Carbon sequestration in agricultural soils and climate change policy in California
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Dept. of LAWR, UC Davis
Sharp rises in greenhouse gases (GHG) over last century
Global warming: rising temperatures
California will be hit hard based on estimates of improved climate models by end of century.

- Higher emissions yield higher summer temperatures
  - "Higher scenario" summer: + 8.5 to 18°F
  - "Lower scenario" summer: + 3.5 to 9°F
- Heat waves 2-5 times more common, more intense, and longer lasting
- Reduction of snowpack; precipitation variable
- Sea level rise 3-5" by 2050
- Threat to levees

CA is part of the problem but can play important role in the solution.

### World’s Largest GHG Emitters

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>2000 Emissions (Mt CO2)</th>
<th>Per Capita Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>USA</td>
<td>5,661</td>
<td>19</td>
</tr>
<tr>
<td>2</td>
<td>China</td>
<td>2,795</td>
<td>02</td>
</tr>
<tr>
<td>3</td>
<td>Russia</td>
<td>1,437</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Japan</td>
<td>1,186</td>
<td>09</td>
</tr>
<tr>
<td>5</td>
<td>India</td>
<td>1,073</td>
<td>01</td>
</tr>
<tr>
<td>6</td>
<td>Germany</td>
<td>787</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>UK</td>
<td>569</td>
<td>09</td>
</tr>
<tr>
<td>8</td>
<td>Canada</td>
<td>437</td>
<td>13</td>
</tr>
<tr>
<td>9</td>
<td>California</td>
<td>430</td>
<td>12</td>
</tr>
<tr>
<td>10</td>
<td>Italy</td>
<td>429</td>
<td>07</td>
</tr>
<tr>
<td>11</td>
<td>South Korea</td>
<td>428</td>
<td>09</td>
</tr>
<tr>
<td>12</td>
<td>Mexico</td>
<td>425</td>
<td>04</td>
</tr>
</tbody>
</table>

Sources: Oak Ridge National Lab & The Tellus Institute

“I say the debate is over. We know the science. We see the threat. And we know the time for action is now.”

-- Governor Schwarzenegger
June 1, 2005
World Environment Day
Governor’s Executive Order
S-3-05 signed on June 1, 2005
• Reduce GHG emissions to 2000 levels by 2010
• Reduce GHG emissions to 1990 levels by 2020
• Reduce GHG emissions to 80% of 1990 levels by 2050
• Established the Climate Action Team led by CalEPA
• Climate Action Team
  o Lead by Secretary Loyd and Deputy Secretary Anne Baker
  o Multi-agency - ARB, PUC, RA, CalTrans, CEC (PIER), IWMB, CDF
    o Developing scenarios
    o Evaluating Cap and Trade program
      o Offsets

• Climate Action Registry
  o Diane Wittenberg President
diane@climateregistry.org 213.891.1444
    o New forestry protocol
    o Model for agriculture?
Analysis of climate change scenarios for CA (UC, LLNL, LBL, other univ)

- Impact analyses underway of impacts of different climate scenarios on public health, water, agriculture (Cavagnaro, Jackson and Scow), forests, coast. Identification of adaptation and mitigation strategies (including C sequestration)
- Identification and analysis of various cap and trade strategies

REPORT TO GOVERNOR JAN 2006
Carbon Sequestration in agricultural soils
Potential for U.S. Agriculture to Mitigate CO2 Emissions

<table>
<thead>
<tr>
<th>Scenario</th>
<th>MMTC/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>C sequestration in cropland</td>
<td>132 (69-195) 8%</td>
</tr>
<tr>
<td>C sequestration in CRP</td>
<td>13</td>
</tr>
<tr>
<td>C sequestration in rangelands</td>
<td>58 (30-110) 5%</td>
</tr>
<tr>
<td>Biofuel production (C offset)</td>
<td>~50</td>
</tr>
<tr>
<td>Saving in fuel consumption</td>
<td>1-2</td>
</tr>
<tr>
<td>Reduction of C emitted</td>
<td>~15</td>
</tr>
<tr>
<td>from eroded sediments</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>270</strong></td>
</tr>
</tbody>
</table>

(Lal et al., 1999, 2003)

US emissions: \(~1800 \text{ MMTC/yr}\)
Opportunities for C sequestration in soil

- Carbon sequestration is long term storage of C in environment (soil, water, biota, rocks)

- Soils contain 75% of terrestrial C pool
- Soil C can be increased by reducing losses and increasing inputs
Estimates of potential C sequestration in US soils

75–200 Tg C in croplands (Lal et al. 1998)

30–90 Tg C in grazing lands (Follett et al. 2001)

• Assumes widespread adoption of improved management practices.
• Does not account for changes in other biogenic greenhouse gases (nitrous oxide and methane) that may be by-products of management changes.

THUS C sequestration in terrestrial ecosystems can account for about 6.4% of emissions (based on 5000 Tg C per yr in 1990).

Management-induced C sequestration in soil is only a temporary and partial solution to the greenhouse gas problem.
Focus on CO2 can lead to neglect of importance of other GHGs

- Global Agriculture Activity Accounts for About:
  - 5% of CO2 emissions
    - root & soil respiration
  - 30% of CO2 emissions (if land use change included)
    - deforestation & shifting cultivation
  - 45-60% of CH4 emissions
    - rice cultivation
    - livestock production
    - deforestation & shifting cultivation
  - 5-70% of N2O emissions
    - nitrogen fertilizer
    - animal wastes
    - deforestation & shifting cultivation

(International Panel on Climate Change, IPCC 1997)
(Mosier et al. 1998 Nut. Cycling Agroecosystems 52:225)
Opportunities for Offsetting Greenhouse Gas Emissions

Croplands . . .
- Less tillage
- Increase crop intensity, reduce fallow
- Use of cover crops
- Fertility and water management
- High biomass crops

Rangeland or Pasture . . .
- Management of marginal lands
- Adding legumes
- Improved grazing management
- Fertility and water management

Animal Agriculture . . .
- Improved feed and forage
- Methane capture
Take Action Against Global Warming, Retire GHG Emission Reductions

Click here to enter the site or choose a link below.

- Who We Are
- Taking Action
- Where Does the Money Go
- Where Do Our ERCs Come From
- Calculate Your Emissions
- Buy Some GHG Emission Reductions
- Check-out Our Online Registry

Home - Who We Are - Taking Action - Global Warming - Links - Site Map

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SOIL CARBON HAS MANY OTHER (often unrecognized) ECOSYSTEM SERVICE BENEFITS

- Reduction of airborne particulates (e.g. air pollution)
- Reduction of soil erosion
- Reduction of run off, filtration of pollutants
Research Areas

Technical strategies to increase soil C and reduce GHGs

- Where can it work and how much can be sequestered?
- How to manage, maintain, monitor?
- Interaction with irrigation, soil type, environmental factors, microbial communities
- Trade offs with other demands/restrictions

• Inventory of C stocks
• Models for management and decision making
• Developing market, managing risk