Land Use Land Cover Change & Extraction of Natural Resources
3. List and describe two examples of ecosystem services mentioned in this paper.
New Vocab: Foley et al. 2005

- Sensible heat – change in temp with no change in phase of matter
- Latent heat – temperature change as well as phase change
- Albedo – reflectance of a surface
- Troposphere – lower atmosphere
- Biogenic – from a living organism
- Morbidity – lower quality of life/higher rate of disease
Foley takes a strong ‘ecosystem services’ perspective on conserving ecosystems. Alternative arguments?
Alternative argument: Species have intrinsic value

Giant Panda

*Endangered*

Found in central China
Species have intrinsic value?

Giant Panda
Endangered
Found in central China

Cave Catfish
Critically Endangered
Found only in the Aigamas Cave, Namibia
Ecosystems have intrinsic value?

- You should not throw garbage because it affects your environment and it can kill the mangroves.
- You should not pollute the mangroves because they are very special because they are the only trees that grow in salt water.
- You should not knock down mangroves because the fishes during a hurricane they won't have shelter.
Case studies – long term loss of ecosystem services

NPV = Net Present Value (\$)

Mangrove, Thailand
\( \delta = 6\% \text{ over } 30 \text{ years} \)

NPD (2000 US$ ha\(^{-1}\)) - Intact and Shrimp farming

Wetland, Canada
\( \delta = 4\% \text{ over } 50 \text{ years} \)

NPD (2000 US$ ha\(^{-1}\)) - Intact and Intensive farming

Coral reef, Philippines
\( \delta = 10\% \text{ over } 10 \text{ years} \)

NPD (2000 US$ ha\(^{-1}\)) - Sustainable and Destructive fishing

Balmford et al., 2002
Ecosystem Services
Ecosystem Services

SOCIAL AND ECONOMIC DEPENDENCE ON CORAL REEFs

Source: WRI, Reefs at Risk Revisited, 2011.
How do you protect a marine resource that is also a subsistence fishery?
Ecosystem Services
It is economically beneficial (long-term) to conserve many native ecosystems.
How are we using land?
New England
Agriculture

Croplands cover 24% of the land surface

“Croplands and pastures have become one of the largest terrestrial biomes on the plant, rivaling forest cover in extent” – Foley et al. 2005
More than 96% of native tallgrass prairie has been lost in the mid-west
Global increase across 174 major crops due to higher yield/unit area alone: 20% between 1985-2005

Foley et al., 2011
Global crop yield trends

Negative projections for maize in parts of Africa & China

Ray et al., 2012
Potential arable lands globally

Global increase across 174 major crops due to expansion of agricultural land ("extensification"):

5% between 1985-2005

But...much more extensification possible

Foley et al., 2011
More sustainable -> less meat

Only 62% of food production feeds people directly (35% animal feed; 3% biofuels)

Foley et al., 2011
More sustainable -> more efficient

Better use of fertilizer, water & improved crop cultivars could **increase yield +50%**

Foley et al., 2011
Deforestation
Global deforestation rates (1990s)

~0.5% of tropical forests lost per year during 1990s

Achard et al., 2002
Deforestation accounts for 20% of global carbon emissions
What drives tropical deforestation?
What drives tropical deforestation?

Figure 2: The causes of forest decline – I

Forest decline

Direct causes

Natural causes
- Hurricanes
- Natural fires
- Pests
- Floods

Resulting from human activity
- Agricultural expansion
- Cattle ranching
- Logging
- Mining and oil extraction
- Construction of dams
- Roads…

Underlying causes

Market failures
- Unpriced forest goods and services
- Monopolies and monopolistic forces

Mistaken policy interventions
- Wrong incentives
- Regulatory mechanisms
- Government investment

Broader socioeconomic and political causes
- Population growth and density
- Economic growth
- Distribution of economic and political power
- "Excessive" consumption
- Toxification
- Global warming
- War…

Governance weakness
- Concentration of land ownership
- Weak or non-existent ownership and land tenure arrangements
- Illegal activities and corruption…

Agents
- Slash and burn farmers
- Agribusiness
- Cattle ranchers
- Miners
- Oil corporations
- Loggers
- Non timber commercial corporations

Source: After Contreras-Hermosilla (2000), Underlying causes, CIFOR, p. 5.
More sustainable -> less meat

Only 62% of food production feeds people directly (35% animal feed; 3% biofuels)

Foley et al., 2011
Deforestation in Borneo through 2005 and projected through 2020
Where does palm oil go?

- **71%** Foods (margarine, processed foods, chocolate, etc.)
- **24%** Consumer products (cosmetics, detergents, candles, etc.)
- **5%** Energy (electricity, heating, fuels, etc.)

Worldwide palm oil consumption by use (2010). Source: AGEB
Water Resources

Water Withdrawals / Renewable Water Supply
(average climate)

Water Withdrawals / Renewable Water Supply
(driest ~10% of years)
90% of the Ogallala is used for agriculture
Projected lifetime of the Ogallala Aquifer in Kansas

(Based on ground water trends from 1996 to 2006 and the minimum saturated thickness required to support well yields at 400 gpm under a scenario of 90 days of pumping with wells on 1/4 section)
California Drought 2013-2016

Increased water use efficiency:
Residential water use dropped 132 gal/person/day (July 2014) to 98 gal/person/day (July 2015)

Statewide reduction of 31%

U.S. Drought Monitor
California

September 1, 2015
(Released Thursday, Sep. 3, 2015)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

<table>
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<th>D0</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
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<tr>
<td>Current</td>
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<td>99.86</td>
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<td>Water Year</td>
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<tr>
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<td>100.00</td>
<td>100.00</td>
<td>95.42</td>
<td>61.92</td>
</tr>
</tbody>
</table>

Intensity:
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions; local conditions may vary. See accompanying text summary for forecast statements.

Author:
Anthony Adusa
NOAA/NWS/NCEP/CPC

http://droughtmonitor.unl.edu/
Small Groups Discussion

Remaining questions from Foley

1. Give two examples of negative environmental consequences associated with food production. Can you think of any solutions to reduce the impacts of food production?

2. What is albedo? Where are boreal forests? Why does clearing of boreal forests actually lead to cooler temperatures?

3. List and describe two examples of ecosystem services mentioned in this paper.