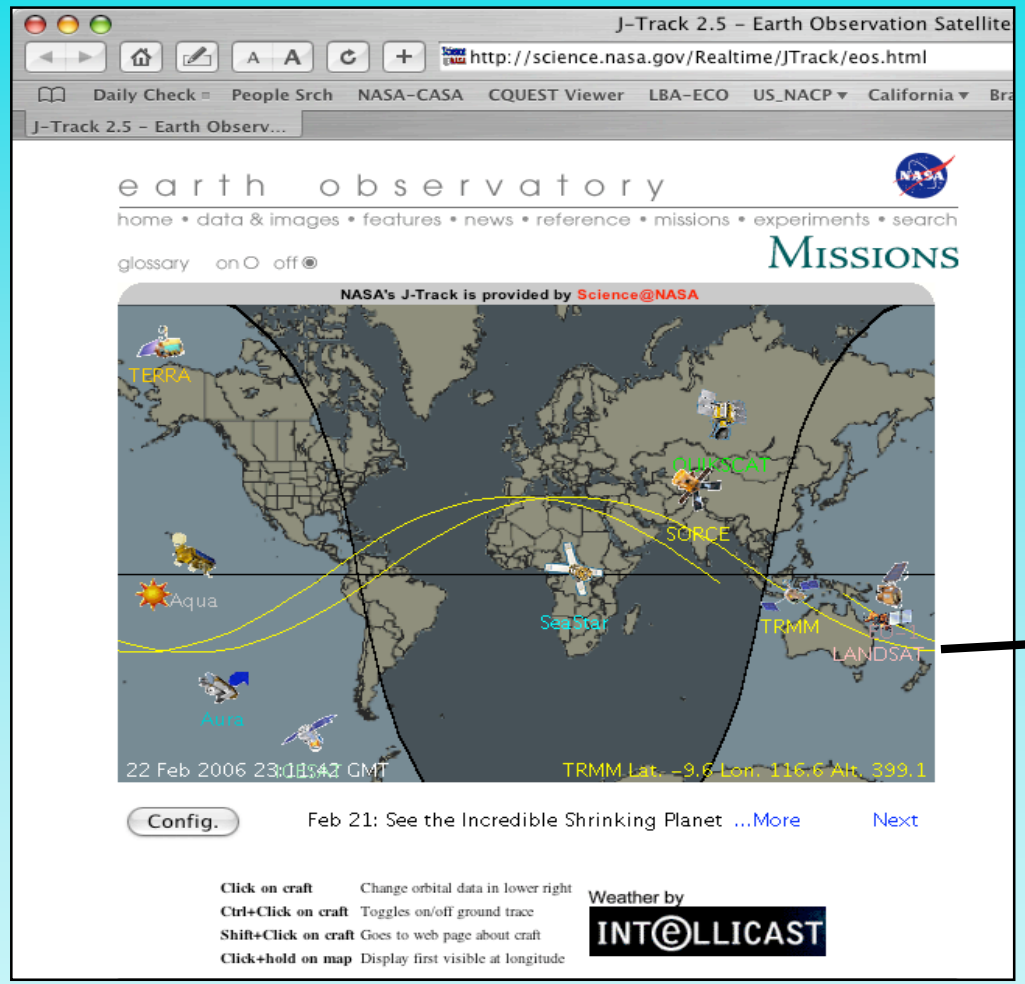
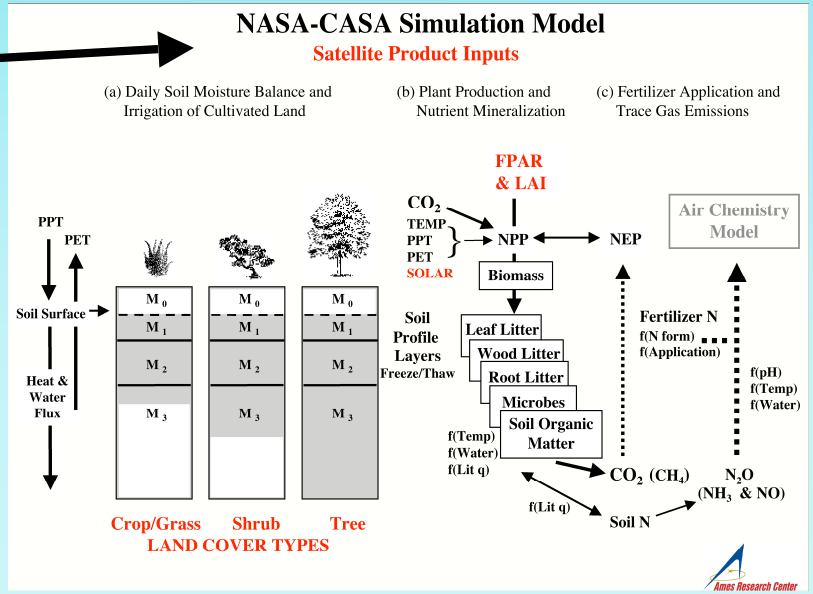
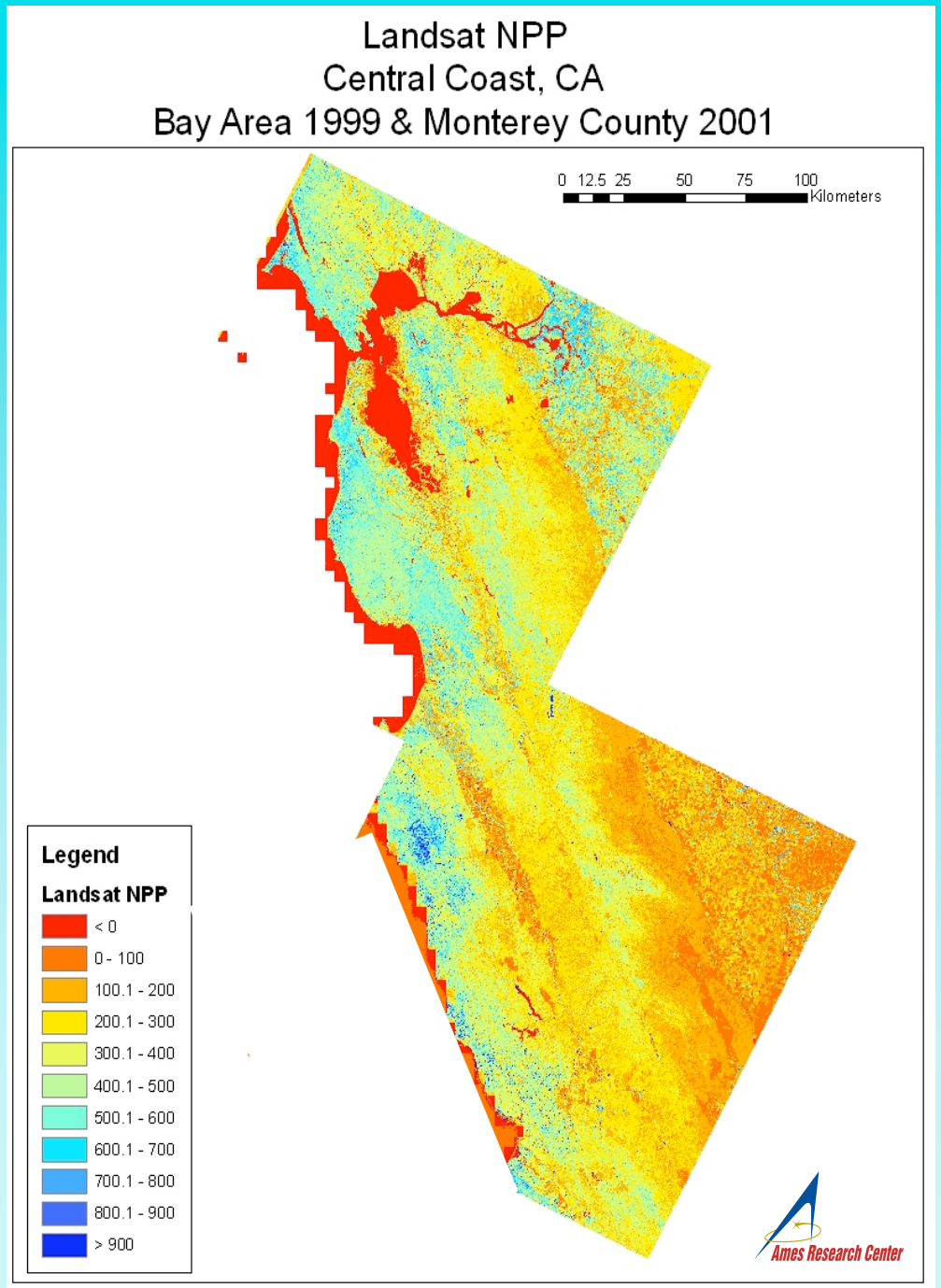
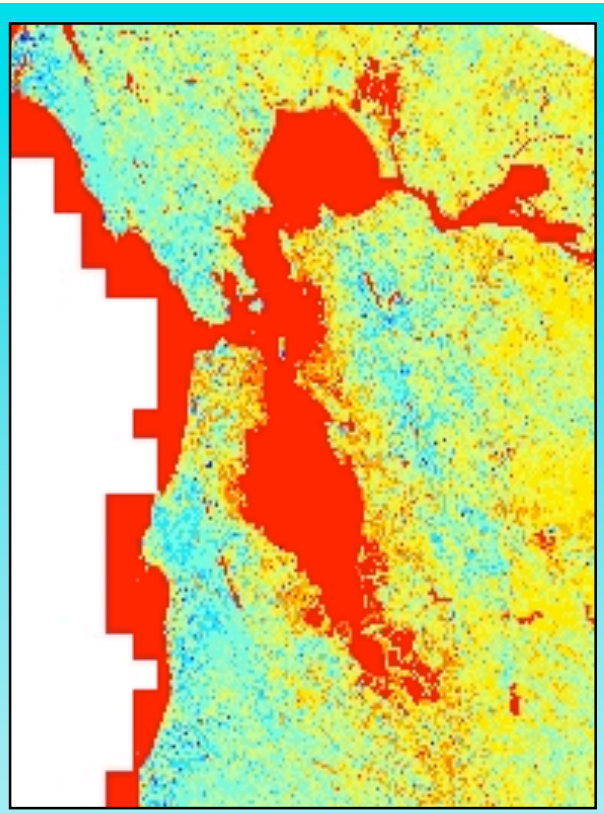


Satellite remote sensing data become inputs to simulation models…







NLCD Class	Monterey Co.	SF Bay Area
Developed, Open Space	285	376
Developed, Low Intensity	252	363
Developed, Medium Intensity	226	320
Developed, High Intensity	160	260
Barren Land	221	304
Deciduous Forest	341	486
Evergreen Forest	391	458
Mixed Forest	349	410
Shrub	295	359
Grassland	276	356
Pasture/Hay	285	366
Crops	256	369
Forested Wetland	330	385
Scrub Wetland	259	279

Net primary production (NPP) was estimated as 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).

Capabilities Related to Urban and Ex-Urban Carbon Management

- Determine the location and magnitude of biomass fuels that are susceptible to burning during fire events and the corridors of vegetation cover that may carry fires across a wildland - urban landscape.

- Monitor the health of urban parkland vegetation and demands for supplemental irrigation water to sustain healthy perennial plant cover.

- Estimate the net greenhouse gas (H_2O, CO_2 , CH_4 , N_2O) exchange of urban plants and soils and the effects of previous land use.

- Estimate the carbon (CO_2) sink potential of urban vegetation cover, including effects of future climate change.

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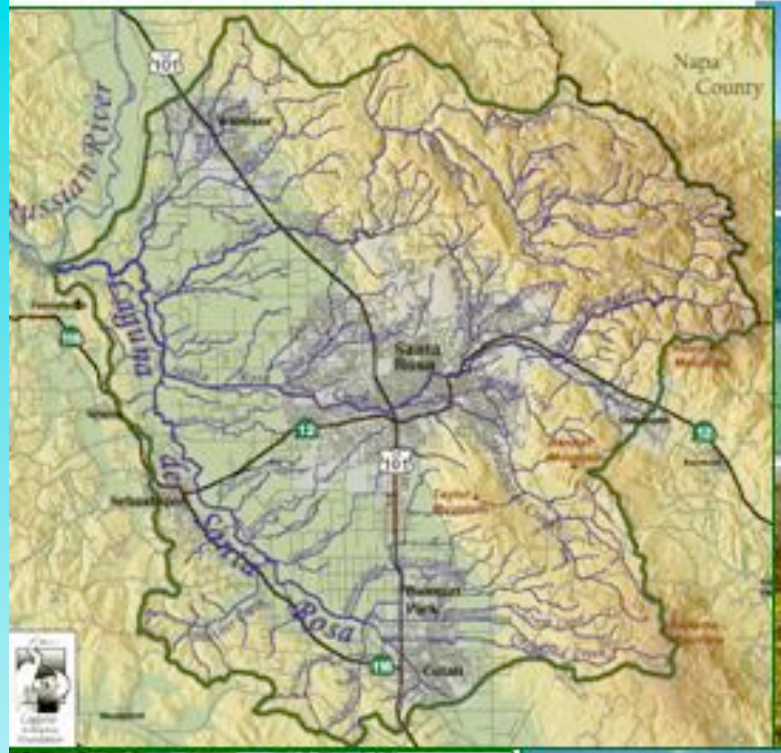
The Laguna de Santa Rosa, Russian River Basin



-250 sq. mile drainage (largest tributary of the Russian River

-90% private land: **75% Agricultural land**, Vineyards, Dairy farms

-2004 Sonoma County Agricultural production: $525,992,600

Wine Grape Production $309.9 Million

Dairy Production: $98.8 Million (> 75 million gallons milk)

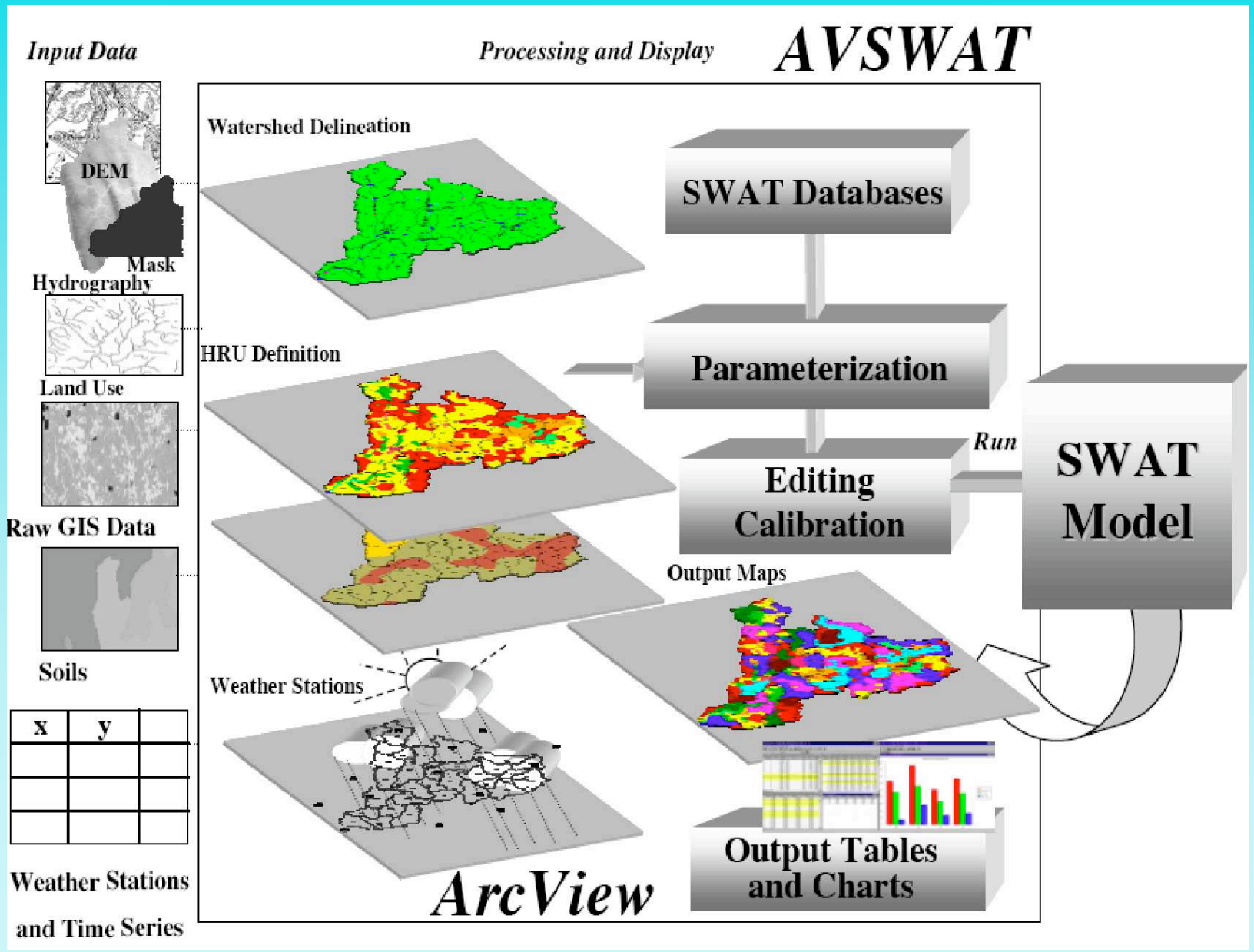
Largest freshwater aquatic ecosystem complex in the northern California coastal region

Water Quality Issues in the Laguna Watershed

• Surface water quality in the Laguna 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.

Watershed Modeling with USDA-SWAT Model



Major Features of the USDA-SWAT Model

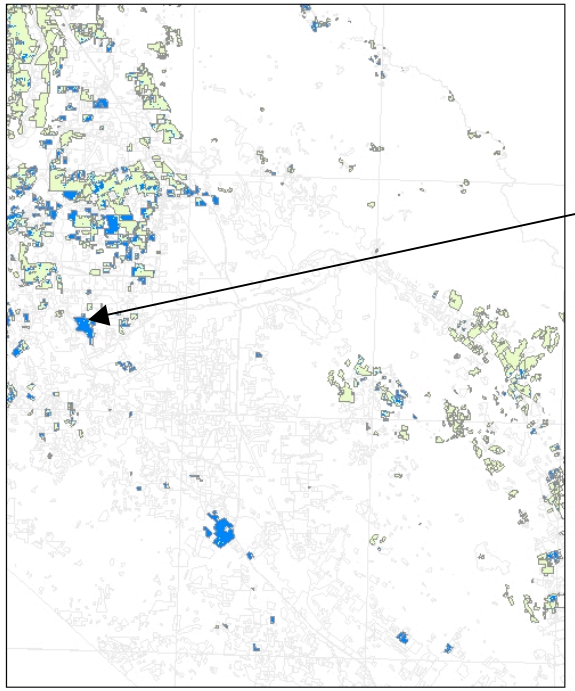
• Predicts the impact of land management practices on daily water, sediment, and agricultural chemical yields in large watersheds;

• GIS-based and computationally efficient, readily accepts updated remotely sensed layers, land cover, climate and soil file inputs;

• 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.

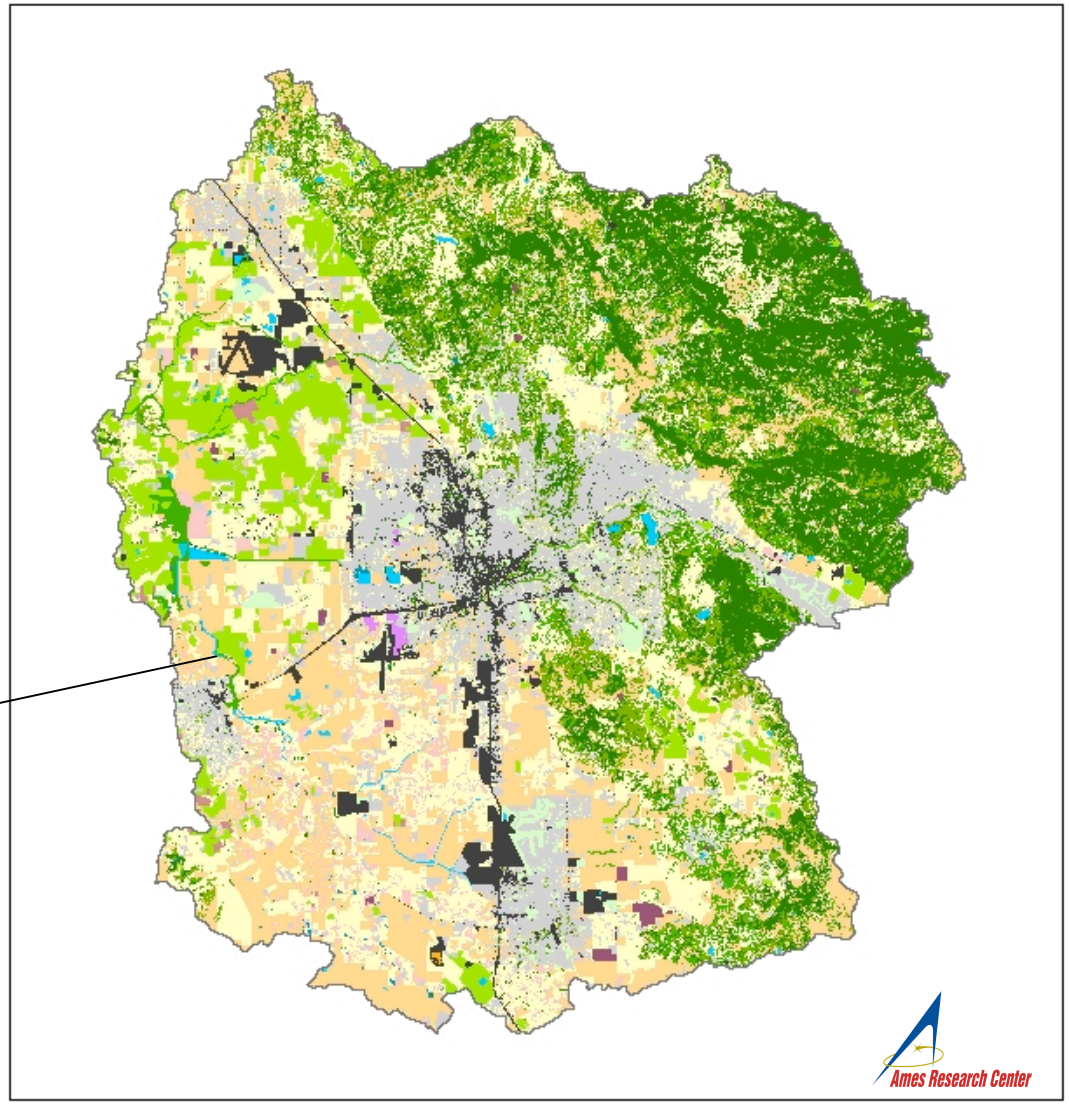
Land Cover in the Laguna de Santa Rosa

NLCD 1992
DWR 1999
Parcel Map 2004
NAIP 2005



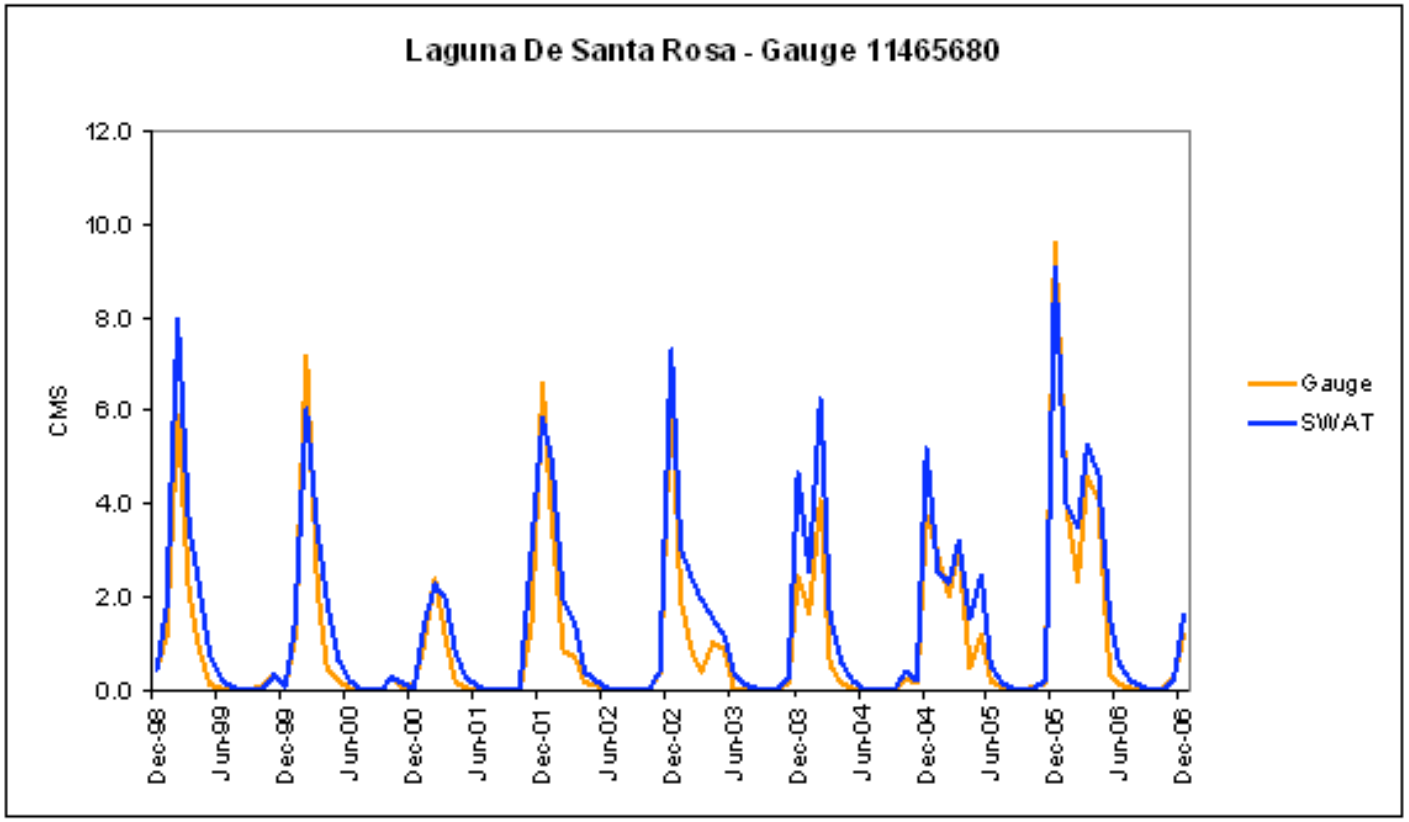
NLCD Natural Vegetation/Pasture to DWR Vinyard/Orchard

Vinyard
Change to Vinyard



Orchard
Water
Low Density Residential
High Density Residential
Comm/Indust/Transport
Rock/Sand/Clay
Quarries/Mines
Transitional
Deciduous Forest
Evergreen Forest
Mixed Forest
Shrubland
Vinyard
Grassland
Pasture
Row Crops
Small Grains
Fallow
Urban Grasses
Woody Wetland
Emergent Herbaceous Wetland

Laguna de Santa Rosa Discharge Rate Predictions



Performance of the SWAT model before and after groundwater extraction (GWE).

Gauge	*Location*	E_{NS}	R^2	E_{NS} (GWE)	R^2 (GWE)
11465680	LSR Stony Point	0.71	0.81	0.84	0.92
11465700	Colgan Creek	0.83	0.84	0.86	0.87
11465750	LSR Sebastopol	0.75	0.84	0.83	0.91
11466320	SRC Willowside	0.91	0.92	0.94	0.93
11465800	SRC upstream	0.85	0.90	0.84	0.89
11466800	MWC at Trenton	0.84	0.86	0.84	0.86

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Land Cover Contributions to Pollutant Runoff Rates

Sediment and nutrients contributions from SWAT land cover classes, ranked by sediment yield rates.

Land Use/Cover	Soil Yield T/ha	Organic N kg/ha	Organic P kg/ha	NO_3 released kg/ha
Pasture	19.6	15.3	2.0	0.7
Vineyard	19.1	10.8	1.4	0.9
Grassland	15.0	14.3	1.7	0.8
Brushland	9.6	8.6	1.0	0.4
Urban	8.8	7.3	1.1	1.0
Forest (mixed)	4.8	6.2	0.8	0.4
Forest (evergreen)	1.3	2.3	0.3	0.3
Forest (deciduous)	0.8	1.3	0.2	0.5
Irrigated Pasture	0.2	0.6	0.1	2.0
Orchards	0.0	0.0	0.0	0.3

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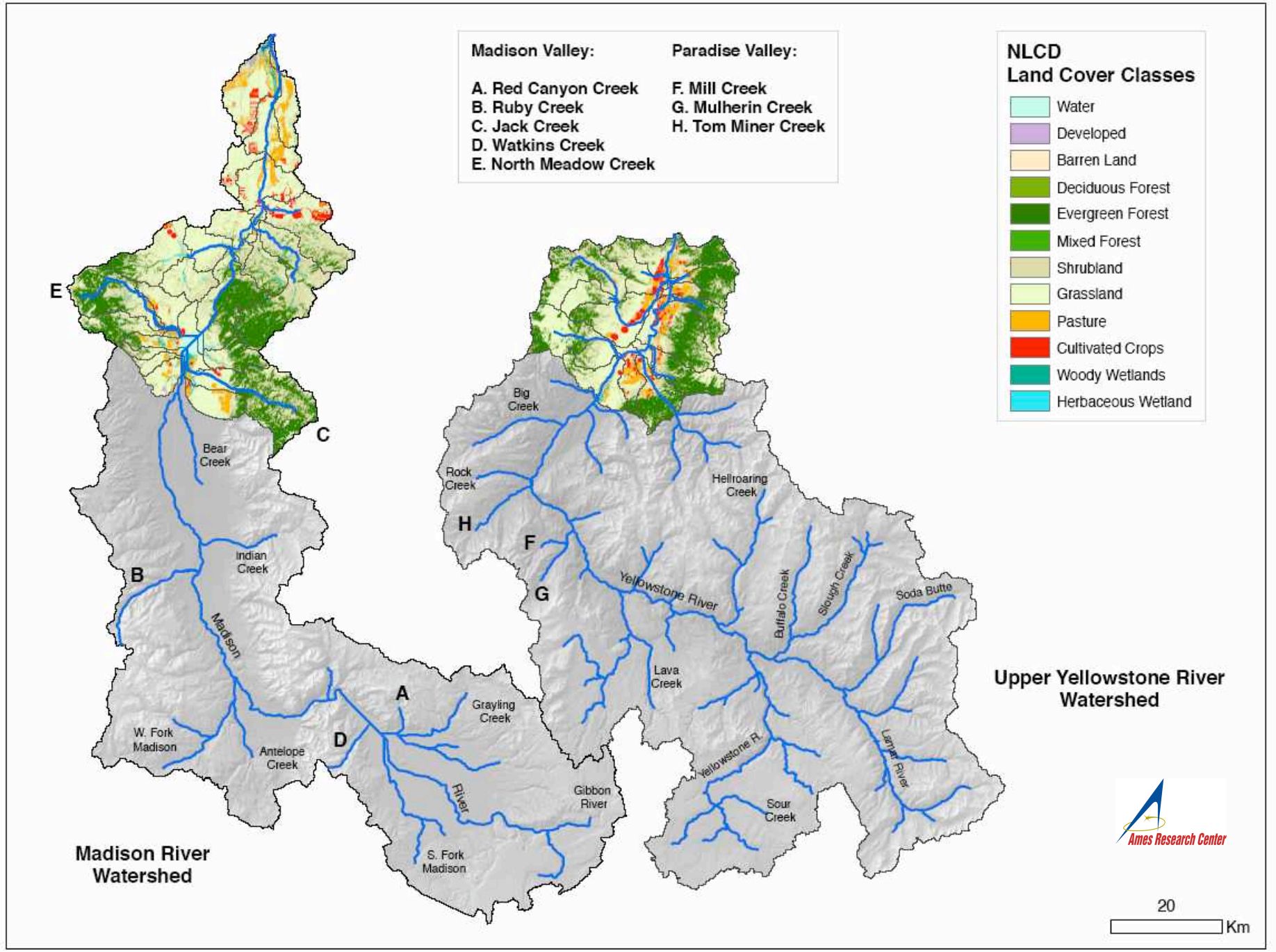
Madison Valley:
A. Red Canyon Creek
B. Ruby Creek
C. Jack Creek
D. Watkins Creek
E. North Meadow Creek
Paradise Valley:
F. Mill Creek
G. Mulherin Creek
H. Tom Miner Creek
NLCD
Land Cover Classes
Water
Developed
Barren Land
Deciduous Forest
Evergreen Forest
Mixed Forest
Shrubland
Grassland
Pasture
Cultivated Crops
Woody Wetlands
Herbaceous Wetland
Bear Creek
Indian Creek
Madison
W. Fork Madison
Antelope Creek
Grayling Creek
River
Gibbon River
S. Fork Madison
Big Creek
Rock Creek
Hellroaring Creek
Yellowstone River
Buffalo Creek
Slough Creek
Soda Butte
Lava Creek
Yellowstone R.
Lamar River
Sour Creek
Madison River Watershed
Upper Yellowstone River Watershed
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20
Km

Capabilities Related to Urban and Ex-Urban Water Management

- 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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