Class #19
Climate Change
1) Is it happening?
2) What are the impacts?
3) The economics of adaptation.

Is the planet warming?
(NOAA Estimates)
10 Warmest Years Since 1880.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Year</th>
<th>Anomaly °C</th>
<th>Anomaly °F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2015</td>
<td>0.90</td>
<td>1.62</td>
</tr>
<tr>
<td>2</td>
<td>2014</td>
<td>0.74</td>
<td>1.33</td>
</tr>
<tr>
<td>3</td>
<td>2010</td>
<td>0.70</td>
<td>1.26</td>
</tr>
<tr>
<td>4</td>
<td>2013</td>
<td>0.65</td>
<td>1.19</td>
</tr>
<tr>
<td>5</td>
<td>2005</td>
<td>0.65</td>
<td>1.17</td>
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<tr>
<td>6</td>
<td>1998</td>
<td>0.63</td>
<td>1.13</td>
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<td>7</td>
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<tr>
<td>8</td>
<td>2012</td>
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</tr>
<tr>
<td>9</td>
<td>2006</td>
<td>0.61</td>
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</tr>
<tr>
<td>10</td>
<td>2012</td>
<td>0.61</td>
<td>1.10</td>
</tr>
</tbody>
</table>

Berkeley Avg. Study (black line) and other prominent estimates

Degree of climate change
What is happening up to now – Sea Ice

Scientists using satellite data have confirmed that the amount of sea ice in the Arctic is much less than it used to be.

In 1980, there was about 11.6 million square miles. By 2010, the ice was about 3.8 million square miles. The loss is dramatic, but not entirely unexpected since 2007 there has been a particularly warm period.
Degree of climate change

What is happening up to now – Glaciers

Glaciers are retreating almost everywhere around the world — including the Alps, Himalayas, Andes, Rockies, Alaska and Africa.

Left: 1898. Right: 2003

http://climate.nasa.gov/stateOfFlux/

Glaciers are retreating almost everywhere around the world — including the Alps, Himalayas, Andes, Rockies, Alaska and Africa.

http://maps.grida.no/go/graphic/retreat-of-seven-andean-glaciers

Team Activity #1

A) Decide on a number from 0 – 100 indicating your team’s certainty that long term climate change resulting in increasing global temperatures is occurring:

0 = Absolutely not;
100 = Without a shadow of a doubt, yes.

B) When done, send a representative to the front who can explain the argument(s) behind your team choice. If the answer is a compromise, the representative should be able to explain the reasons behind both sides.

Climate Change is projected to go on

There is strong evidence that Climate Change is altering the planet

Available observational evidence indicates that regional changes in climate, particularly increases in temperature, have already affected a diverse set of physical and biological systems in many parts of the world.

Observed changes include
• Shrinkage of glaciers and sea ice
• Thawing of permafrost.
• Later freezing and earlier break-up of ice on lakes/rivers
• Lengthening of mid- to high-latitude growing seasons
• Poleward and altitudinal shifts of plant and animal ranges,
• Declines of some plant and animal populations,
• Earlier flowering of trees, emergence of insects, and egg-laying in birds
• Global average sea level has risen and ocean heat content has increased
• More unusually hot days and nights,
• Fewer unusually cold days and nights, and
• Heavier downpours
• Droughts are becoming more severe in some regions
• More frequent and more powerful Atlantic hurricanes

2) What are the impacts?

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Information provided by Bruce A. McCarl

http://environment.newscientist.com/channel/earth/mg19526141.600-huge-sea-level-rises-are-coming-unless-we-act-now.html

http://maps.grida.no/go/graphic/potential_impact_of_sea_level_rise_on_bangladesh

What is Projected - sea level
Impacts of climate change

- Some are very likely
- Some are probable
- Some are possible, but we can’t be sure based on currently available data.

If only the very likely problems are considered, the issue still deserves our attention.

Team Activity #2

1. Choose the 1 consequence of climate change that you think is likely to be the most important for the United States.
2. What is the probability that this effect will be “very severe”?
3. Send a team member to the board to report your findings.

How would we value…?

The economics of adaptation

- **Adaptation** is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.
- **Reactive adaptation**: response to climate change.
- **Proactive adaptation**: activities to diminish the impacts of anticipated climate change.
When does economics suggest that government should get involved?

- **Hint:** characteristics of efficient property rights and public goods.

- **Reactive adaptation:** response to climate change.

- **Proactive adaptation:** activities to diminish the impacts of anticipated climate change.

### Costs of Global Warming - Agriculture

![Graph showing the cost of global warming for agriculture.](image)

### Substitutes

![Graphs showing the substitution of wheat and corn in Arkansas.](image)
The net effect can be small or large, positive or negative.

Consider ____
- What types of reactive adaptation might occur?
- What types of proactive adaptation might be appropriate?
- How does the prospect of adaptation affect the costs of climate change?

How does adaptation affect the costs of climate change?
- Valuing CC impacts should anticipate reactive climate change.
- Adaptation will occur – people respond to incentives.
- Proactive measures
  - Do benefits (reduced damages) exceed costs?
  - Should take into account reactive adaptation.

Team Activity #3
- Consider ____
- What reactive adaptation might occur?
- What proactive measures should be considered?

Team Activity #4
- Consider ________
- 1) Should government be involved in reactive adaptation? (team answer on white boards)
- 2) Should government be involved in proactive adaptation? (team answer on white boards)