Energy

19 March 2007
26th class meeting

(http://www.earth911.org/master.asp)

READINGS, Mon 19 March:
None

Wednesday 21 Mar:
Miller Chapter, NG Coal Article

Lab 21/23 Mar:
Energy Lab
(see website)

Saturday 24 March MT LEMMON!
BSE 7am, return 6pm

Lab 28/30 March:
meet in lab

Environmental Biology (ECOL 206)
University of Arizona, spring 2007
Kevin Bonine, Ph.D.
Anna Tyler, Graduate TA


Mt. Lemmon Ski Area, March or April 2005
Mt. Lemmon this Saturday...

24 March

Meet **0700h** at S side of BSE (corner of 4th and Highland)
“Be on time or get left behind.”
Return around 1800h to campus

Please Bring:

**Food** (snacks and lunch)
We will bring a cooler with ice for you to put stuff in if you wish.
Water (bring a small **bottle**, we will bring big **jug** for refills)
**Hat**
**Clothes** for variable weather conditions. Up top it **might** be in the 30s F and raining or snowing.
Be prepared to enjoy yourself no matter the weather.

**Small Notebook, Writing Instruments, Handout from 206 lab website**

Sunscreen?
Binoculars?
Camera?
Money?

Please don’t bring personal music devices, no text-messaging or phone calls, etc.
We will be interacting as a group all day.

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**SNR Special Seminar Information**

Thanks to financial support from the Graduate Student and Professional Council, Institute for the Study of Planet Earth, and USGS, we are honored to welcome **Dr. Sharon Collinge** from The University of Colorado at Boulder for a visit to SNR on March 27th and 28th. Dr. Collinge will be giving a talk entitled *Got plague?: Links between landscape change and disease occurrence in western USA grasslands*, as part of the School of Natural Resources Seminar Series (Wednesday, March 28th at noon in the Old Chem Bldg (across the quad) room 209).

Dr. Collinge’s current research focuses on the role of landscape spatial heterogeneity in shaping ecological processes, including responses of individual organisms, populations, and communities to spatial variation in landscape structure. More information on Dr. Collinge’s lab can be found at [<<http://www.colorado.edu/eeb/EEBprojects/CollingeLab/index.html>>](http://www.colorado.edu/eeb/EEBprojects/CollingeLab/index.html).

A selection of Dr. Collinge’s papers can be found by following this link [http://www.u.arizona.edu/~obrienc/research/collinge/collinge.html](http://www.u.arizona.edu/~obrienc/research/collinge/collinge.html).

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Tuesday, March 27th
Undergraduate student luncheon, 12:00 1:00 pm, room 218 BSE
Break-out session (professional development and research), 1:15 2:15, room 218 BSE

Wednesday, March 28th
SNR Noon Seminar, 12:00-1:00, Old Chem Bldg room 209
Potluck social, 6:00 9:00 (more information to come)
### 206 Exam2 2007

- **min**: 39
- **max**: 93
- **s.d.**: 17.16
- **median**: 68.25
- **mean**: 69.31
- **N**: 16

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[Bar chart showing the distribution of scores with various statistical measures listed.]
Urbanization and Sprawl
Role of the automobile?

U.S. 4.6% population
~33% of world’s cars

Bicycles!!
Mass transit
Figure 11-20 Some of the undesirable impacts of urban sprawl and car-dependent development.
Reining in Urban Sprawl
Stoel, 1999

- Sprawl, suburbs, city center
- greenspace, pollution, traffic, erosion, water
- more highways do not help
- wealth vs. quality of life
- fossil fuels
- gov’t subsidies
- divided jurisdictions
- symptoms vs. causes
- Portland, Oregon
  success attracts people!
- antisprawl legislation
  developers and property rights advocates opposed
- last sentence about need to tax fossil fuels

(Cars Rule)
Miller p. 95

75% Americans drive to work alone
5% commute on public transit
0.5% bicycle to work

In US we drive 2.5 trillion miles/year
(same as all other people combined)

China and others aspiring...

In US, $1 of every $4 related to automobile

Globally: 1.2 million killed each year, 15 million injured

Cars: 25% of CO₂ emissions
Urban areas: 33-50% car related

Externalities accounted: + $5-8 / gallon gasoline
SAN FRANCISCO — City officials are hoping to harness the power of dog doo-doo. San Franciscans already recycle two-thirds of their garbage, but in this dog-friendly town, animal feces make up nearly 4 percent of residential waste, or 6,500 tons a year — nearly as much as disposable diapers, according to the city.

Within the next few months, Norcal Waste, a garbage hauling company that collects San Francisco’s trash, will begin a pilot program under which it will use biodegradable bags and dog-waste carts to pick up droppings at a popular dog park.

The droppings will be tossed into a contraption called a methane digester, which is basically a tank in which bacteria feed on feces for weeks to create methane gas. The methane could then be piped directly to a gas stove, heater, turbine or anything else powered by natural gas. It also could be used to generate electricity.

Methane digesters are nothing new. The technology was introduced in Europe about 20 years ago, and more than 600 farm-based digesters are in operation there. Nine are in use on California dairy farms, and chicken and hog farms elsewhere in the United States also use them.

Neither Norcal Waste spokesman Robert Reed nor Will Brinton, a Maine-based recycling and composting consultant, knew of anyone in the United States who is using the $1 million devices to convert pet waste to energy. But Brinton said some European countries process dog droppings along with food and yard waste.

“The main impediment is probably getting communities around the country the courage to collect it, to give value to something we'd rather not talk about,” Brinton said. “San Francisco is probably the king of pet cities. This could be very important to them.”

San Francisco — the city named after St. Francis, patron saint of animals — has an estimated population of 240,000 dogs and cats.

Energy (Miller Ch 10)

- Solar 99% (not in market place)
- Commercial 1% (82% nonrenewable)
  (incl. indirect solar: wind, water, biomass)
NonRenewable Energy

U.S. 4.6% population, 24% commercial energy
India 16% population, 3% commercial energy

U.S. Energy Sources

1. Availability
2. Net Energy
3. Costs to Develop
4. Subsidies, Tax Breaks
5. National Security
6. Terrorism
7. Environment, Climate, Human Health
**Net Energy**

1. Find
2. Extract
3. Transfer
4. Process
5. Transport
6. Burn

- 2nd Law of Thermodynamics

**Energy Efficiency**

- **Lightbulbs**
  - Incandescent
  - vs. Fluorescent

- **Hybrid Cars**
  - Fuel Efficient and Battery
  - 80-300 miles/gallon

- **Hydrogen Cells** (cars etc.)
  - \( \text{H}_2 + \text{O}_2 = \text{energy} + \text{H}_2\text{O} \)

- **Cogeneration** (heat and power)

- **Electric Motors**

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Miller, 2003 (2005: 10-21, 10-25)
U.S. Flow of Energy

Figure 6-5 Flow of commercial energy through the U.S. economy. Note that only 10% of all commercial energy used in the United States ends up performing useful tasks or being converted to petrochemicals; the rest is either automatically and unavoidably wasted because of the second law of thermodynamics (44%) or wasted unnecessarily (46%).

Energy Sources

Solar - passive or active
Hydrogen - (green algae??) need to decompose water

Hydropower
Wind
Biomass
Geothermal

Fossil Fuels
Oil
Natural Gas
Coal

Nuclear

CO₂

Figure 6-25 CO₂ emissions per unit of energy produced by various fuels, expressed as percentages of emissions produced by coal.
Fossil Fuels

Oil
Natural Gas
Coal

Advantages
- Ample supplies (250-5000 years)
- High net energy yield
- Low cost (with huge subsidies)
- Mining and combustion technology well developed
- Air pollution can be reduced with improved technology (but adds to the cost)

Disadvantages
- Very High environmental impact
- Severe land disturbance, air pollution, and water pollution
- High land use (including mining)
- Severe threat to human health
- High CO₂ emissions when burned
- Relatively radioactive particles and mercury into air

Figure 6-30 Advantages and disadvantages of using coal as an energy resource.

Miller, 2003 (2005: 10-11)

Natural Gas

Advantages
- Ample supplies (125 years)
- High net energy yield
- Low cost (with huge subsidies)
- Less air pollution than other fossil fuels
- Lower CO₂ emissions than other fossil fuels
- Moderate environmental impact
- Easily transported by pipeline
- Low land use
- Good fuel for fuel cells and gas turbines

Disadvantages
- Non-renewable resource
- Releases CO₂ when burned
- Difficult to transport among countries
- Methane (a greenhouse gas) can leak from pipelines
- Shipped across ocean as highly explosive liquefied natural gas (LNG)
- Sometimes burned off and wasted at wells because of low price
- Requires pipeline distribution system

Figure 6-28 Advantages and disadvantages of using conventional natural gas as an energy resource.

Miller, 2003 (2005: 10-9)
When you turn up the AC, think of Gibson and the grimy fuel it devours at the rate of three 100-car trainloads a day.

WHO HAS COAL? The world has more than a trillion tons of readily available coal. The U.S. has the largest share, but other energy-hungry countries, such as China and India, are richly endowed as well.

<table>
<thead>
<tr>
<th></th>
<th>U.S.</th>
<th>RUSSIA</th>
<th>CHINA</th>
<th>INDIA</th>
<th>AUSTRALIA</th>
<th>SOUTH AFRICA</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>27%</td>
<td>17%</td>
<td>13%</td>
<td>10%</td>
<td>9%</td>
<td>5%</td>
<td>19%</td>
</tr>
</tbody>
</table>

WHO USES COAL NOW? Global coal consumption is roughly five billion tons a year, with China burning the most. Western Europe has cut coal use by 36 percent since 1990 by using available natural gas from the North Sea and Russia.

<table>
<thead>
<tr>
<th>MILLIONS OF TONS</th>
<th>CHINA</th>
<th>EUROPE*</th>
<th>U.S.</th>
<th>INDIA</th>
<th>RUSSIA</th>
<th>OTHER</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1,531</td>
<td>1,117</td>
<td>1,094</td>
<td>431</td>
<td>251</td>
<td>1,018</td>
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</table>

WHO WILL USE IT TOMORROW? China's coal needs will more than double by 2025 to satisfy factories and consumers. The country also plans to convert coal to liquid motor fuels. Worldwide, consumption will rise by 56 percent.

<table>
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<tbody>
<tr>
<td></td>
<td>1,599</td>
<td>853</td>
<td>728</td>
<td>285</td>
<td>1,603</td>
<td></td>
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</table>

* Excluding Russia