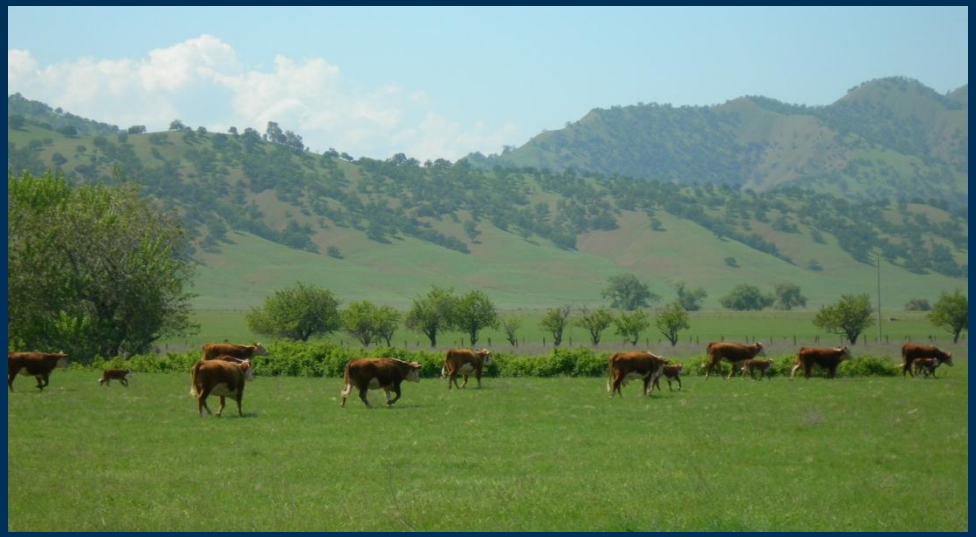
Climate change/land use change scenarios for assessing threats to ecosystem services on California rangelands

Kristin Byrd[1], Chris Soulard[1], Lorraine Flint[2], Frank Casey[3], Pelayo Alvarez[4], Ben Sleeter[1] and Terry Sohl[5]



[1]USGS Western Geographic Science Center, Menlo Park, CA,
[2]USGS California Water Science Center, Sacramento, CA ,
[3]USGS Science and Decisions Center, Reston, VA,
[4]Defenders of Wildlife, Sacramento, CA,
[5]USGS EROS Data Center, Sioux Falls, SD.

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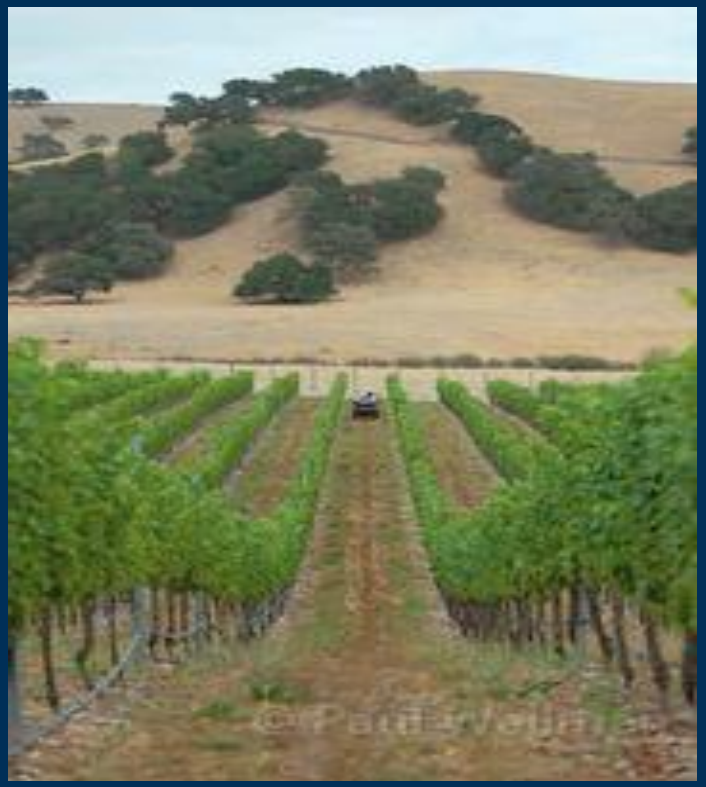
Ecosystem Services provided by Rangelands

- Food, fiber and fuel
- Biodiversity, habitat
- Water
- Carbon sequestration
- Adaptation to climate change
- Open space, cultural values

Integrated Threats to Rangelands

- In California 20,000 acres of rangelands are lost every year
- Privately owned
- Cattle ranching: low profits
- Low levels of protection



Urbanization, irrigated agriculture, climate change lead to loss of grazing land, water availability, and altered species distribution

Project Goals

- Six spatially-explicit climate change/land use change scenarios from years 2000 – 2100 consistent with three IPCC emission scenarios and two climate models –

A2, B1, and A1B and

PCM (warm, wet future), GFDL (hot, dry future)

- Assess potential threats to rangeland ecosystem services
    1. wildlife habitat,
    2. water availability, (runoff/recharge) and
    3. carbon sequestration
- An outreach program through the Defenders of Wildlife that targets the California Rangeland Conservation Coalition network

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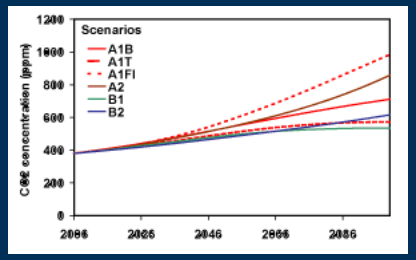
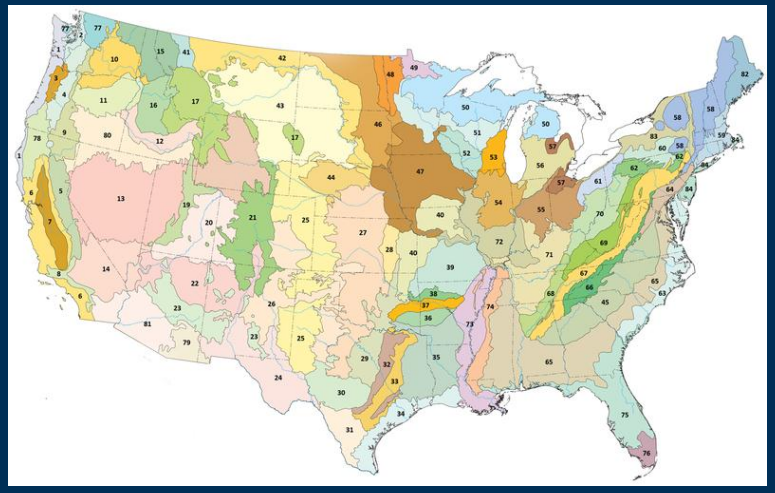


Why IPCC emission scenarios?

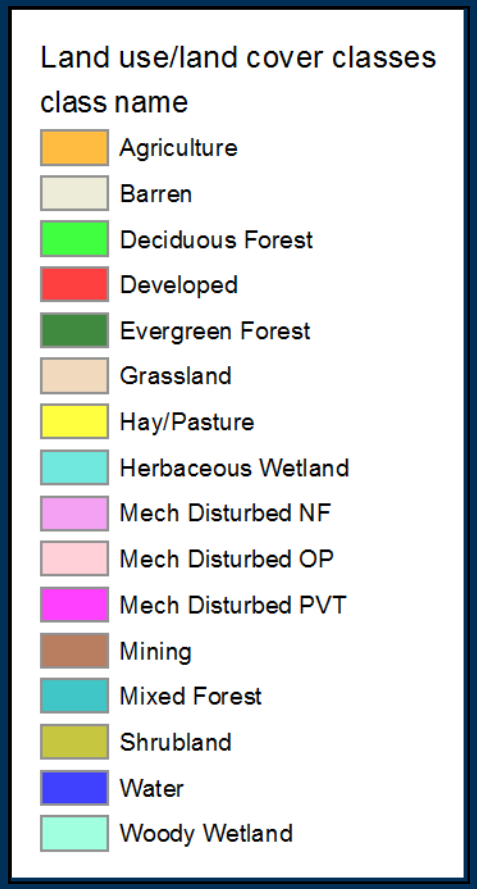
- Climate scenarios and land use scenarios need to be logically consistent to form the basis for integrated assessments and long-term policies (Bierwagen et al. 2010).
- We can leverage existing land use change modeling and climate modeling based on the same scenarios – **A1B, A2, B1**
  - USGS LandCarbon land use change scenarios
  - USGS ensemble projections of climate and hydrology for California (Lorraine Flint and Alan Flint, USGS California Water Science Center)

LandCarbon: National Assessment of Ecosystem Carbon Sequestration and Greenhouse Gas Fluxes

http://www.usgs.gov/climate_landuse/land_carbon/



USGS National Land Cover Dataset (NLCD)



- Three land use change scenarios for each EPA Level III ecoregion – **A1B, A2, B1**(Sleeter, USGS)
- FORE-SCE model creates maps of land use/land cover change by scenario/year to 2100 at 250 meter resolution (Sohl et al., USGS)

Driving Force Assumptions for the United States based on IPCC Emission Scenarios

(table adapted from Ben Sleeter, USGS)

	A1B	A2	B1
DEMOGRAPHICS	Medium growth, sprawl	High growth, sprawl	Medium growth, densification
ECONOMICS	Very High Income	Medium Income	High Income
TECHNOLOGY	Very High rate of innovation	Low rate of innovation	High rate of innovation
ENERGY	Balanced between several sources	Fossil fuel intensive	Rapid diffusion of “green” energy resources
CLIMATE	Temperature change, best estimate and range: 2.8 °C; 1.7 – 4.4 °C	Temperature change, best estimate and range: 3.4 °C; 2.0 – 5.4°C	Temperature change, best estimate and range: 1.8 °C; 1.1 – 2.9°C
ENVIRONMENTAL PROTECTION	Mixed-use based conservation	Conservation lower priority	Conservation high priority

Scenario Narratives for CA Rangelands

Rancher's Focus Group, January 2012, Davis CA

<u>Key Concerns about ranching future:</u>

- Limited availability of grazing land for lease
- Fragmentation of grazing land
- Forage quality and quantity
- High start-up investment

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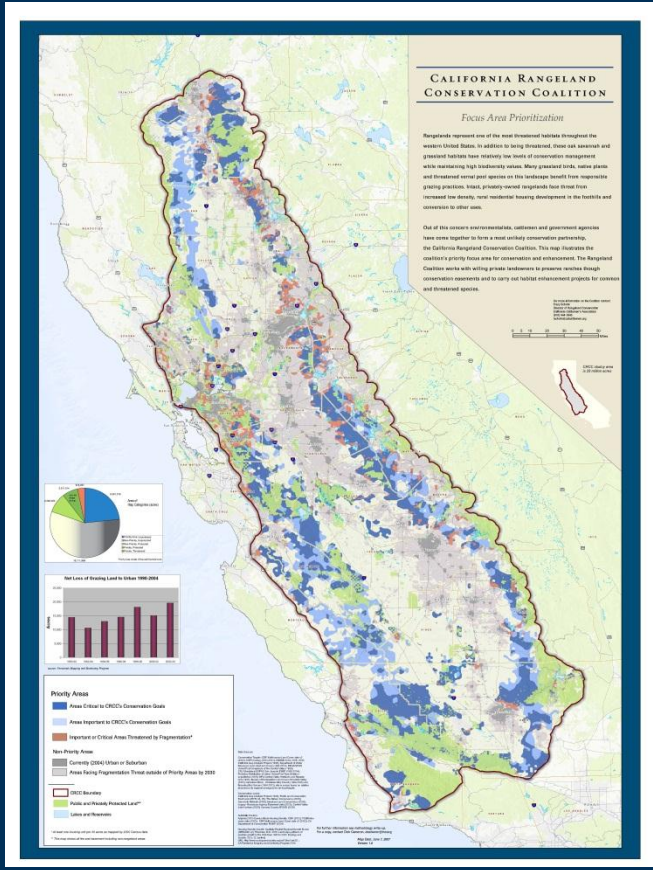
Scenario Narratives for CA Rangelands

– Alternative conservation plans

A1B	Development – low density Agriculture – high value perennial crops	Conservation – mixed-use emphasis	500,000 acres protected by 2100, near urban centers
A2	Development – low density Agriculture – intensive, less innovation	Conservation – low priority	No active conservation planning
B1	Development – high density Agriculture – moderate	Conservation – biodiversity high priority	1,000,000 acres protected by 2100, in high biodiversity areas

Integrated Scenarios



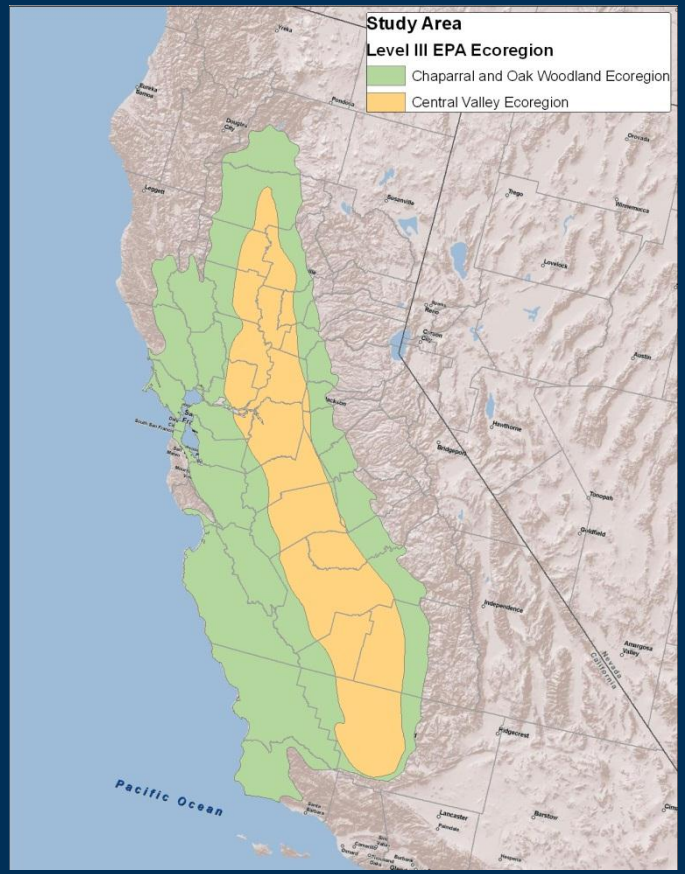
California Rangeland Conservation Coalition Focus Area

Three IPCC scenarios
A1B, A2, B1
Two climate models
PCM, GFDL

Land use/land cover change +

Climate/hydrology decadal change

Maps by scenario/year to 2100 at ~250 meter resolution



EPA Level III Eco-regions: Central Valley and Chaparral and Oak Woodlands

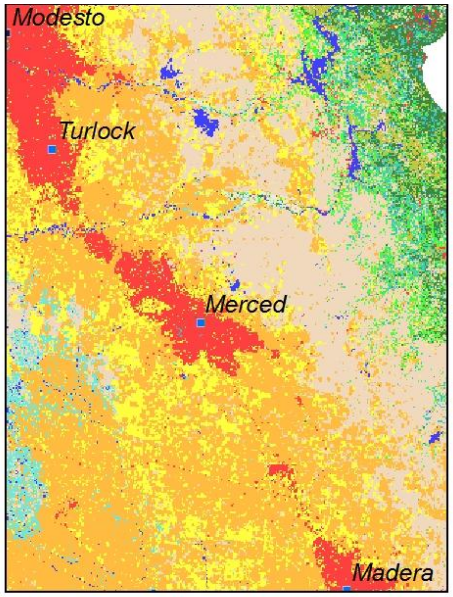
FORE-SCE Land use change model results: A2 and B1,

Terry Sohl, Michelle Bouchard and others,
USGS EROS Data Center, Sioux Falls, SD

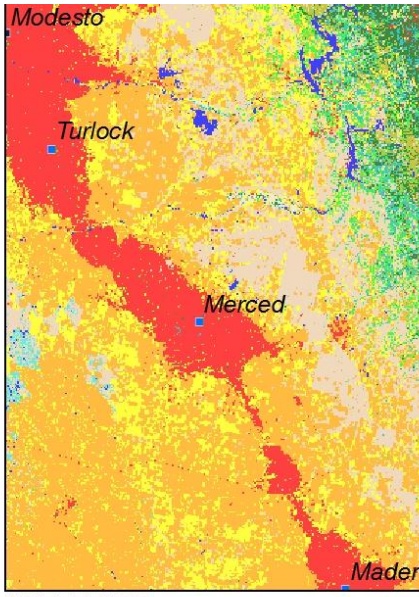
Land use/land cover classes

class name

- Agriculture
- Barren
- Deciduous Forest
- Developed
- Evergreen Forest
- Grassland
- Hay/Pasture
- Herbaceous Wetland
- Mech Disturbed NF
- Mech Disturbed OP
- Mech Disturbed PVT
- Mining
- Mixed Forest
- Shrubland
- Water
- Woody Wetland

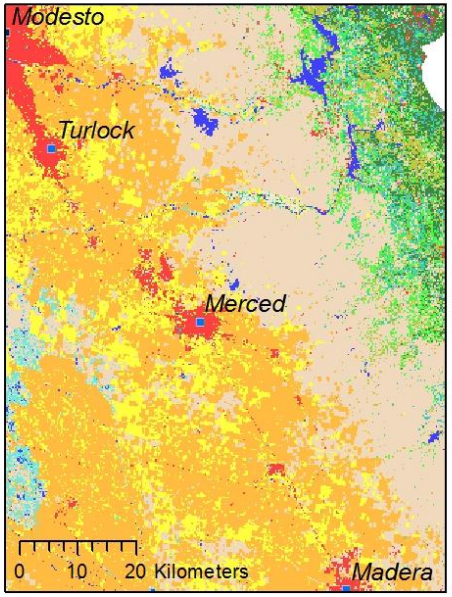


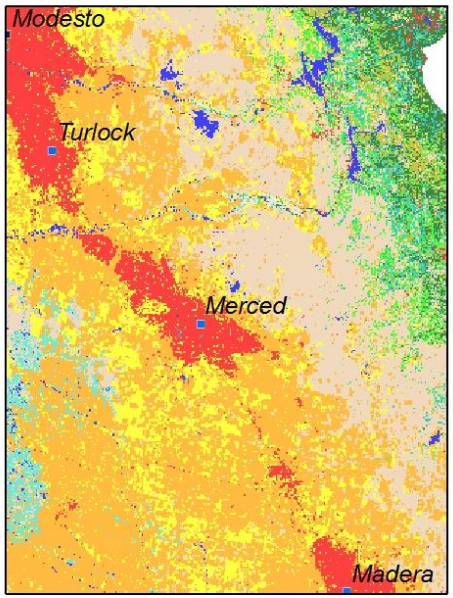
PCM B1 2100
GFDL B1 2100

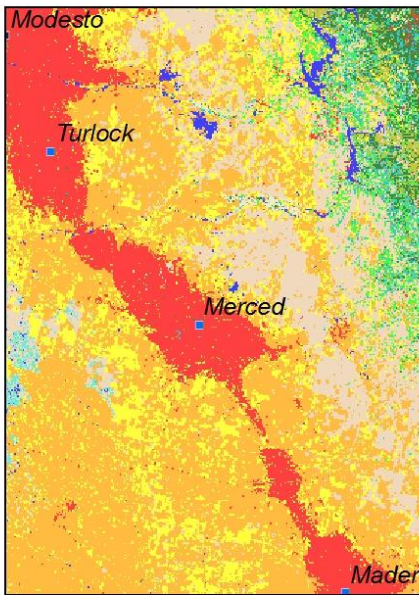


PCM A2 2100
GFDL A2 2100

Present-Day







Case Study of Two Watersheds:

SF Bay-Alameda Creek
Calaveras-Mormon Slough

Habitat and Water

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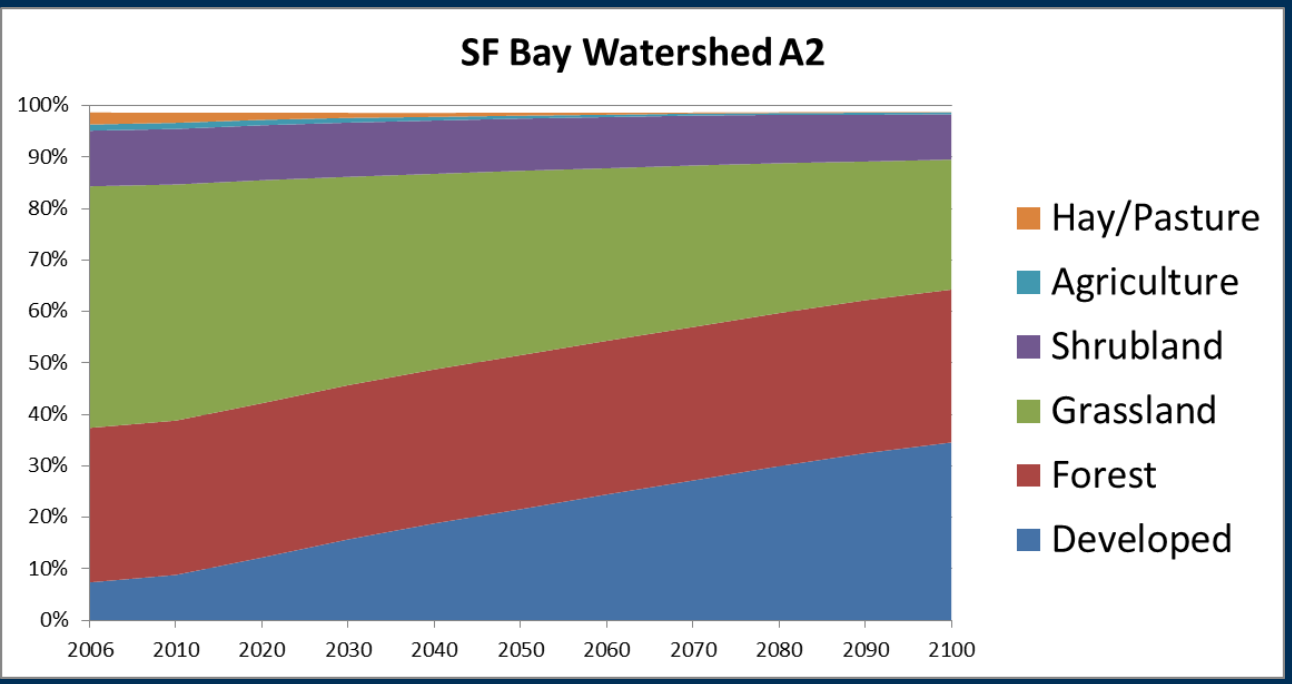

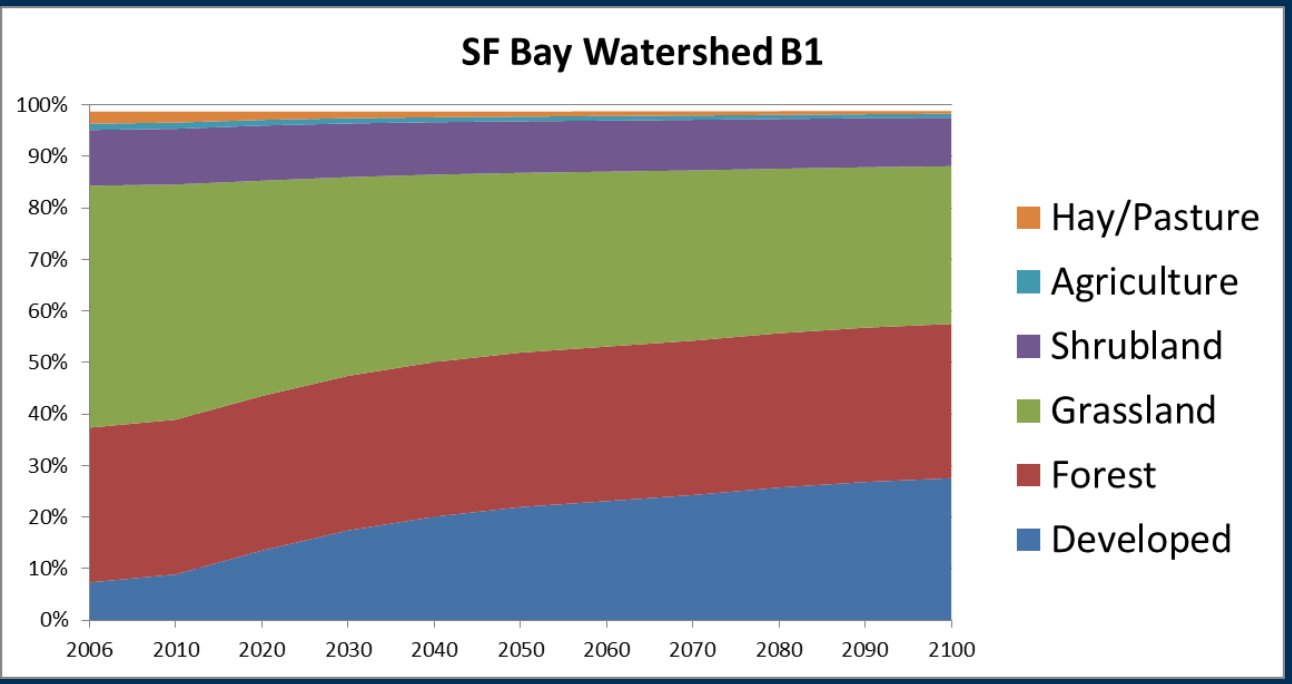

SF Bay-Alameda Creek Habitat Change

More grassland/shrubland conversion to development in A2

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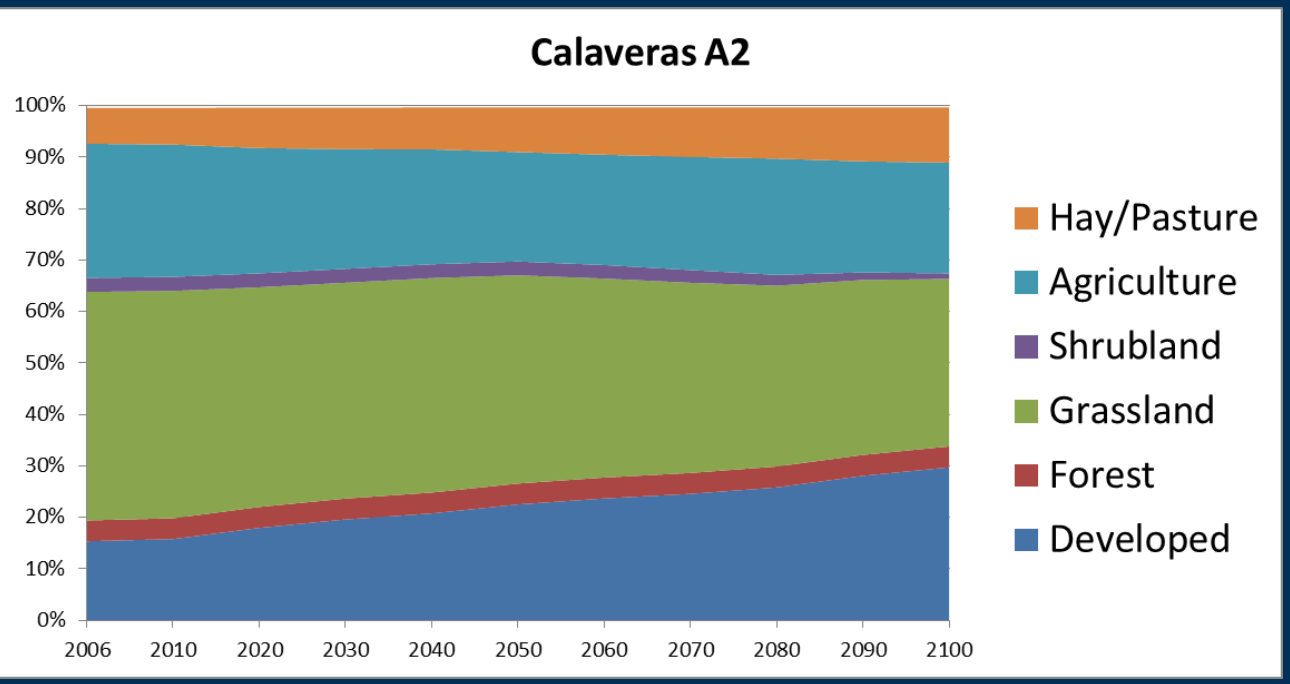

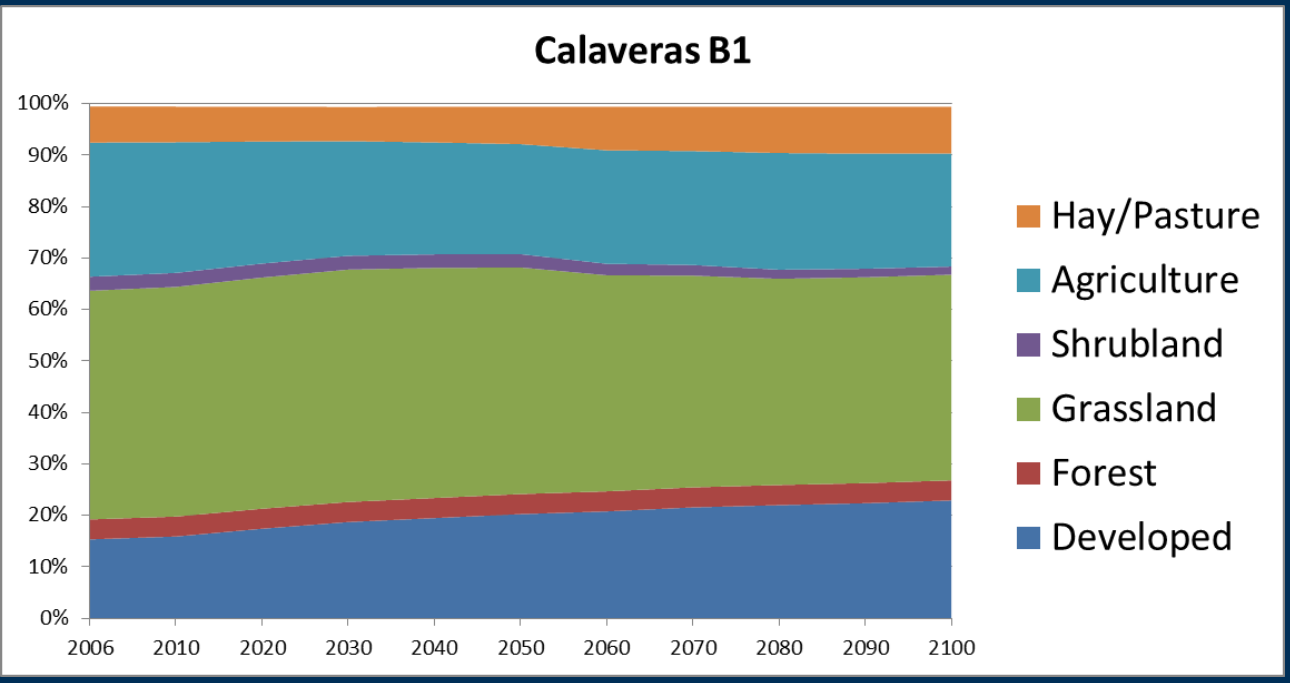

Calaveras Habitat Change

More grassland/shrub land conversion to agriculture in A2

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Influence of Projected Urbanization on Surface Hydrology in California Rangelands

Lorrie Flint and Alan Flint
USGS California Water Science Center

- Objective: Perform a simple sensitivity analysis to determine if urbanization and changes in surface water holding capacity influence recharge and runoff
- Approach: reduce soil storage in locations projected to become urbanized and re-run Basin Characterization water balance model
- Hypothesis: reduced soil storage should decrease recharge and increase runoff

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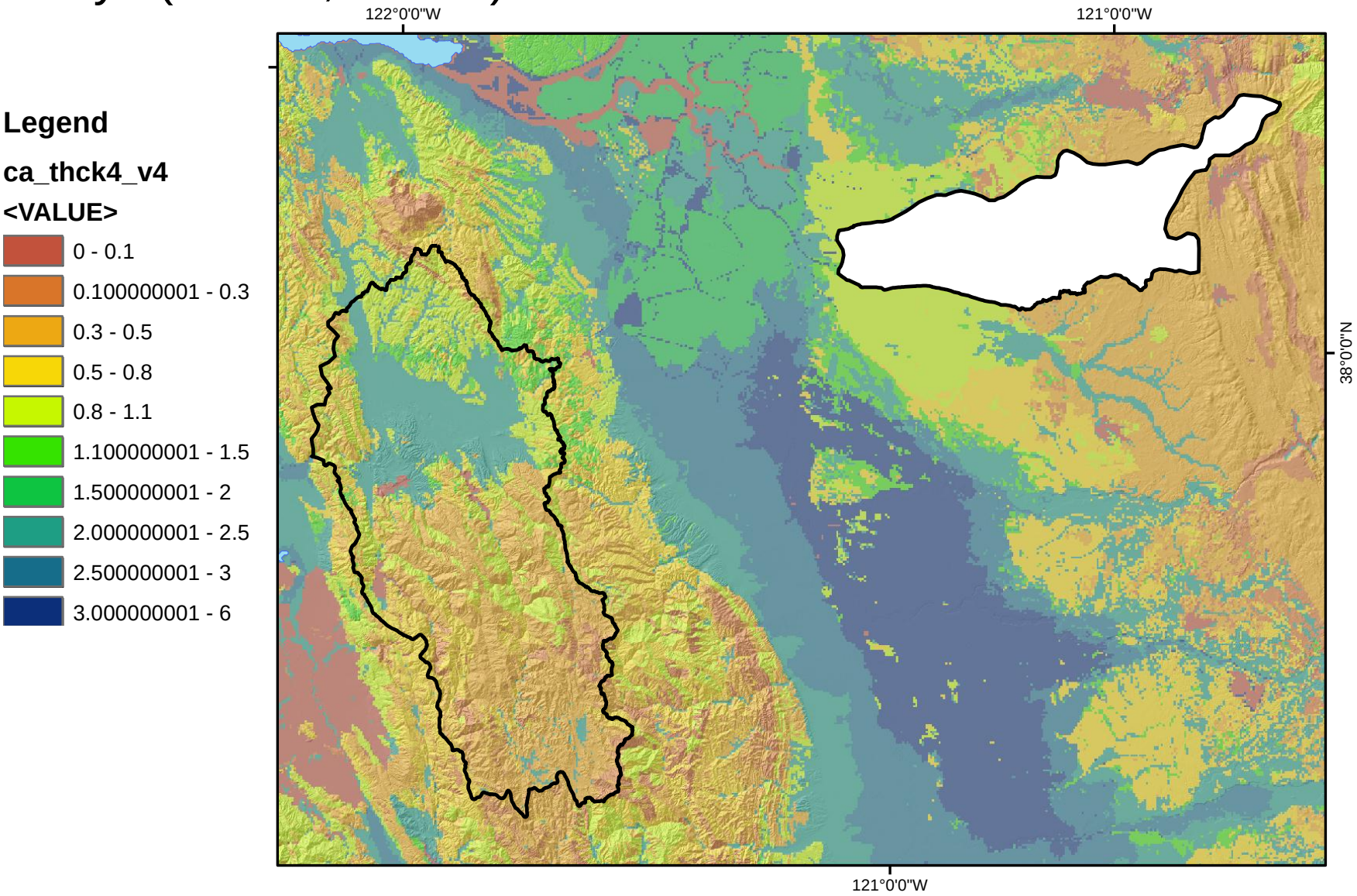
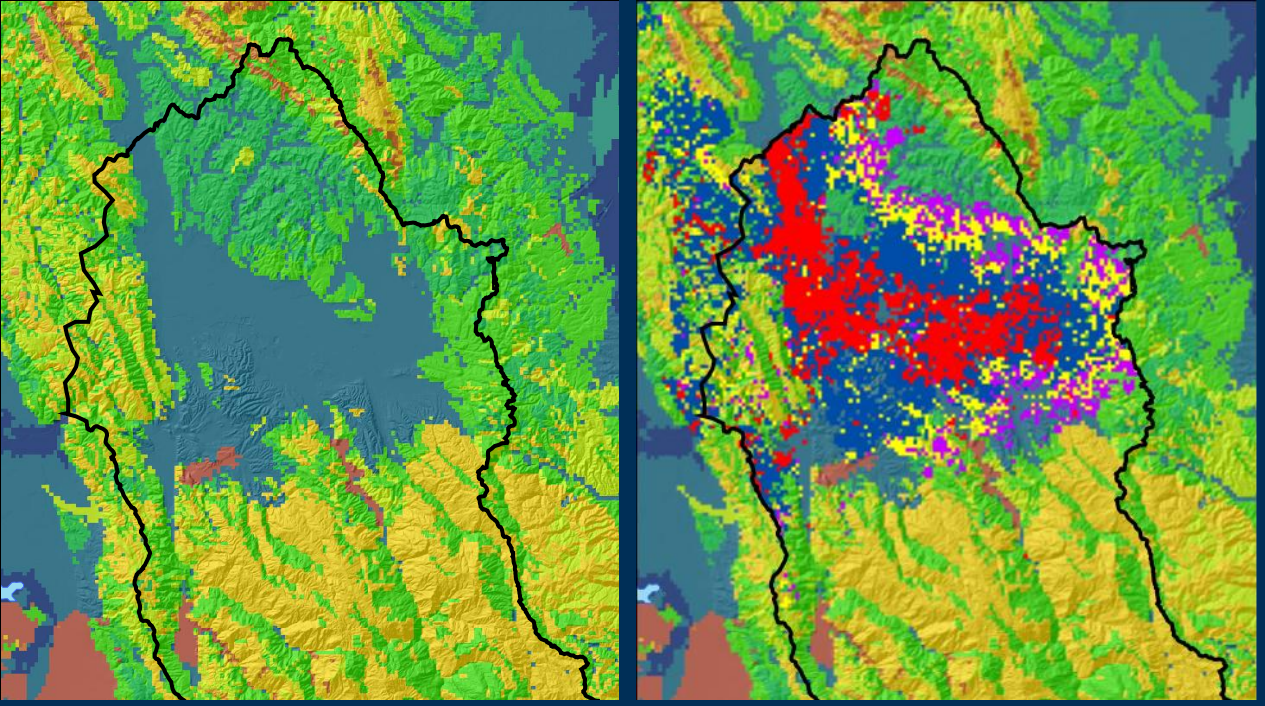
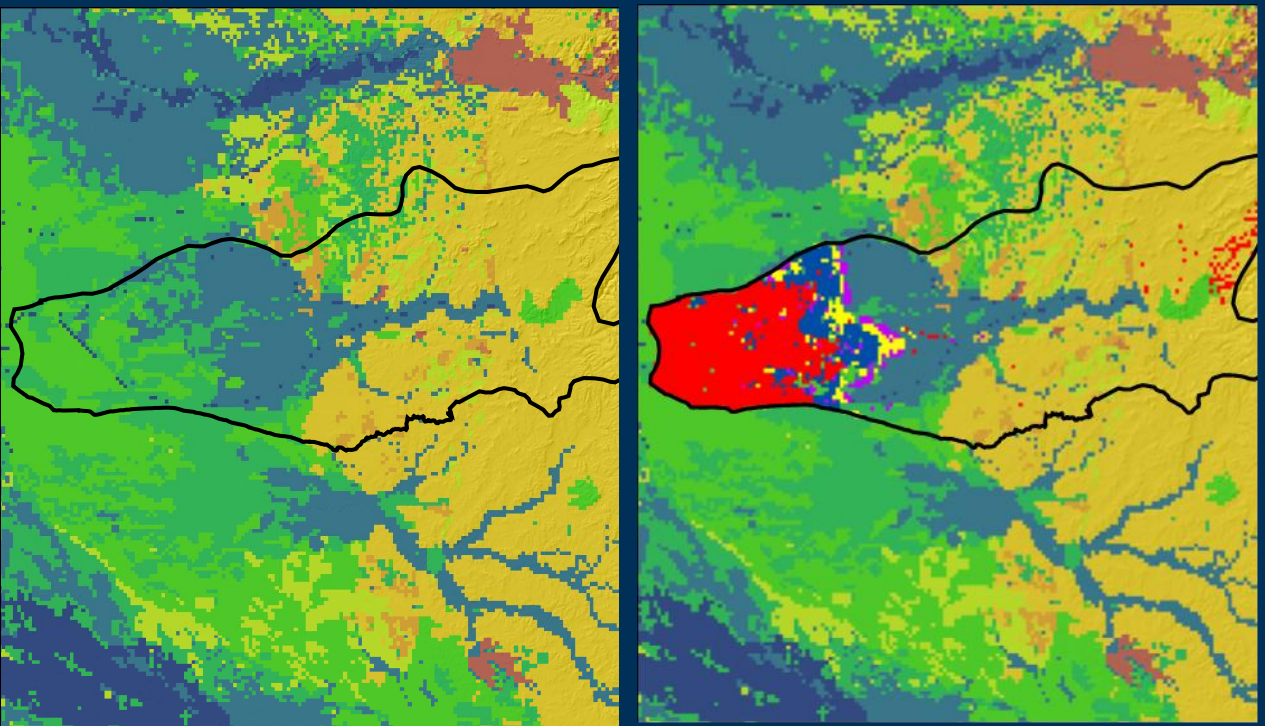
Soil storage affected by soil porosity and soil depth – New soil thickness dataset – SSURGO county-level soil surveys (L. Flint, USGS)



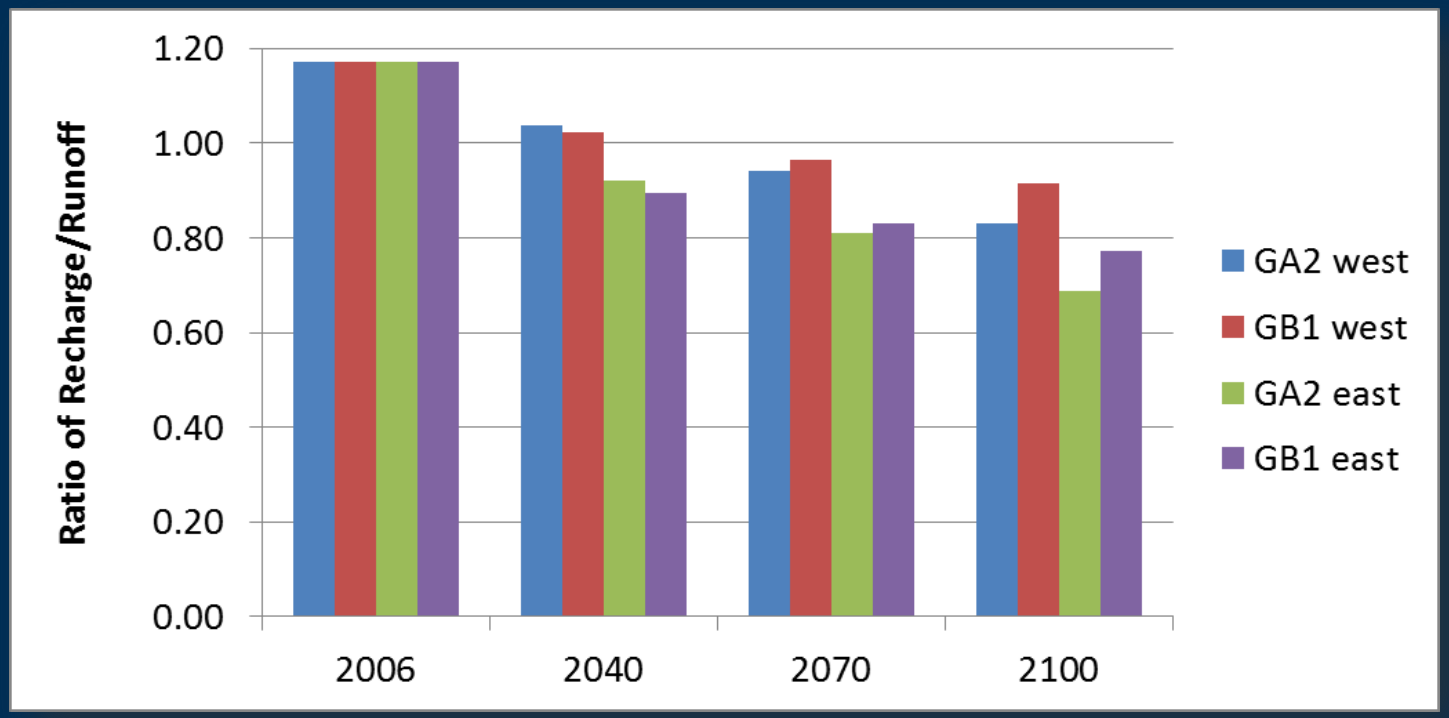


Alameda Creek: Development moves from deep to shallow soils 2006 - 2100



Calaveras: Development moves from shallow to deep soils 2006 - 2100

Ratio of Recharge to Runoff – More runoff in A2 Scenario, Calaveras Watershed



		Ratio (recharge/runoff)			
Basin	Scenario	2006	2040	2070	2100
West	GA2	1.17	1.04	0.94	0.83
	GB1	1.17	1.02	0.97	0.92
East	GA2	1.17	0.92	0.81	0.69
	GB1	1.17	0.89	0.83	0.77

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Summary

- The ratio of recharge to runoff decreases with increasing urbanization in these 2 basins
- Amount of change depends on current soil storage capacity, more change if urbanization on deep soils
- Has implications on water resource planning – water supply and habitat

Initial Ecosystem Services Impact Analysis: SF Bay-Alameda Creek 2006-2100 (F. Casey, USGS Science and Decisions Center)

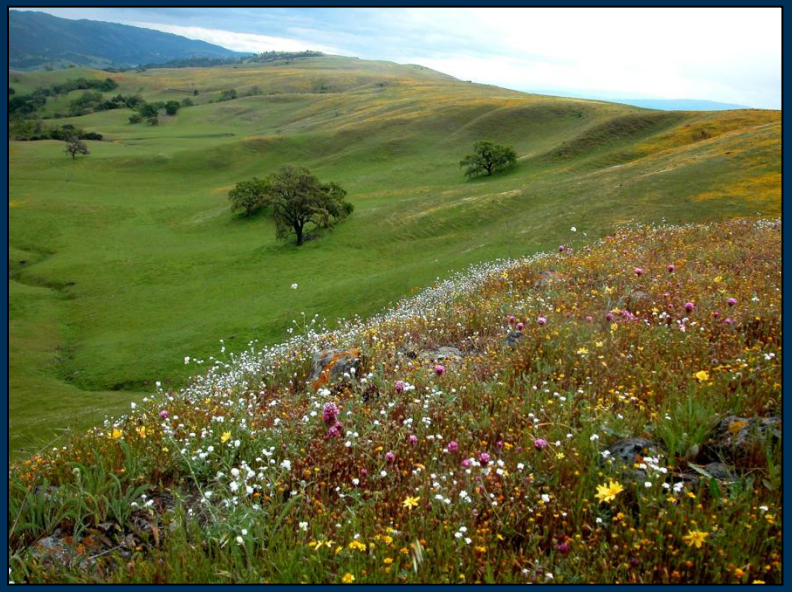
- A2 and B1 similar, though loss rates are lower in B1:
  - Loss of biodiversity,
  - Impaired water quality.
  - Less carbon sequestration,
  - Less ground water storage and
  - Less inputs to food production,

- A2 GFDL (hot, dry) has more impact on wetlands, water quality and carbon sequestration than A2 PCM (warm, wet).

Initial Ecosystem Services Impact Analysis: Calaveras-Mormon Slough 2006-2100
(F. Casey, USGS Science and Decisions Center)

- Little difference among scenarios, but compared to SF Bay:
  - Fewer losses in aboveground carbon sequestration, biodiversity
  - Decreased inputs to rangeland production
  - With increased irrigated agriculture, more impacts to ground and surface water quality through erosion and chemical inputs

Acknowledgments



Ellie Brown, Deputy Chief,
USGS Science and Decisions Center, Reston, VA

Zhiliang Zhu, LandCarbon Project Lead, Reston, VA
Shuguang Liu, EROS Data Center, Sioux Falls, SD
Michelle Bouchard, EROS Data Center, Sioux Falls, SD
The USGS LandCarbon Team

Funding by the California Landscape Conservation Cooperative

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