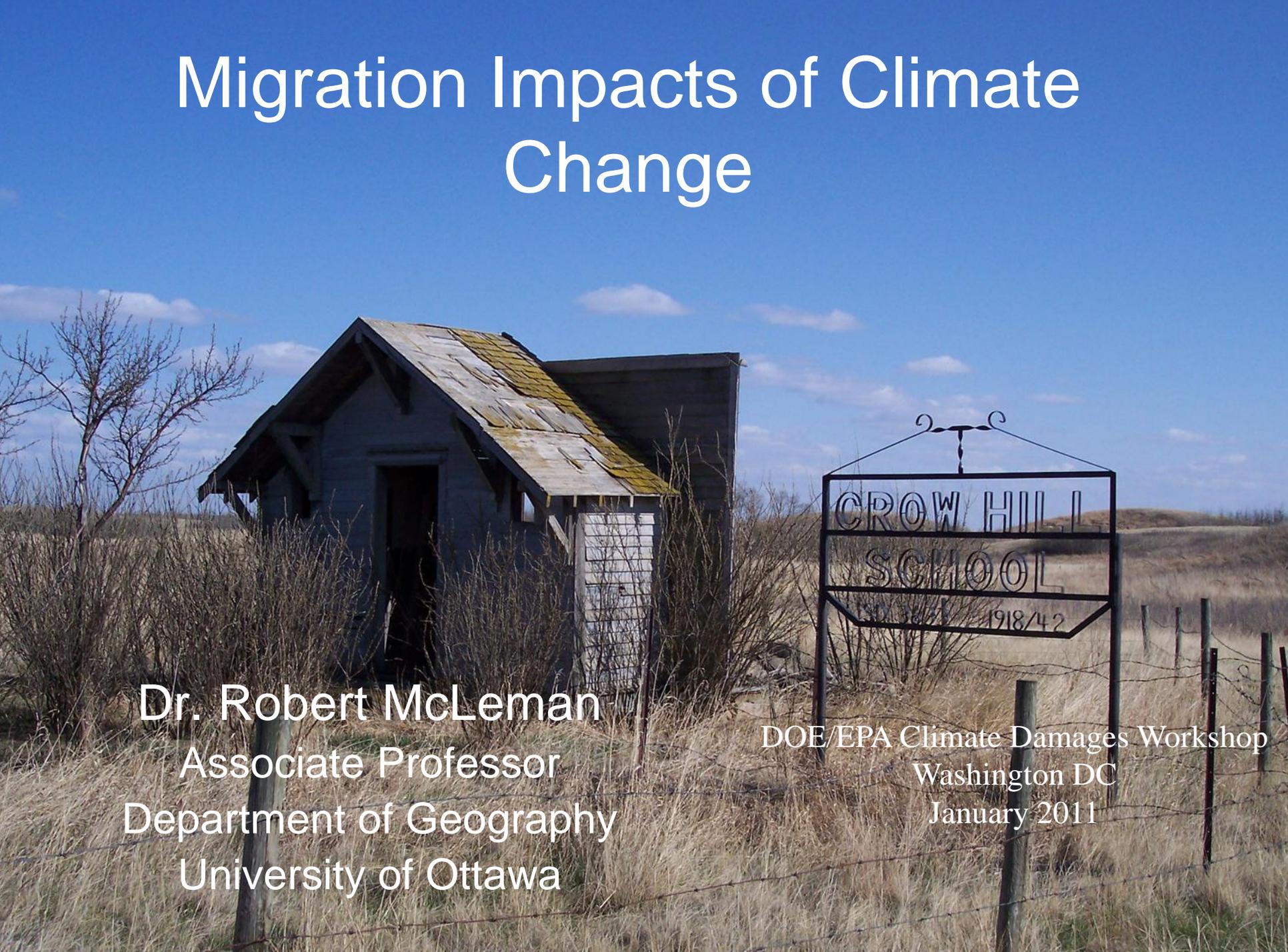


Migration Impacts of Climate Change



Dr. Robert McLeman
Associate Professor
Department of Geography
University of Ottawa

DOE/EPA Climate Damages Workshop
Washington DC
January 2011

Questions

- What regions most vulnerable?
- What models/data are available?
- How confident are we in these?
- Gaps & opportunities

Predictions of a coming exodus

The New York Times
ON THE WEB

Before the Flood

By SUJATHA BYRAVAN and SUDHIR
CHELLA RAJAN

Published: May 9, 2005

Cambridge, Mass. —. One of the paradoxes of global warming is that developing countries, which were not responsible for most of the greenhouse gas emissions that are changing the climate and did not reap the benefits of industrialization, will bear the brunt of the consequences. One of these consequences will be rising seas, which in turn will generate a surge of "climate exiles" who have been

KITCHENER • CAMBRIDGE • WATERLOO A3

FRIDAY, MARCH 5, 2004

Global climate change could lead to refugees: study

OTTAWA

Canada could see an influx of environmental refugees from countries rocked by hurricanes, droughts and other disturbing effects of global climate change, says a study prepared for the national spy agency.

Others might be drawn to Canada as icy regions of the vast North become warmer and more hospitable to marine traffic, posing possible new security challenges.

"Climate-related disruptions of human populations and consequent migration could have significant security

Last summer Europe's hottest in 500 years

PAGE D14

Many scientists believe human activity has prompted global warming that will lead to an increase in average temperatures. Other anticipated changes include rising sea levels, enhanced risk of drought, more frequent and intense storms, and other extreme weather events.

The paper notes sea ice in Canada's Northwest Passage has thinned to previously unimaginable levels. Should

Media identification of the first climate change refugees



Shishmaref, Alaska



Cataret Islands

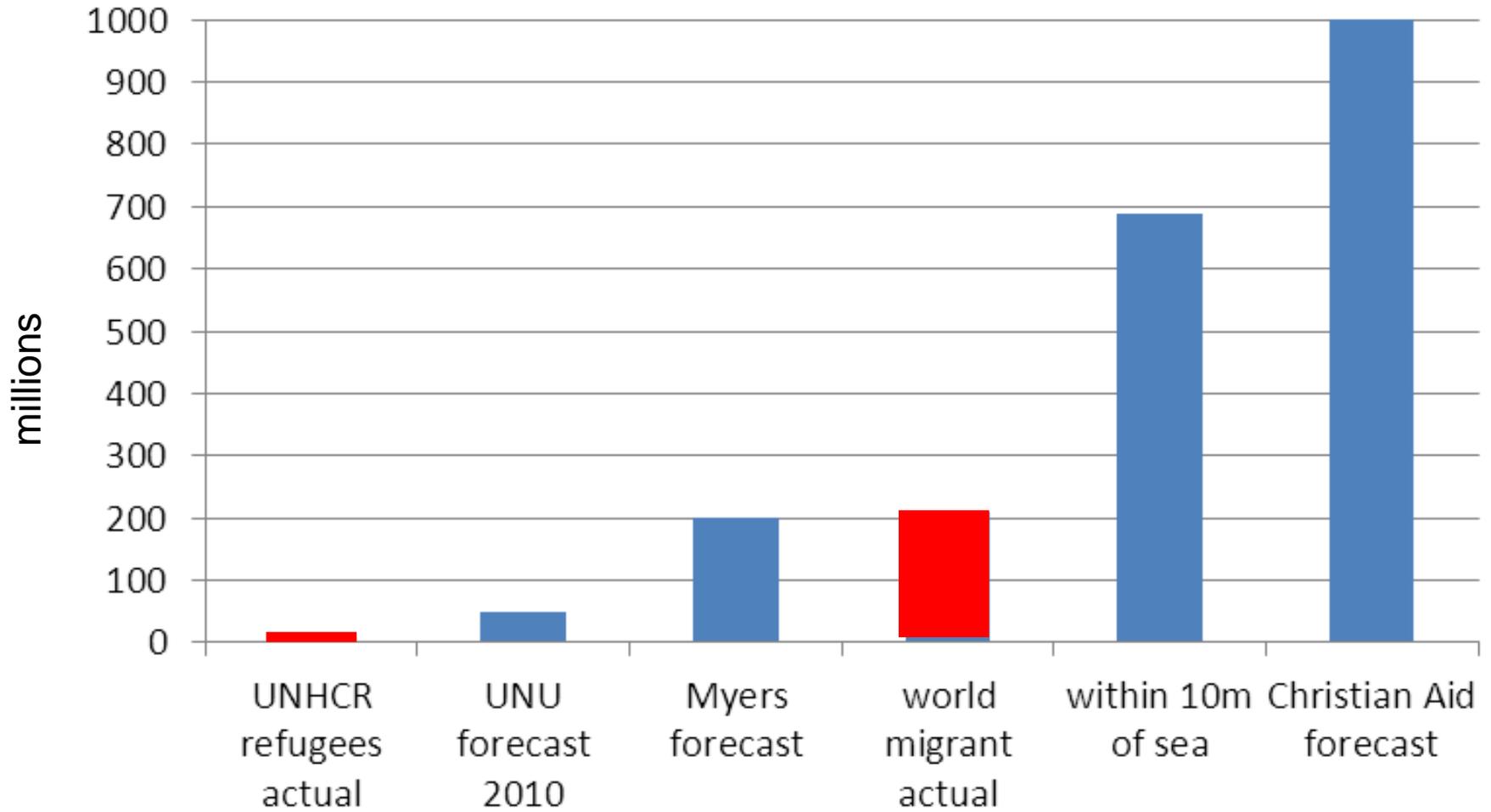


Lake Chad region

Predictions of future environmental refugees

- Up to 1 billion by 2050 (Christian Aid)
- 200 million by 2050 or 2100 (Norman Myers, CARE International press release)
- 50 million by 2010 (UNU 2005 press release)
- 10% of world population lives within 10m of sea level (Mcgranahan et al 2007)

Context



Existing forecasts of climate change migration

- Identify areas/populations exposed to negative CC impacts
- Exposure \neq migration
- Climate-migration not simple stimulus-response
- Intervening socio-economic, cultural & institutional factors

Climatic stimuli known to be associated with migration

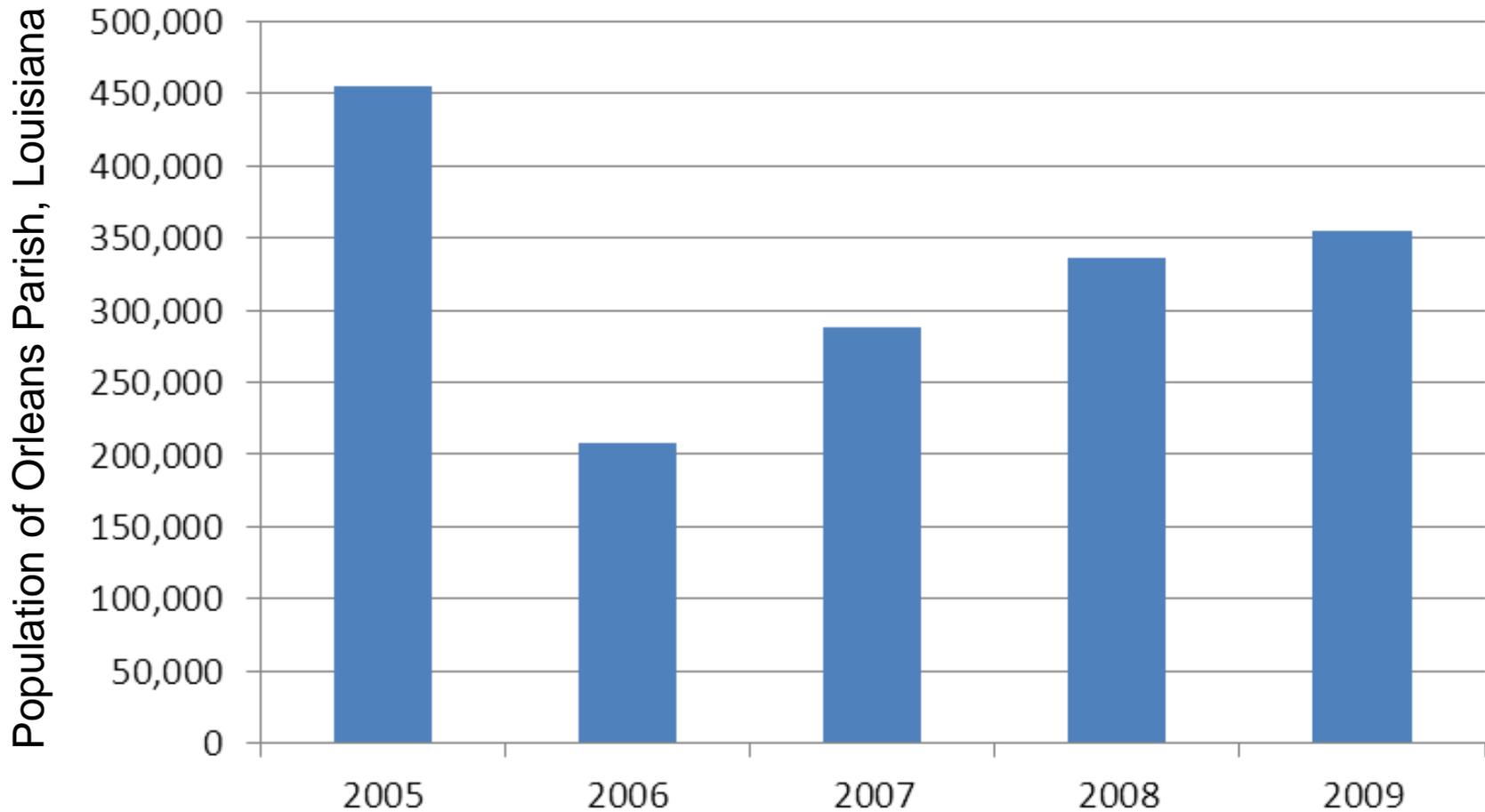
- Sudden onset events (e.g. hurricanes, tropical storms, extreme rainfall events)
- Persistent conditions (e.g. drought, changes in monsoons)
- Climate change expected to exacerbate existing stimuli, create new ones (e.g. sea levels, Arctic ice)

Hurricane Katrina



Sun-Sentinel.com

New Orleans population post-Katrina



Data source: US Census bureau

<http://www.census.gov/popest/counties/CO-EST2009-01.html>

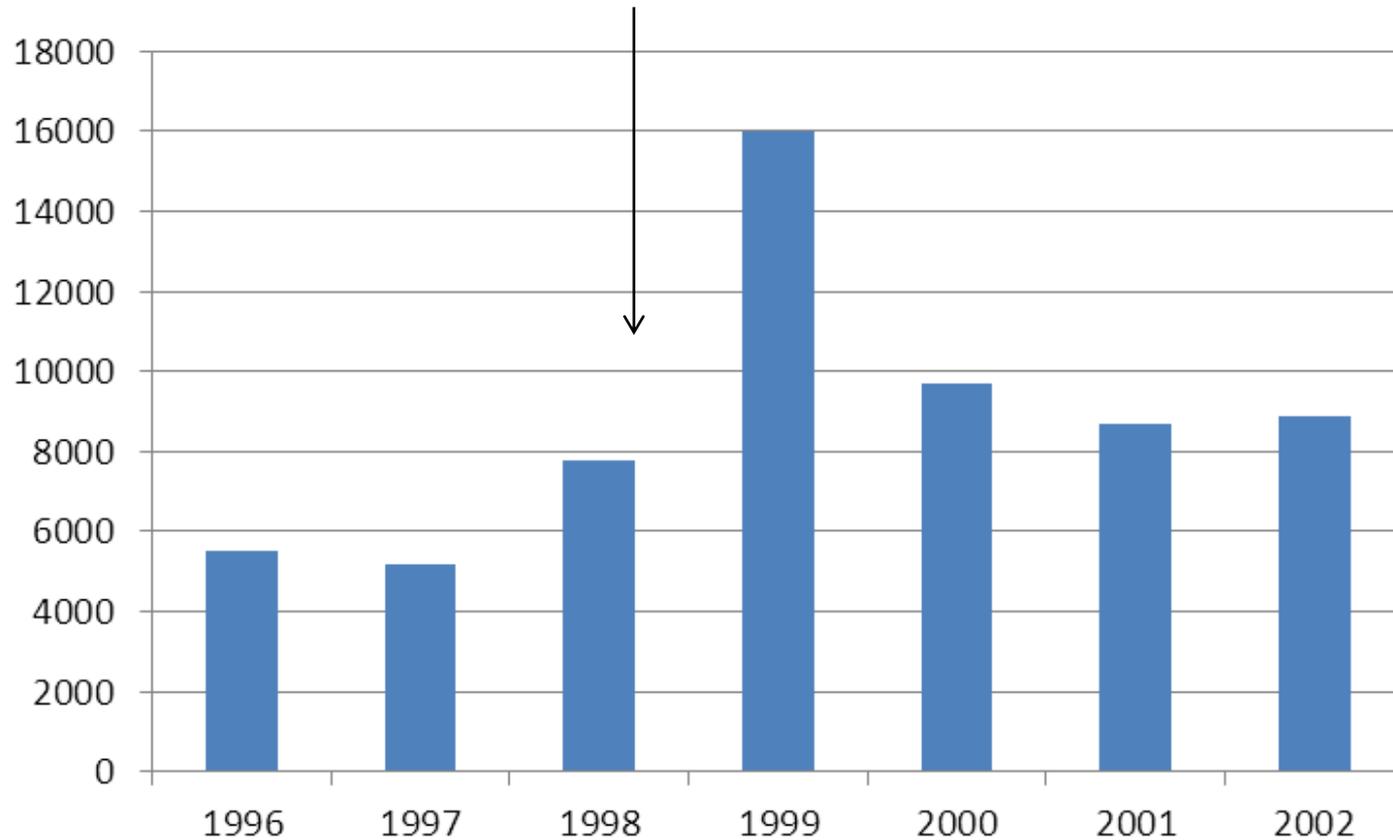
Hurricane Mitch, 1998



NASA image

Undocumented Hondurans arrested at US-Mexico border

Hurricane Mitch strikes Honduras Oct-Nov 1998



Drought & migration

- Feng et al (2010) find that a 10% decrease in agricultural production in Mexico due to drought is associated with a 2% rise in Mexican migration to US

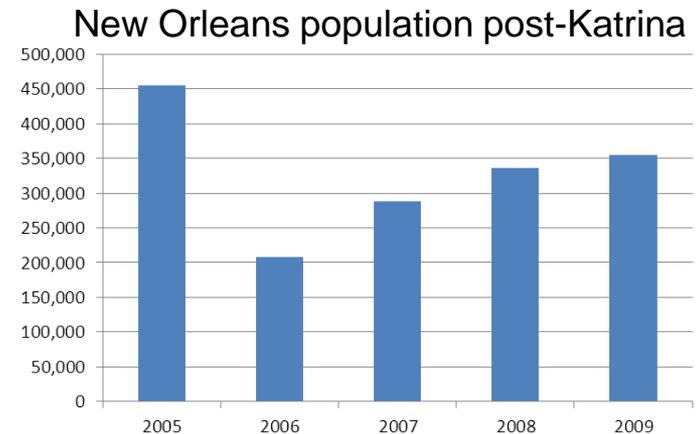
Feng SF, Krueger AB, Oppenheimer M. (2010) Linkages among climate change, crop yields and Mexico–US cross-border migration. *Proceedings of the National Academy of Science*. 107(32):14257-14262.

Where will climate change generate migration stimuli?

- Arctic (permafrost, sea & land ice melt)
- High latitudes, wet tropics (heavy precipitation events, floods)
- Mid- to low-latitudes, dry tropics (drought, water scarcity)
- Coastal plains, deltas, small islands (erosion, storm surges, salinization)

Differential outcomes

- Climate events, conditions don't always stimulate migration
- Multiple migration outcomes can be generated by single climate event
- Why? What distinguishes migrants from non-migrants?



Vulnerability (V)

- Potential to experience loss or harm

$$V = f(E, S, A)$$

E = exposure (i.e. climatic stimulus)

S = sensitivity of the exposed system

A = adaptive capacity

$$V = f(E, S, A)$$

Adaptive capacity

- Options for adapting to drought not the same in rural Nigeria as in rural Saskatchewan



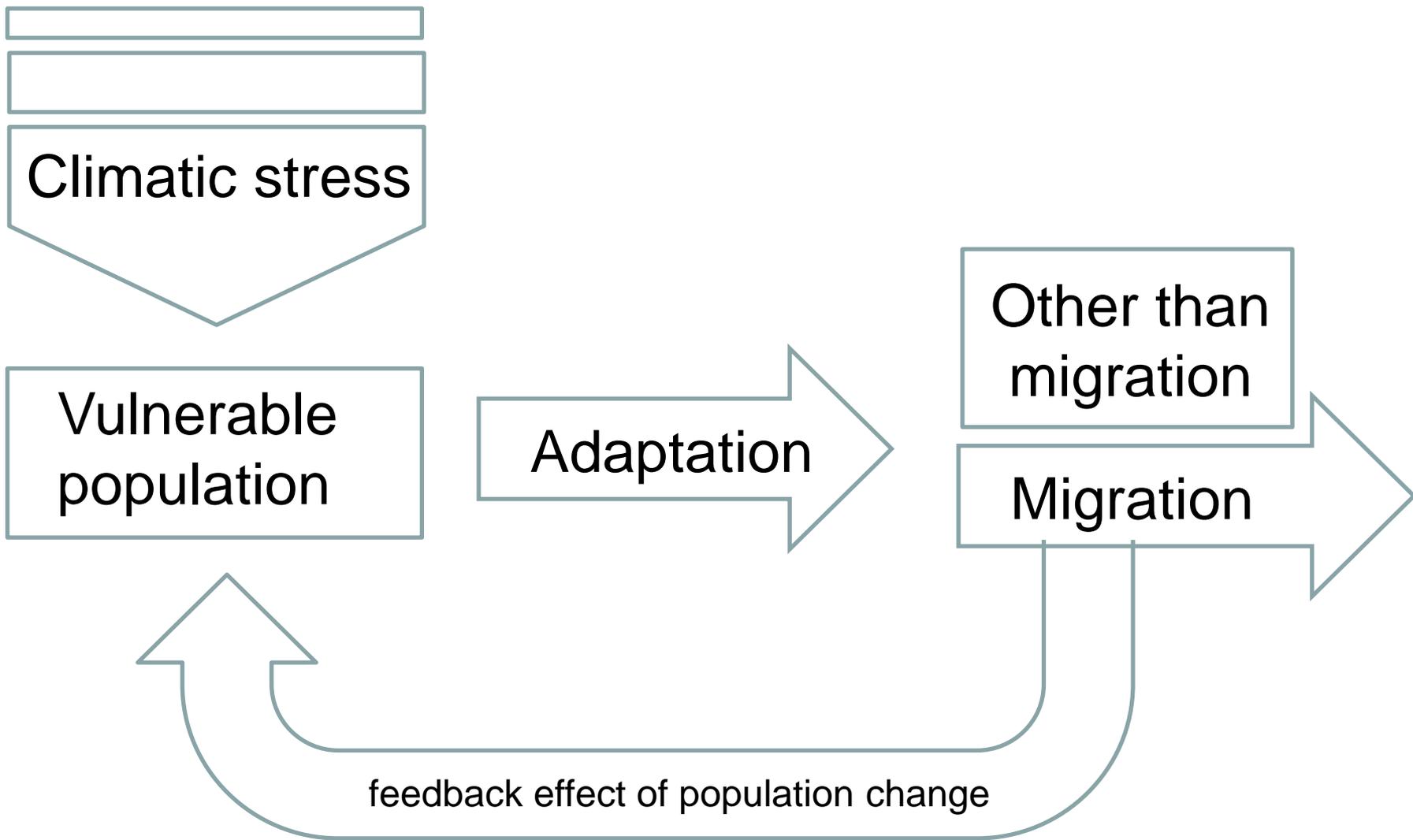
Northern Nigeria, 2005



Saskatchewan 2002

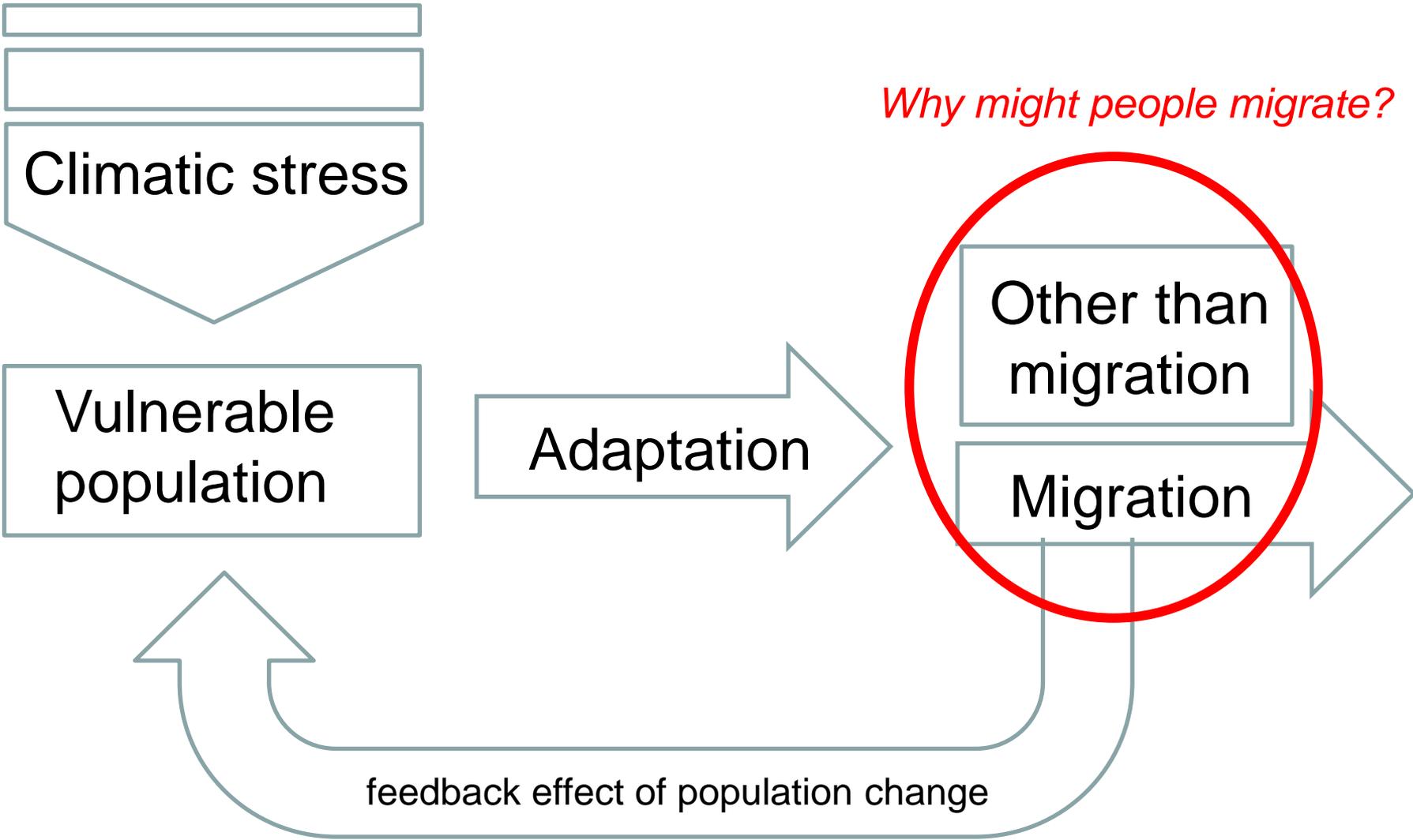
Migration as adaptation

- Migration is one of a range of potential adaptive responses to environmental stress
- Is presently used in many parts of world
- Is typically initiated at the household level
- Is not available to everyone
- Is not always used by all who might do so
- In worst cases, could be the only adaptation



Simplified from McLeman R, Smit B. (2006) Migration as an Adaptation to Climate Change. *Climatic Change*. 76(1-2):31-53.

Why might people migrate?



Simplified from McLeman R, Smit B. (2006) Migration as an Adaptation to Climate Change. *Climatic Change*. 76(1-2):31-53.

What else motivates people to migrate?

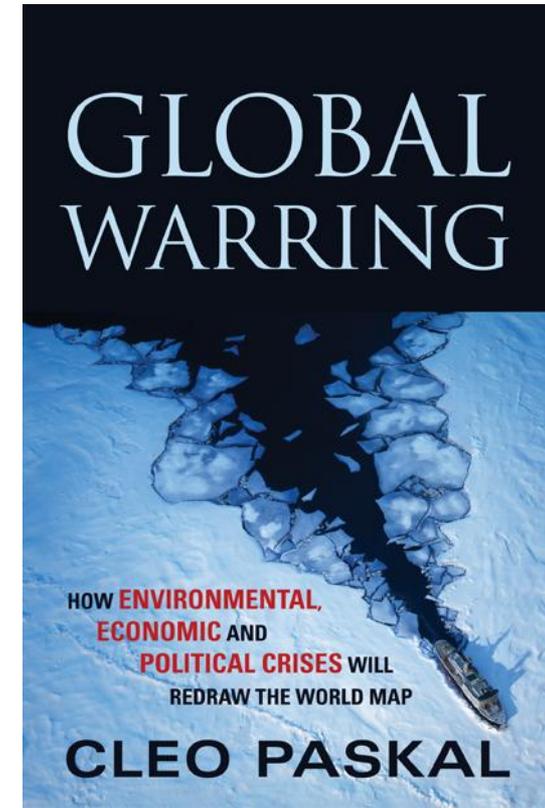
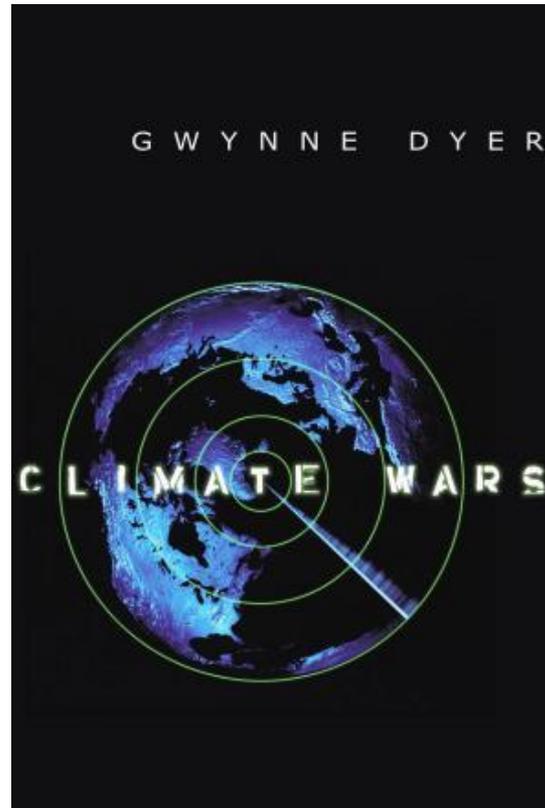
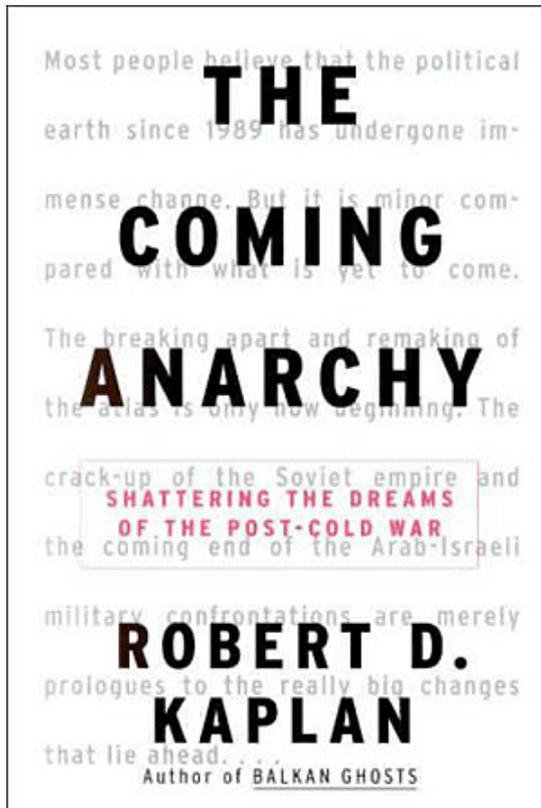
- Opportunity/benefit seeking (economic, public services)
- Household risk diversification
- Macro-scale systems
- Cultural norms
- Lifestyle
- Bright lights-big city
- Love
- Persecution, fear of violence

What else motivates people to migrate?

- Opportunity/benefit seeking (economic, public services)
- Household risk diversification
- Macro-scale systems
- Cultural norms
- Lifestyle
- Bright lights-big city
- Love
- Persecution, fear of violence

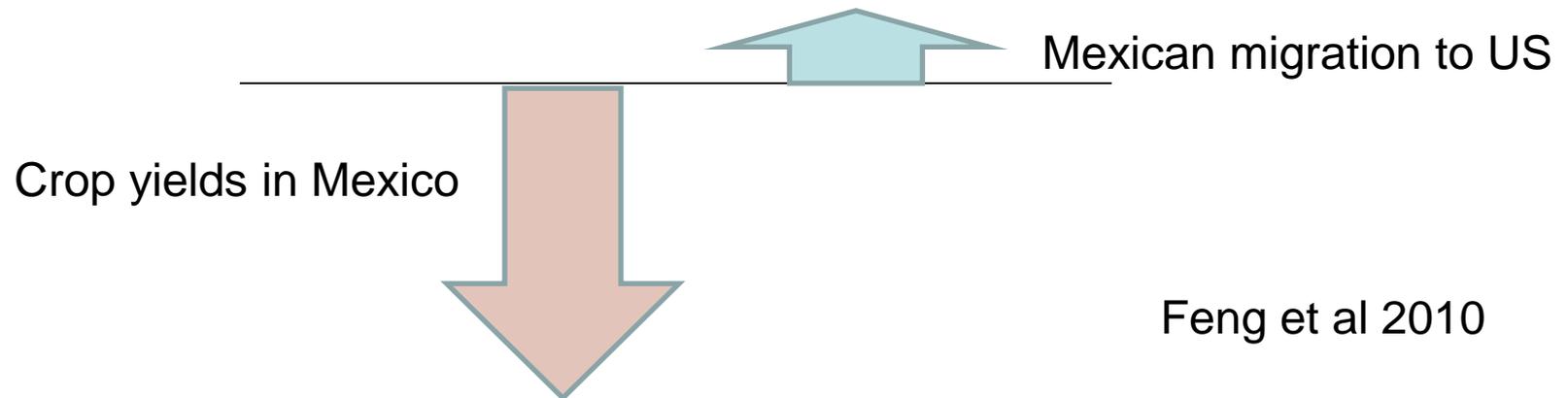
Climate may influence/interact with any of these (except maybe love)

What do we tend to focus on?



But most observed climate-related migration...

- Is not conflict-related
- Is internal/intra-regional
- When international, follows established routes, transnational communities
- Is shaped by other motivations as well



Climate-migration models

Historical climate-migration modeling

- Use known climatic data and known population change data from past events
- Generates learning analogues
- Can be ground-truthed

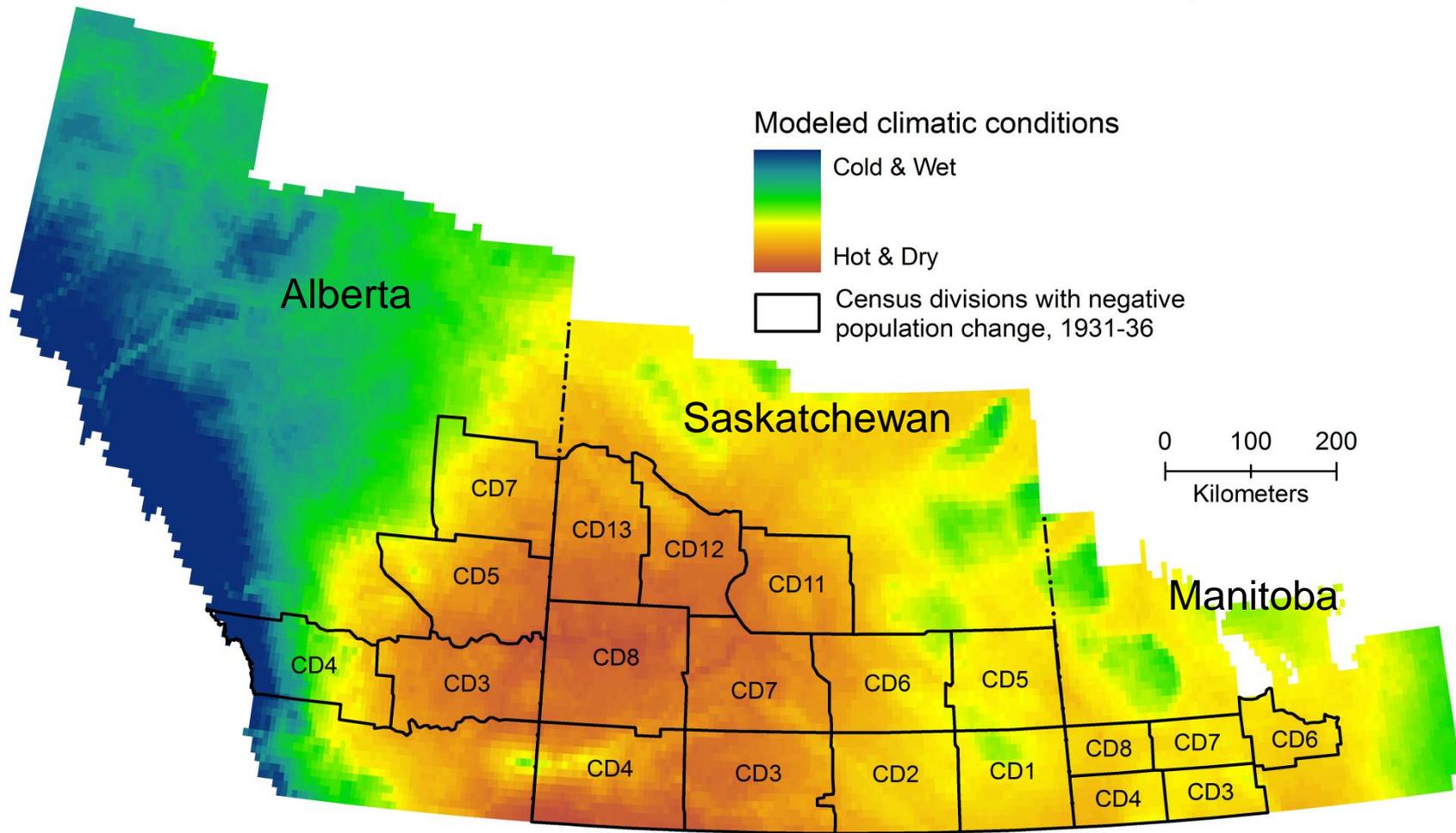
Canadian drought refugees, 1930s



Lenbow Archives NA-4179-15

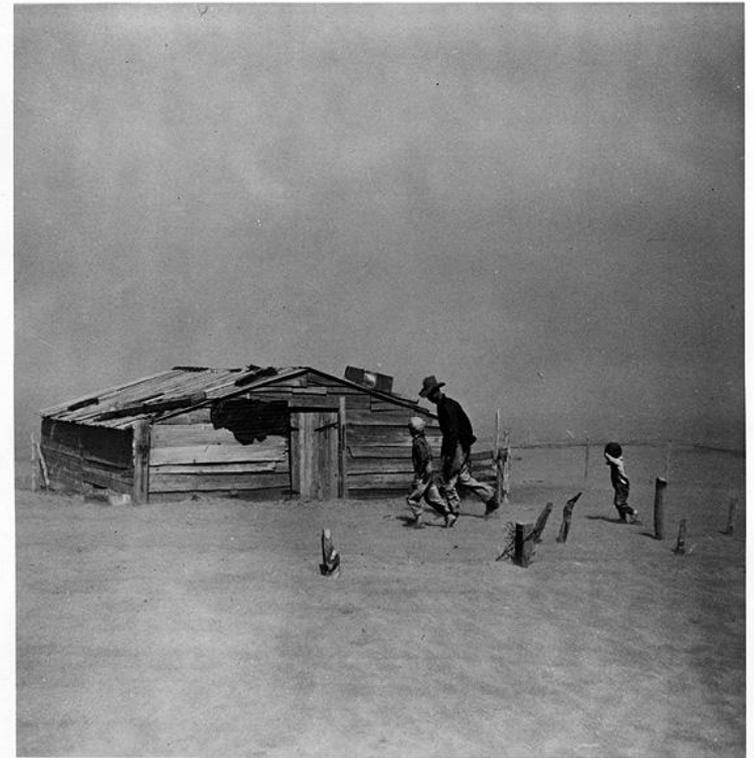


Drought & rural population loss, 1931-36, Canadian prairies



McLeman et al. (2010). GIS-based modeling of drought and historical population change on the Canadian Prairies. *Journal of Historical Geography*, 36, 43-56.

What distinguished migrants from non-migrants?



Qualitative research

Who migrates?

More likely to migrate:

- Young, healthy, skilled, educated
- Middle class
- Uncertain land tenure
- Family ties elsewhere



Less likely to migrate:

- Wealthier classes, landowners (especially good land), owners of fixed assets
- Those with strong local social networks

- Poor, destitute
- Elderly, infirm, broken families

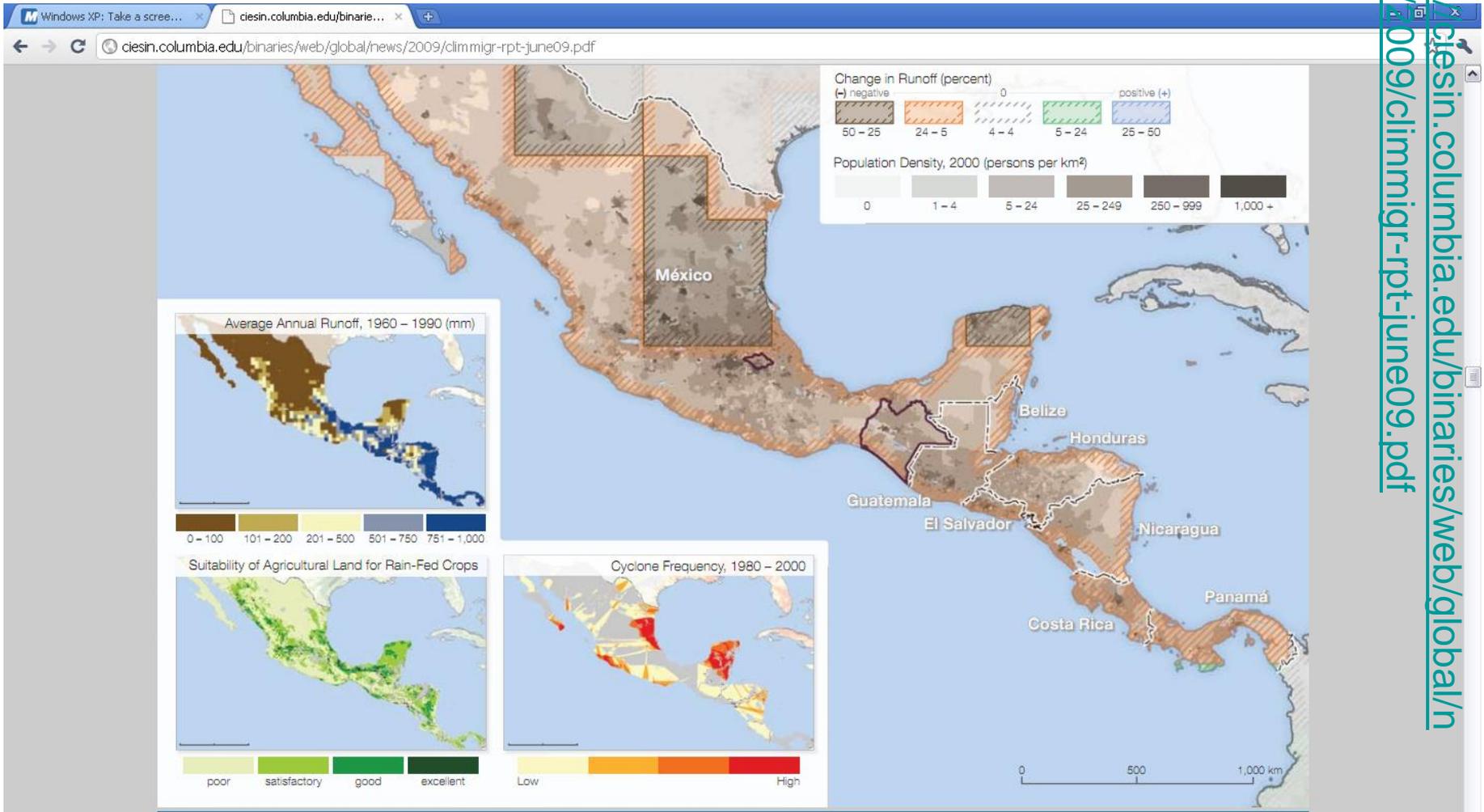
Other types of modeling

Spatial vulnerability models

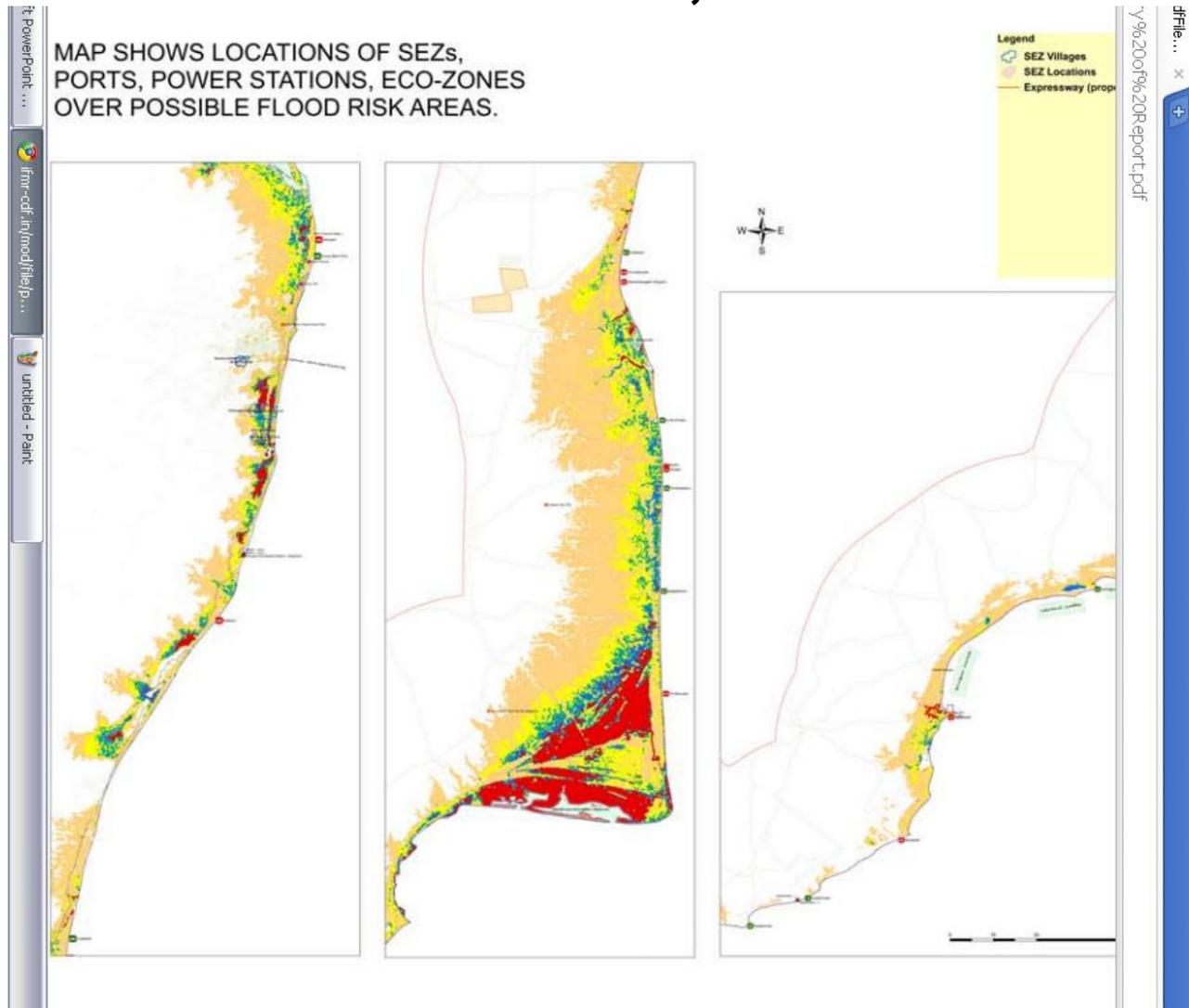
- GIS-based modeling to identify places/ populations at future risk (potential hotspots)
- Are silent on likelihood of migration outcomes

CIESIN models for “In Search of Shelter” report

<http://ciesin.columbia.edu/binaries/web/global/news/2009/climigr-rpt-june09.pdf>



Byravan et al models of sea level rise & coastal settlement, Tamil Nadu



<http://ifmr-cdf.in/mod/file/pdfFiles/Summary%20of%20Report.pdf>

Other types of modeling

- Multi-level hazard analysis models
- Does not refer to natural hazards, but is statistical tool to isolate the relative effect of particular variables on migration outcomes
- Used by Massey, Axinn, others to estimate determinants of Mexico-US migration, environmental drivers of migration in rural Nepal

Massey, D. S., Axinn, W. G., & Ghimire, D. J. (2010). Environmental change and out-migration: evidence from Nepal. *Population and Environment*, 32(2-3), 109-136.

Massey, D. S., & Espinosa, K. E. (1997). What's driving Mexico-US migration? A theoretical, empirical and policy analysis. *American Journal of Sociology*, 102(4), 939-999.

Other types of modeling

- Multi-stage regression model of known & estimated migration + crop yield change
- Then combined with crop simulation models for forecasting
- E.g. estimating potential Mexico-US migration (Feng et al 2010)

Feng SF, Krueger AB, Oppenheimer M. Linkages among climate change, crop yields and Mexico–US cross-border migration. *Proceedings of the National Academy of Science*. 2010;107(32):14257-14262.

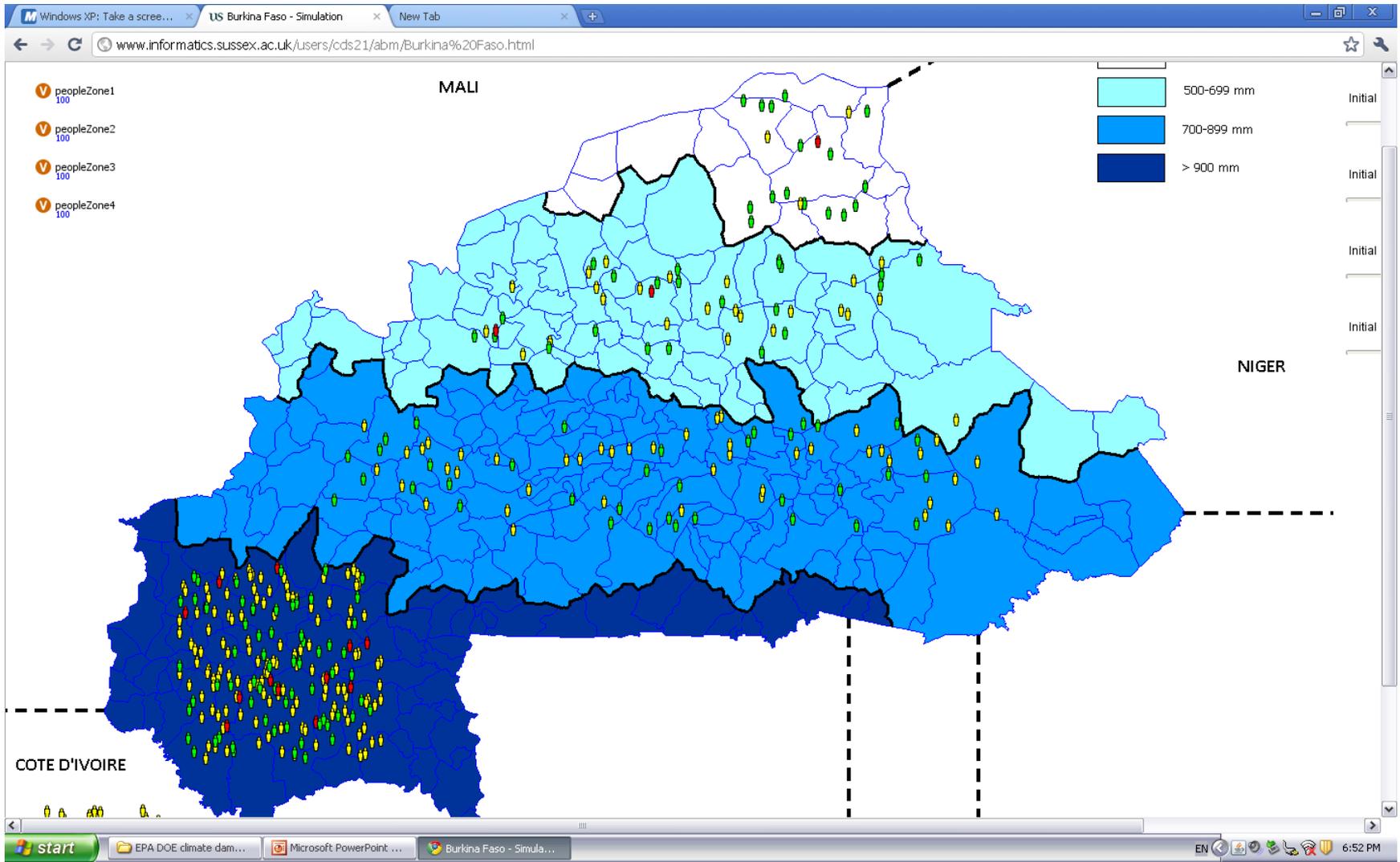
Other types of modeling

- Agent-based modeling
- Simulation modeling to attempt to replicate & then predict interactions (in this case between climatic stimuli & migration outcomes)
- Being used by group at U of Sussex to model drought migration in Burkina Faso

Kniveton, D. R., Schmidt-Verkerk, K., Smith, C., & Black, R. (2008). Climate change and migration: improving methodologies to estimate flows. Geneva: International Organization for Migration.

Agent-based model by Smith for Burkina Faso migration

<http://www.informatics.sussex.ac.uk/users/cds21/abm/>



Challenges & opportunities

Challenges

- Data availability, reliability
- No single global database
- Fragmented data for various regions, time periods
- Even where you have census data for population change/migration, reasons for migration often missing
- Proxy data: disaster displacements (not the best)

Challenges

- Understanding system linkages
- Role of intervening variables (e.g. perception, social networks, labour migration pressures/opportunities...)
- Uncertainty about future frequency/severity of migration-associated climatic stimuli

Opportunities

- To develop monitoring & data collection protocols
- To enhance empirical research into environment & migration linkages
- To develop & improve migration models as climate change models improve

Thanks! Merci!

Robert McLeman

Associate Professor



uOttawa

Département de géographie
Department of Geography

e-mail: rmcleman@uottawa.ca

web: <http://www.geography.uottawa.ca/prof/rmcleman.htm>