

GEOS 3310 Lecture Notes: Introduction to Environmental Geology

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Motivation

Note the material in this section changes each semester, and so items mentioned only in this section will not be on the tests. But they do reflect what I think are the most important topics in Environmental Geology at this time, and can be very helpful in answering High-Value questions.

Weird Weather

Weather extremes are becoming more common (see monthly summaries at NOAA):

- Dallas: record cold in Feb. 2011, record heat July-Aug. 2011 , especially record minimum temperatures
- U.S.: record number of climate extremes in 2011 (flood, drought, snow, hurricane, tornado)
- How to plan?
 - Dallas gets snowplows
 - North Texas drought will persist (nothing to plow!), and conditions should remain warmer and drier than usual

- insurance companies will raise rates (probably worldwide)
- Worldwide
 - e.g. 2011 Scientific American article dramatic increase in extreme weather most likely caused by climate change
 - NOAA many indicators of long term climate change

Weird Politics

Discussions in the political arena also seem to be more extreme:

- many politicians backing away from acknowledging climate change
- but climate change is already here
 - e.g. increasing prevalence of record high temperatures, weird weather, 30% of Arctic ice has melted since 1980
 - strong mainstream scientific consensus for man-caused climate change
 - * National Science Foundation congressional testimony :
“... we do know that the Earth is warming and that
'this warming is linked to human activities.'”

- * National Academy of Sciences : "Climate change is occurring, is caused largely by human activities, and poses significant risks for and in many cases is already affecting a broad range of human and natural systems"
- * 98% of researchers publishing in climate science concur with National Science Foundation view
- * many scientific organizations have similar statements supporting this consensus view
- even conservative-funded efforts have concluded the globe is warming : "Global warming is real." (Berkeley Earth Surface Temperature Project)
- New thinking is needed
 - U.S. (and global) politics seems to preclude a significant reduction in CO₂ emissions

- but U.S. emissions are down significantly
- stated goal of UN climate talks is $\leq 2^{\circ}\text{C}$ warming. Not reachable given current agreements
- an unacknowledged reality: “Global action is not going to stop climate change. The world needs to look harder at how to live with it”
- new **practical** plan is needed. How about “ Simultaneously Mitigating Near-Term Climate Change and Improving Human Health and Food Security ” ?

Introduction

Why Study Environmental Geology?

- We live in, affect, and are affected by the environment
- Much of what we'll study here you already have some qualitative understanding of
- This class will give a practical, applicable, more quantitative background to extend that understanding
- So what can you do with that?
 - it could save your life (Fig. 1)
 - it'll certainly save you some money over your lifetime (e.g. avoiding natural hazards when choosing a home)

- and help you understand and vote on complex issues (e.g. water, air pollution, energy policy)
- plus its fun

Geography Lesson Saves Lives

Girl, 10, used geography lesson to save lives

(Filed: 01/01/2005)

A 10-year-old girl saved her family and 100 other tourists from the Asian tsunami because she had learnt about the giant waves in a geography lesson, it has emerged.

Tilly Smith, from Oxshott, Surrey, was holidaying with her parents and seven-year-old sister on Maikhao beach in Phuket, Thailand, when the tide rushed out.



A woman searches a pile of rubble near Patong beach in Phuket

As the other tourists watched in amazement, the water began to bubble and the boats on the horizon started to violently bob up and down.

Tilly, who had studied tsunamis in a geography class two weeks earlier, quickly realised they were in danger.

She told her mother they had to get off the beach immediately and warned that it could be a tsunami.

She explained she had just completed a school project on the huge waves and said they were seeing the warning signs that a tsunami was minutes away.

Her parents alerted the other holidaymakers and staff at their hotel, which was quickly evacuated. The wave crashed a few minutes later, but no one on the beach was killed or seriously injured.

In an interview with the Sun, Tilly gave the credit to her geography teacher, Andrew Kearney, at Oxshott's Danes Hill Prep School.

She said 'Last term Mr Kearney taught us about earthquakes and how they can cause tsunamis.

'I was on the beach and the water started to go funny. There were bubbles and the tide went out all of a sudden.

'I recognised what was happening and had a feeling there was going to be a tsunami. I told mummy.'

Figure 1: A timely geography lesson allowed 100 people to avoid the Indonesian tsunami. See 2009 followup story and video .

What is Environmental Geology?

- it is applied geology used to understand the mutual interaction of man and the natural environment. We'll divide these interactions into two broad groups
 - natural hazards/benefits (Chps. 1-11)
 - environmental health/degradation/exploitation (Chps. 12-20)
- we study geology using the *scientific method*, which consists of proposing and testing *hypotheses*

Important terms

- *land ethic*
- *environmental crisis* (more like interconnections that require constant attention)
- myth of superabundance

Key Concepts

Key Concepts

Chapter 1 of the textbook discusses several key concepts:

- population growth (Figs 2–5)
- *sustainability*
- Earth systems (e.g. hydrosphere).
 - open and closed systems
 - feedback
 - growth rate (G), doubling time (D), where

$$D \approx \frac{70}{G}$$

(see also investment doubling time)

- input-output analysis, average residence time
- earth system science - study of interconnectivity
- *Uniformitarianism*: “the present is a key to the past”

World Population Growth

- problematic because of *exponential growth* (Fig. 2)
- but the growth rate is slowing (Fig. 3)
- leading to less dramatic population increase (Fig. 4)
- still a major problem in areas such as Asia and India (Fig. 5), and therefore ultimately for the world

Exponential Growth

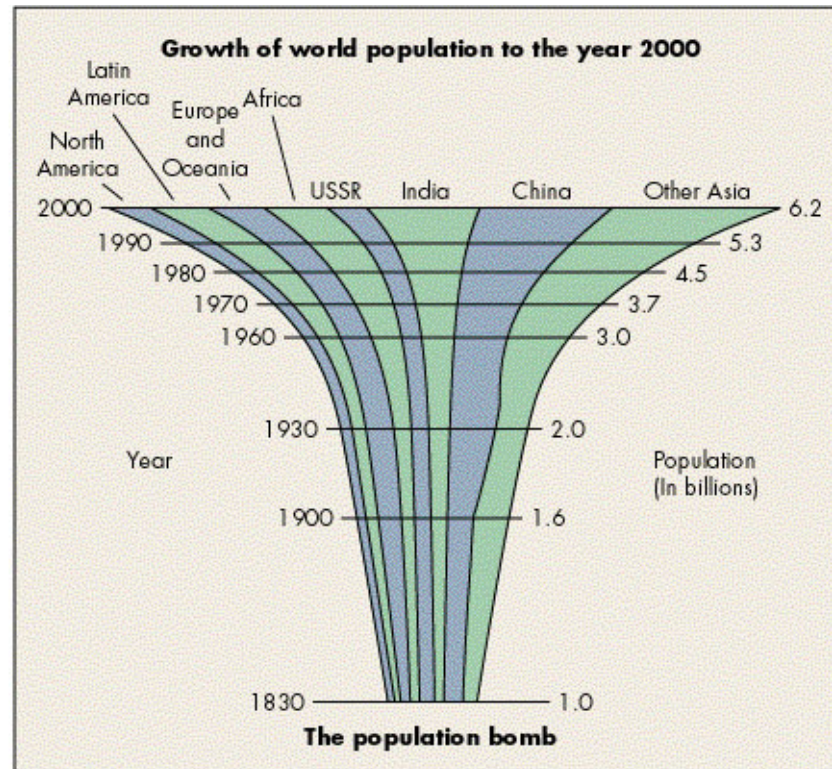


Figure 2: World “population bomb” [Keller, 2008, Fig. 1.3,]. Note increasing fraction for India/Asia.

Slowing Population Growth Rates

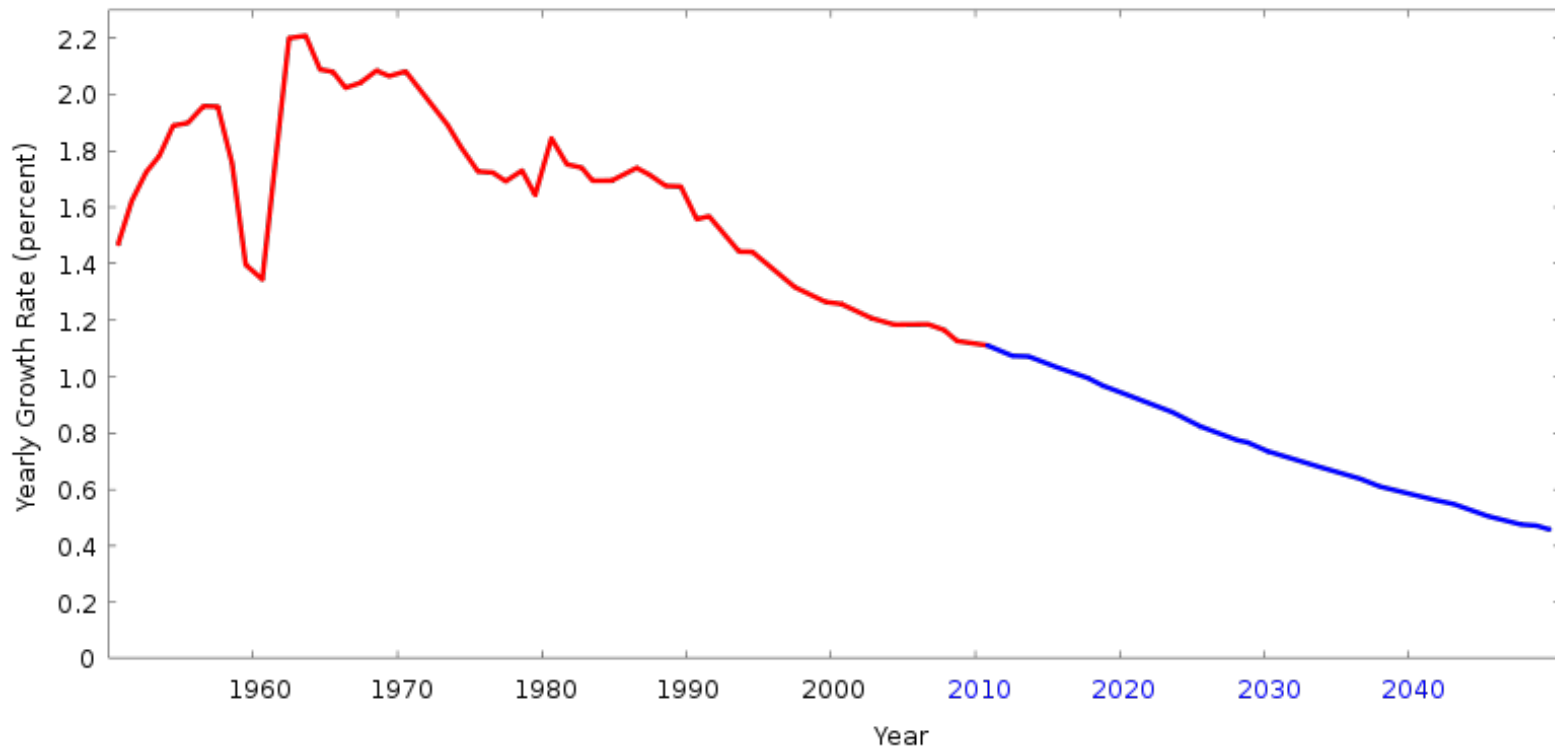


Figure 3: Slowing world population growth rate (blue is projected, after Wikimedia Commons). See also BBC and U.S. Census Bureau .

Less-Than-Exponential Growth

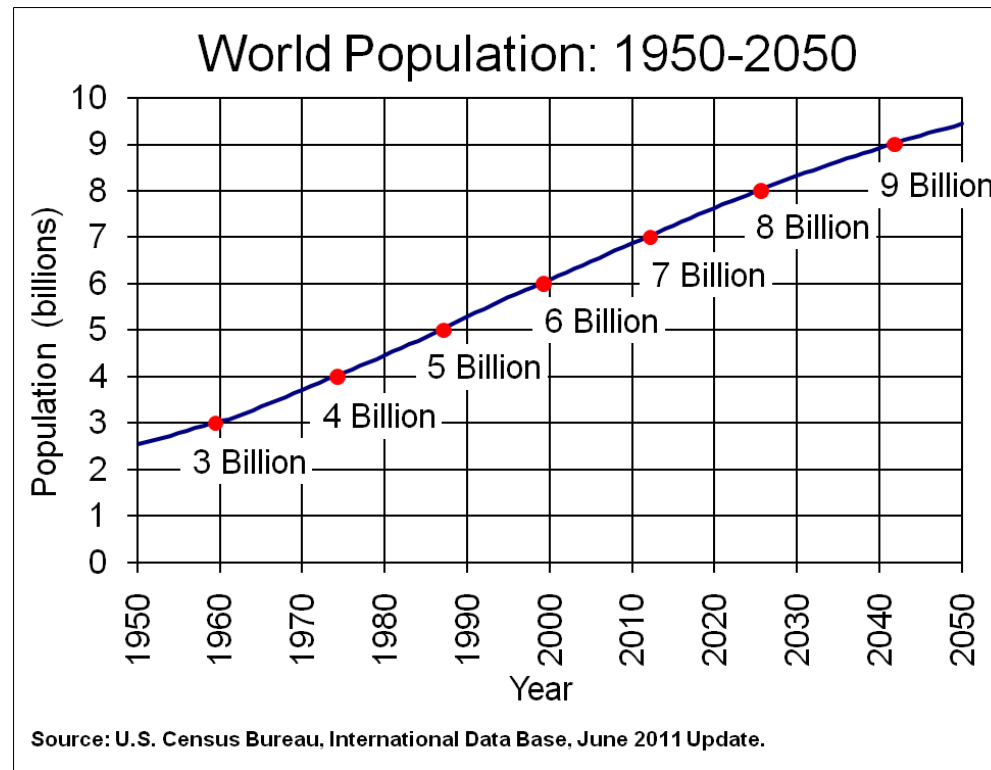


Figure 4: Declining growth rates lead to a less-than-exponential growth in world population (after U.S. Census Bureau). Still troubling, but not as bad as it could be!

World Population Density 2000

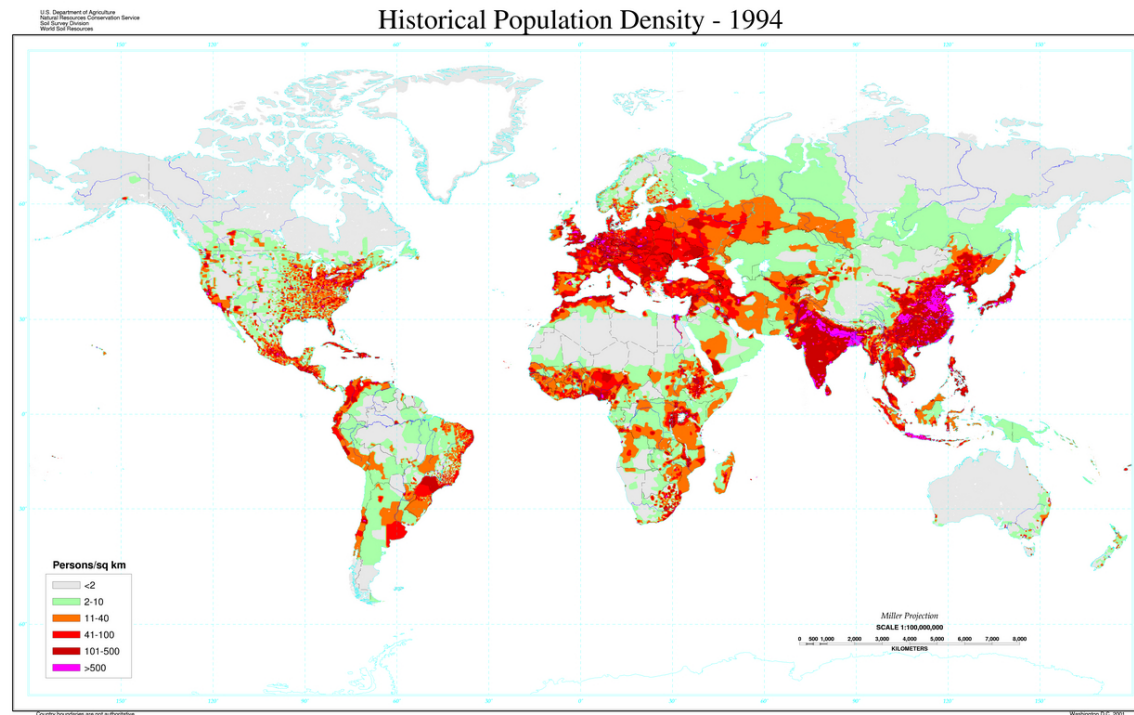


Figure 5: World population density (after USDA). Crowded places will be getting more crowded, mostly in Asia and India. See also by-country image .

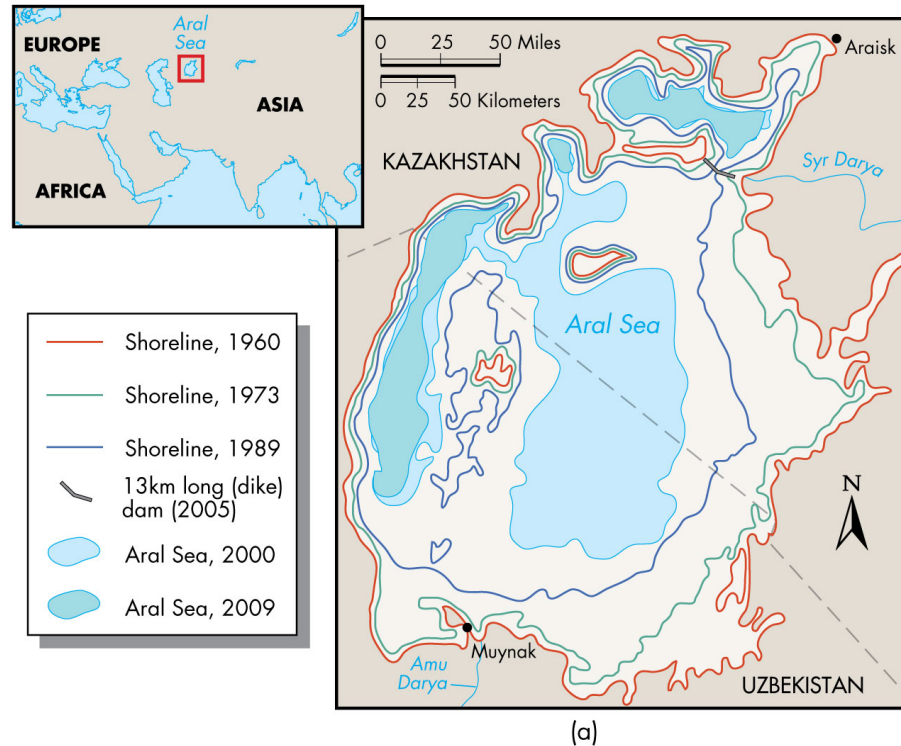
Examples of Environmental Management

A few cautionary tales are discussed in the book

- Easter Island
 - very isolated island settled by Polynesian culture
 - peak population was around 10,000 about 200 years ago
 - overuse of resources caused rapid population decline (pollen analysis shows elimination of trees)
 - only 2-3,000 inhabitants at first European contact in 1772
 - 187 inhabitants in 1877
- Aral Sea (Fig. 6)
 - was world's 4th largest freshwater body, severe decline since 1960

- north part recovering after construction of a dam in 2005
- see Wikipedia page for good images of lake changes
- Ducktown, TN (Fig. 7)

Aral Sea Changes



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Figure 6: Changes in the shoreline of the Aral Sea [Keller, 2011, Fig. 1.B1,]. See animated GIF and Wikipedia for more details.

Ducktown, Tennessee

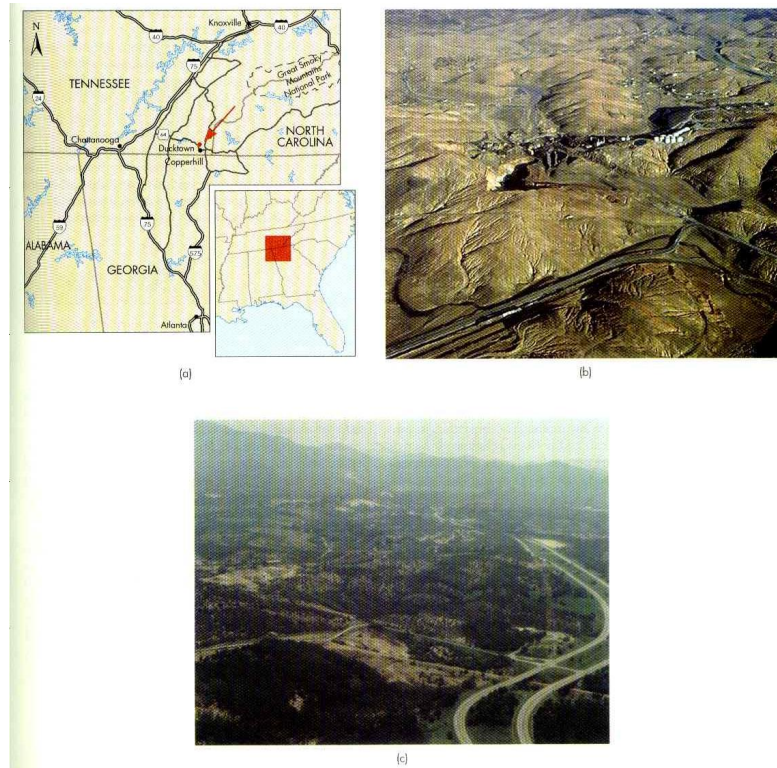


Figure 7: Severe devegetation and erosion at Ducktown, TN, copper mine and smelter [Fig. 1.B, Keller, 2008]. See closeup of devegetation .

Other Resources

Useful Links

This is intended to be an ever-evolving list of useful links on the general topic of this note set.

- 2005 BBC show “Planet Under Pressure” main website. Discusses major issues related to human impact on environment, energy, climate change, land use, etc.
- Al Gore “An Inconvenient Truth” . Somewhat dramatic, but certainly attention-getting.

Bibliography

- E. A. Keller. *Introduction to Environmental Geology*. Prentice Hall, 4th edition, 2008. ISBN 9780132251501. URL <http://www.pearsonhighered.com/educator/academic/product/0,3110,0132251507,00.html>.
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