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Sandia National Laboratories

Global Futures: Demographic & Economic Divergence

Presented to Laboratories' Leadership Team (LLT) March 28, 2016

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Contributors: Sandia Center 100, Senior Scientists and Engineers

U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

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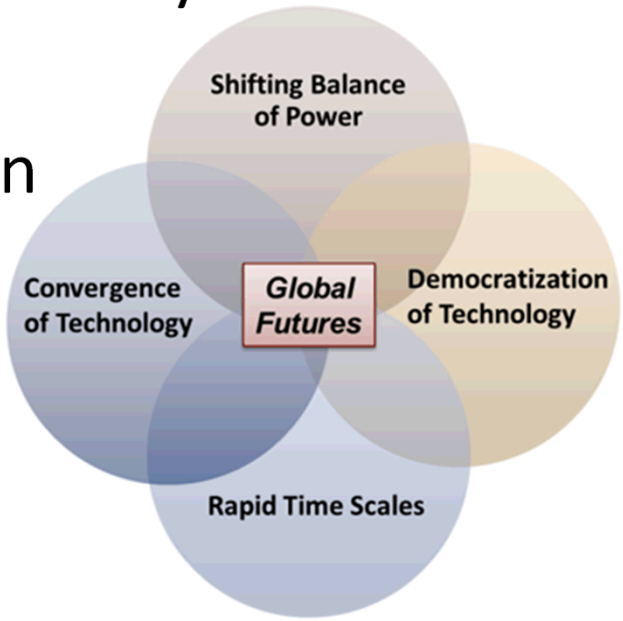
Characterization of the System

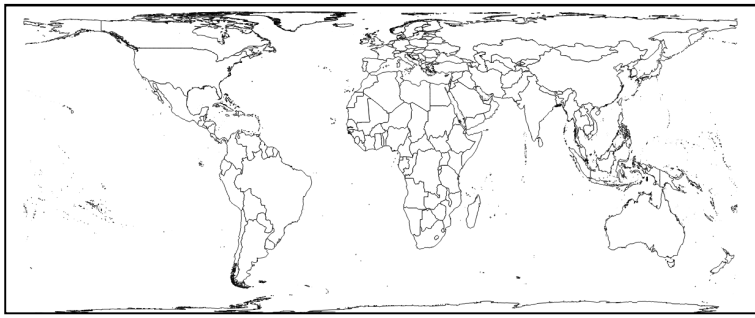
- National Security from lens of protecting lives and material wellbeing
  - Population ⇨ Lives
  - Gross Domestic Product (GDP) ⇨ Material Wellbeing
- Divergence of global population and GDP dynamics dominate future national security
- The interdependence of these two can create instabilities and risks addressable via complexity-science



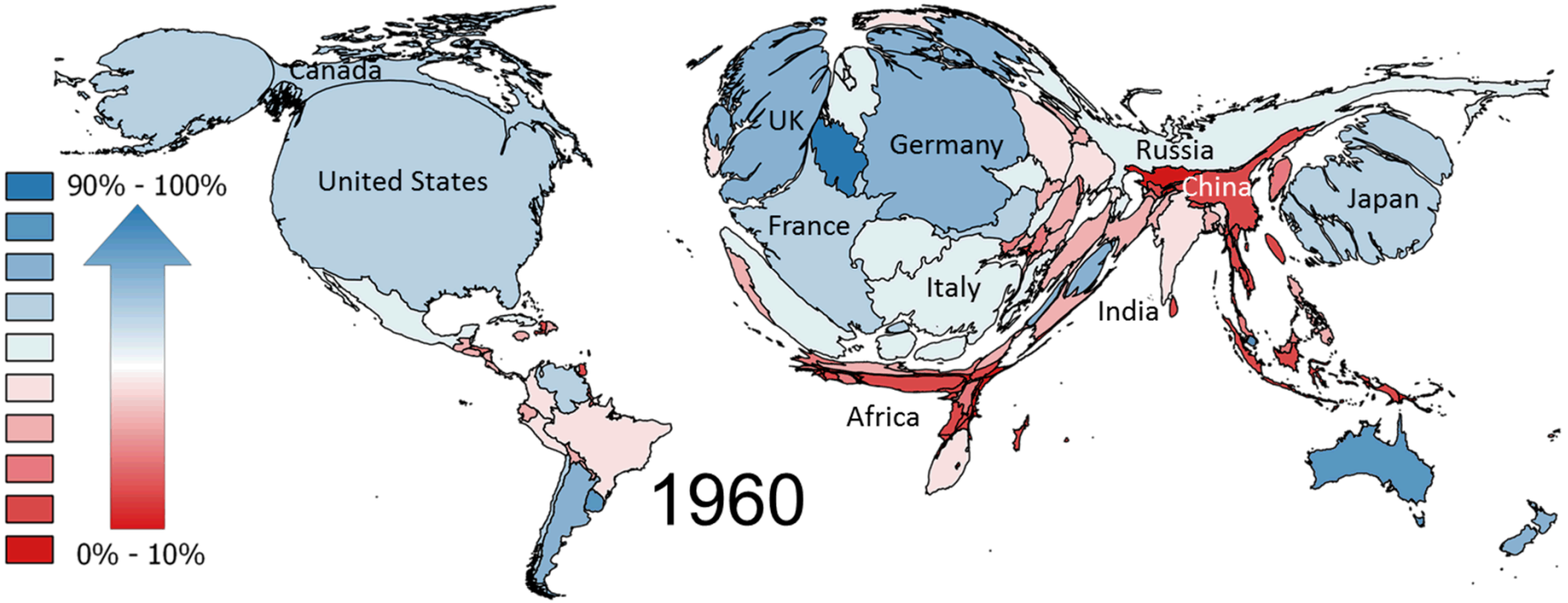
Approach

- Considered the same data and estimates (1960-2050) that inform domestic and international policy
- All optimistically assume world
  1) converges to Western Fertility Rates (Future of 1.85 vs 7.6)
  2) converges to Western Quality of Life (Industrialized)
- Explored additional effects of technology transition & urbanization on optimistic assumptions
- Evaluated robustness of results

Sources and background in slide notes

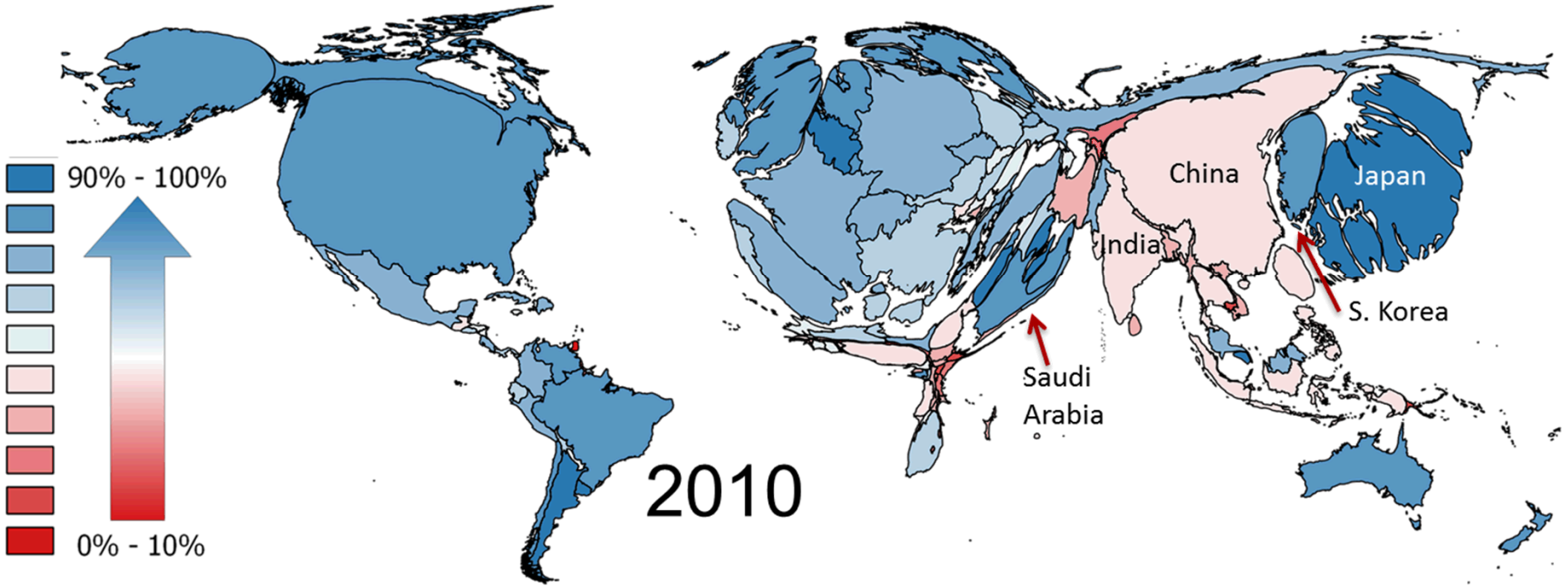


GDP (size) & Urban Percentage (color)



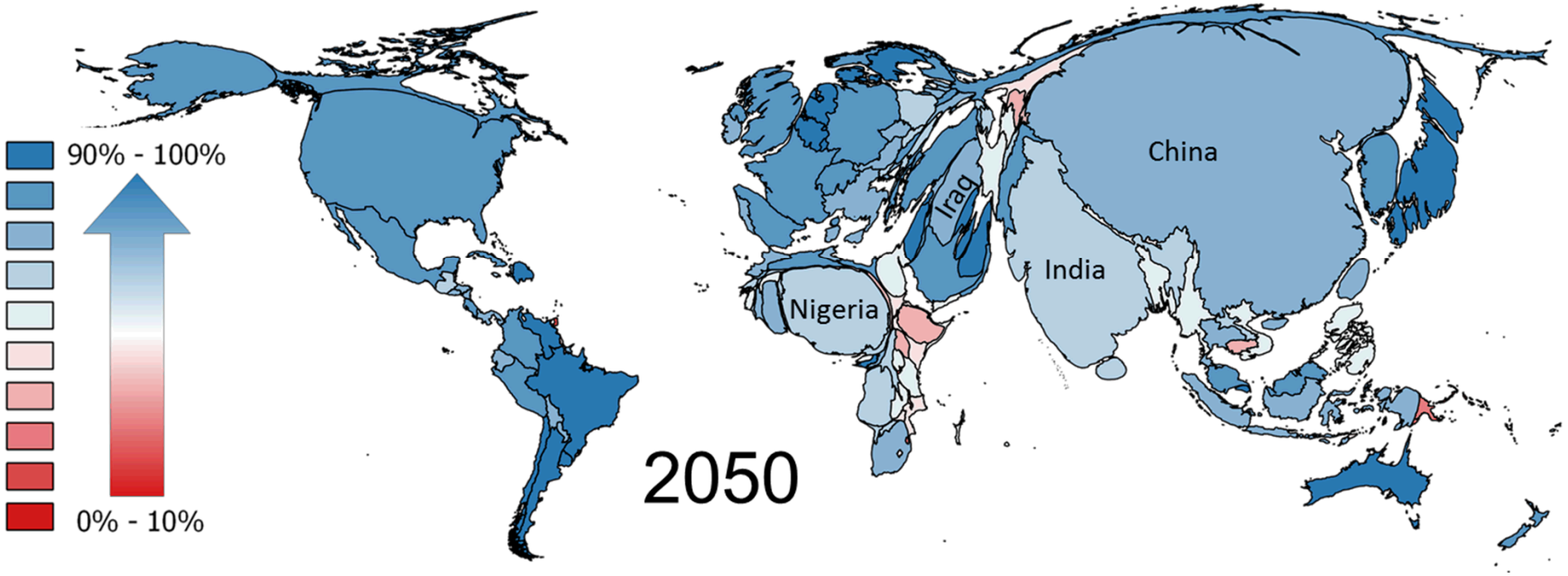
- Urbanized, developed countries dominate the map
- Urbanization from industrialization, workers pulled into the city for jobs
- Most urban areas are ports or centers of (international) trade

GDP (size) & Urban Percentage (color)



- Globally increased urban percentage, but GDP growth lags
- China, S. Korea, & Japan industrialize
- “Blue” Africa economies reflect oil “development”

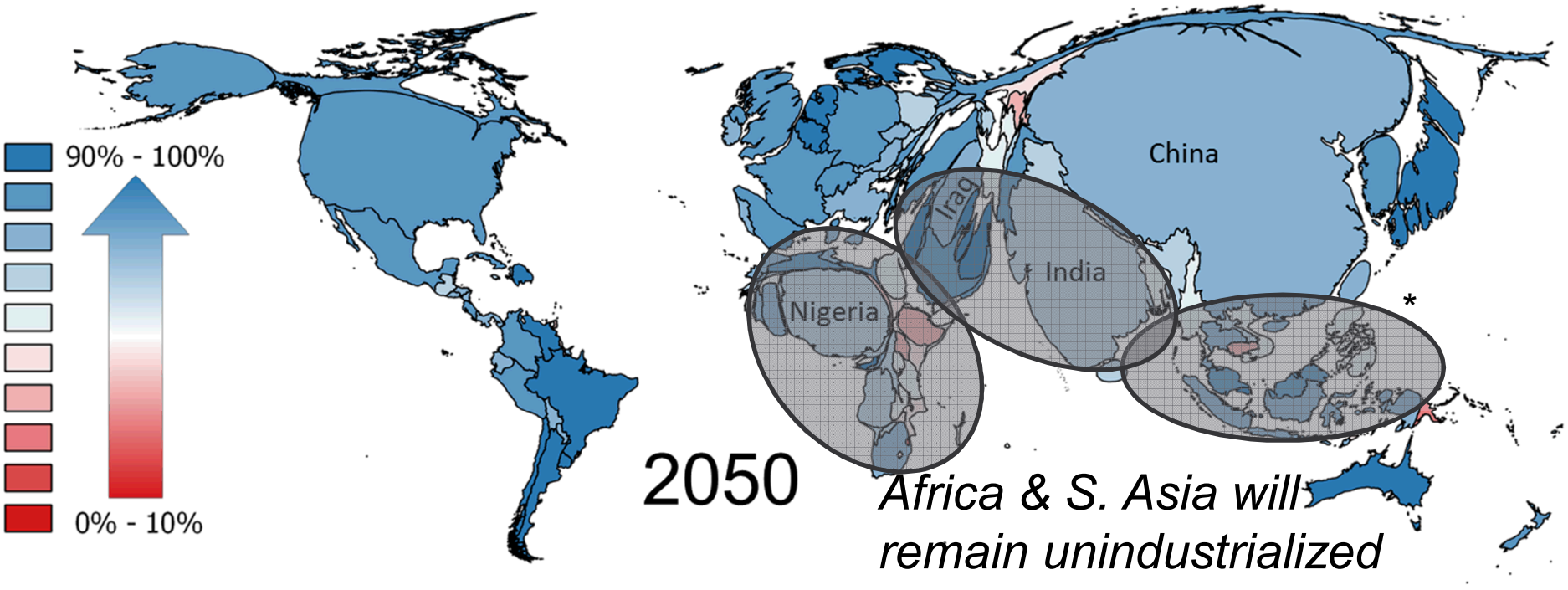
GDP (size) & Urban Percentage (color)



Forecast optimistically assumes continued global industrialization

- Used for policy

GDP (size) & Urban Percentage (color)

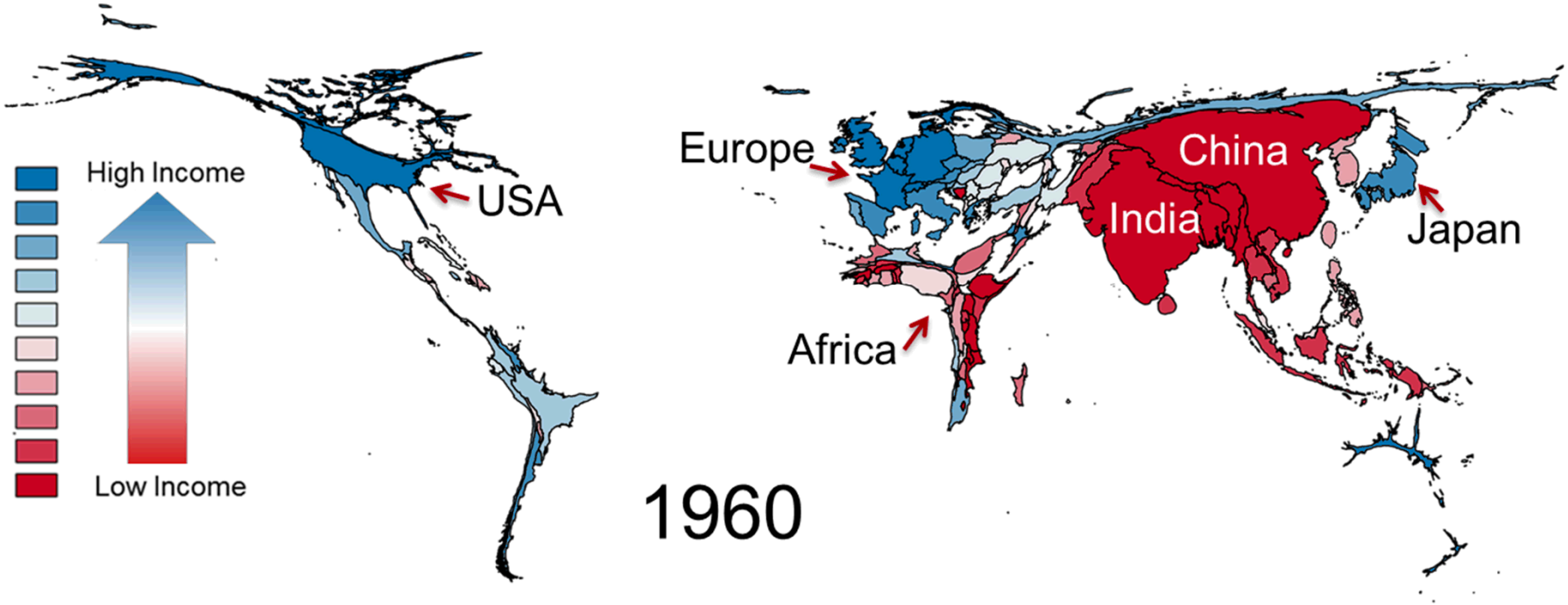


Adding missing effects:

- Intelligent machines thwart spreading industrialization
- Urbanization: Population pushed out of rural areas & into urban slums
- Developed world depends on the resources & strategic supply chains captured by these megacity ports

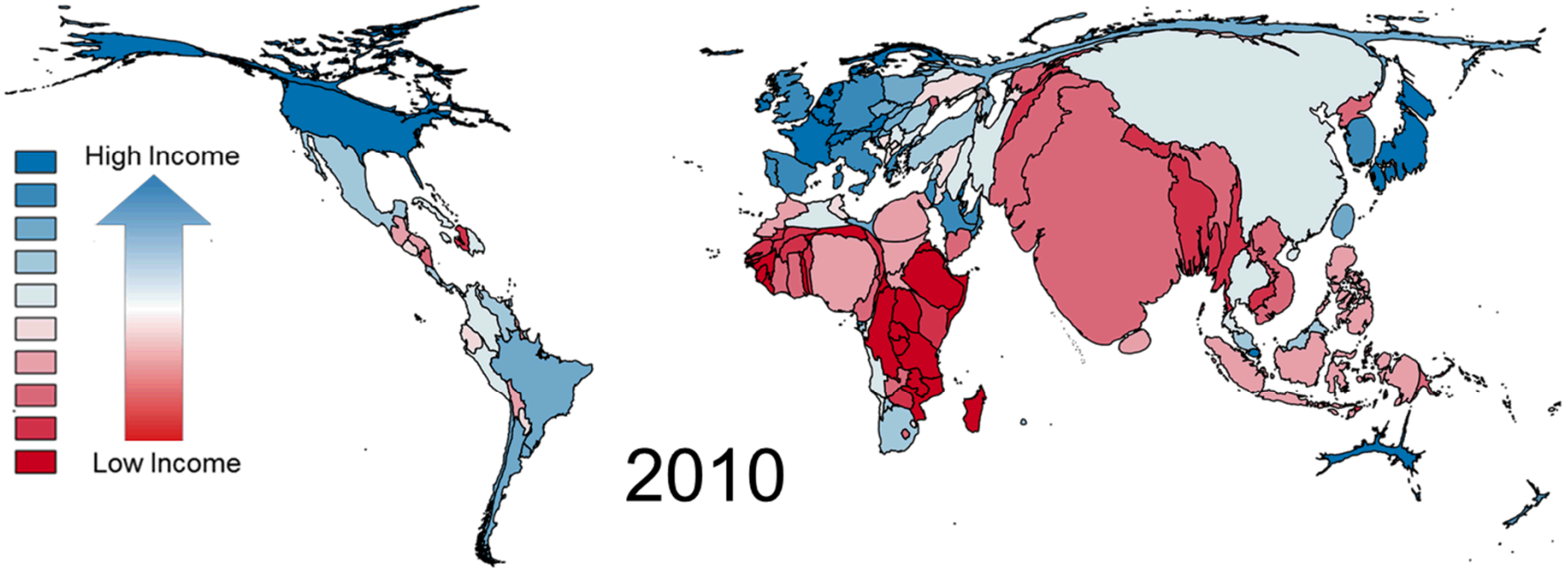
*The grey-out areas, covering the default forecast, indicate where the GDP is likely overestimated.

Population (size) & GDP Per Capita (color)



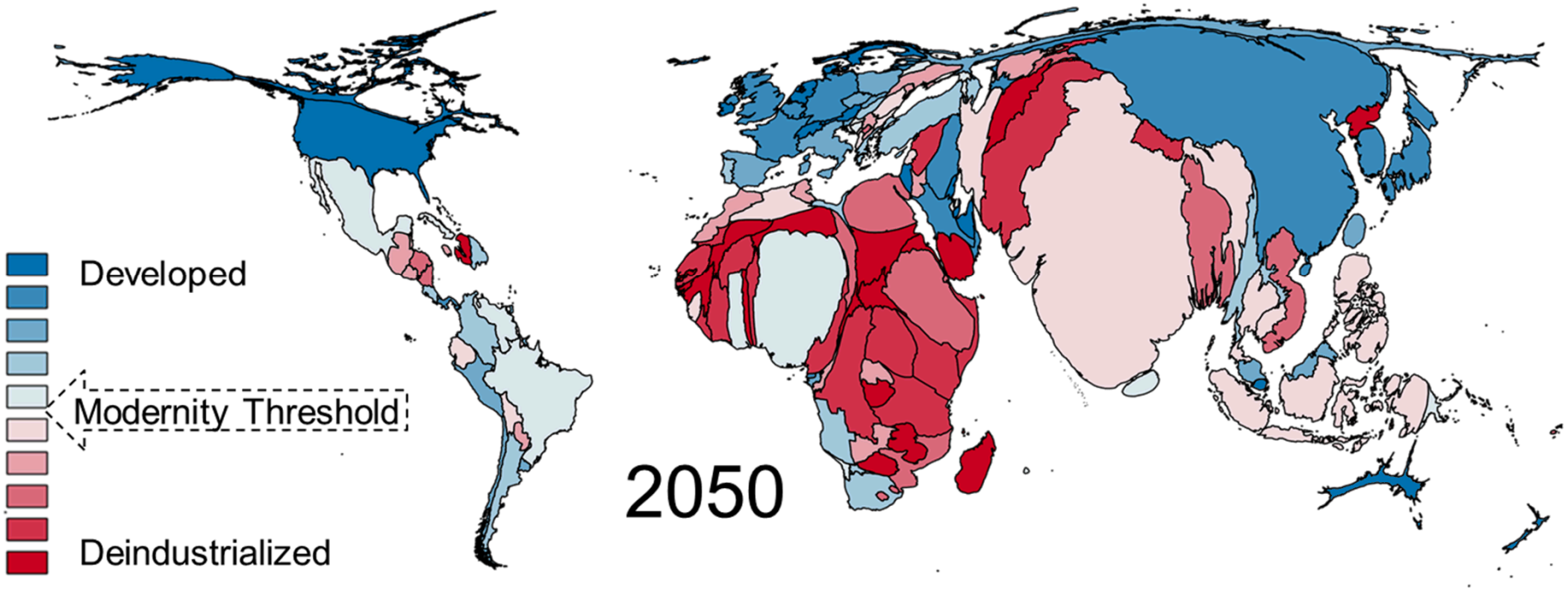
- Developed and developing world have comparable populations
- Color pattern looks like the previous 1960 map...

Population (size) & GDP Per Capita (color)



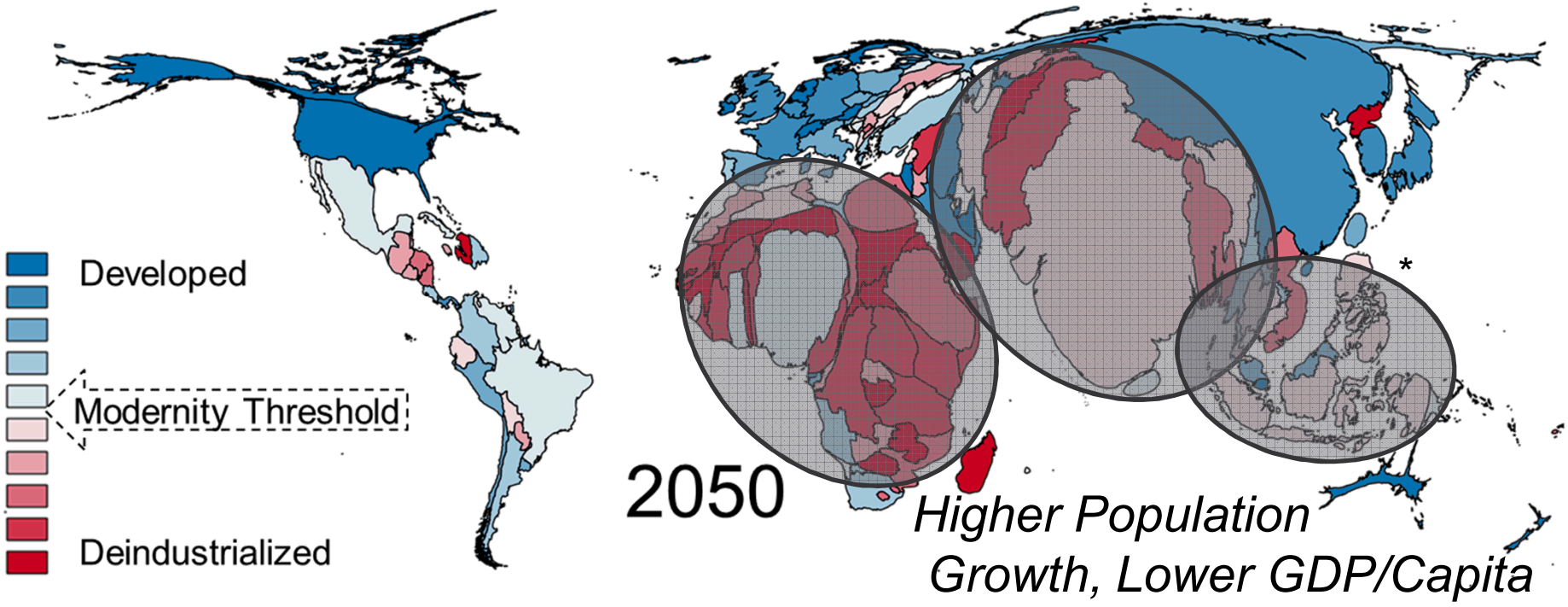
- The global population centroid is moving South and East
- China is improving, but data show no convergence in GDP/Capita for Africa and Southern Asia to industrialized levels

Population (size) & GDP Per Capita (color)



The US/Europe each have about 400M people, and globally, 8 billion unskilled, unemployed people under stress

Population (size) & GDP Per Capita (color)

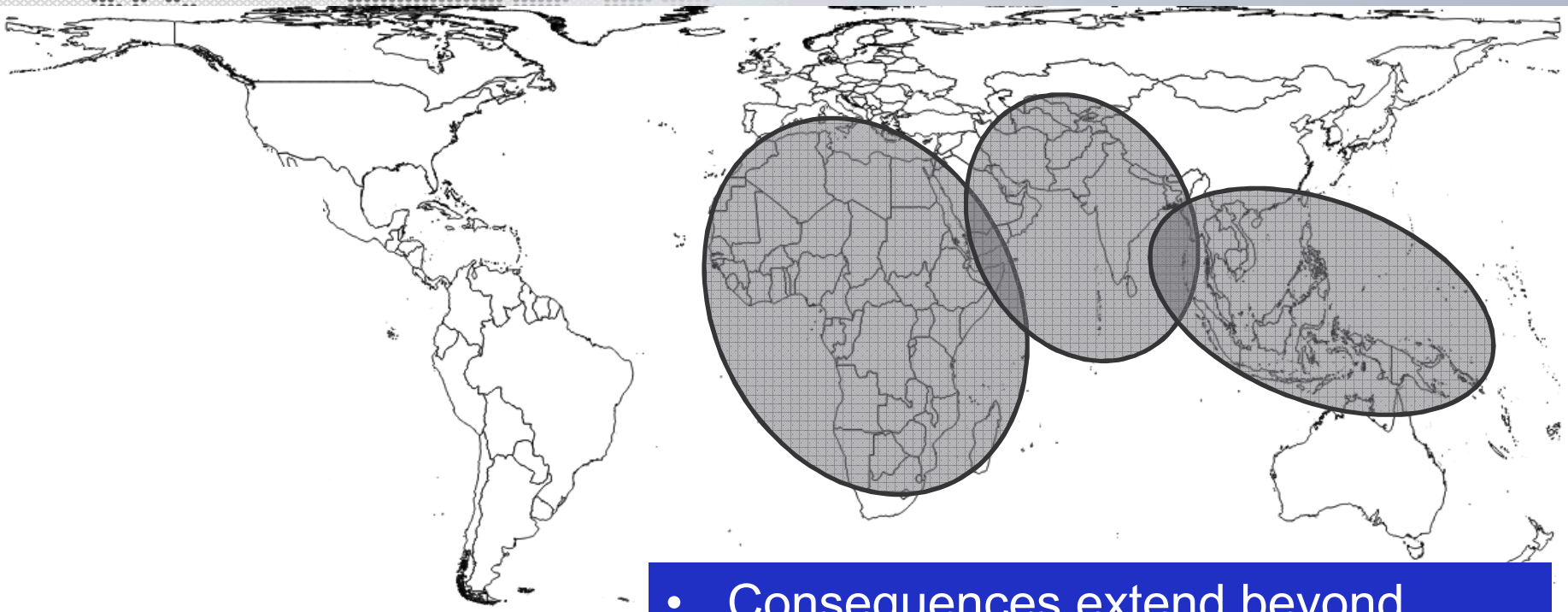


Adding missing effects:

- Developed countries challenged by influx of unskilled population
- World depends on stressed areas for resources & to manage migration
- U.S./Allies face persistent conflict & need to ensure global supply chains

*The grey-out areas, covering the default forecast, indicate where the population is likely underestimated.

Confluence of Stresses



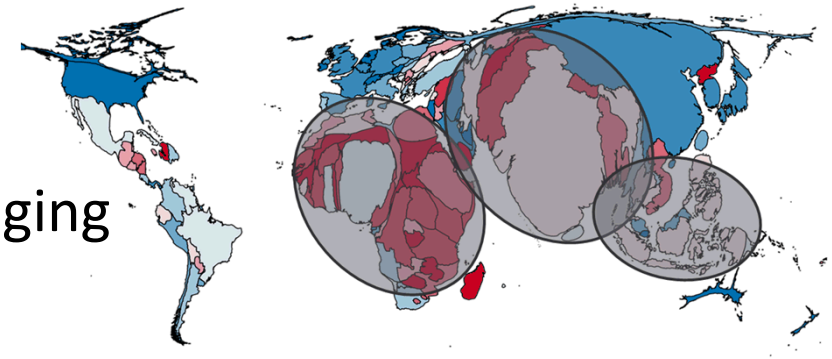
- Consequences extend beyond Africa and Southern Asia
- Not apocalyptic, just complex, requiring complexity-based security

Regions Under Stress:

- Deindustrialization
- Population
- Climate Change (up to 50% reduced food/water)

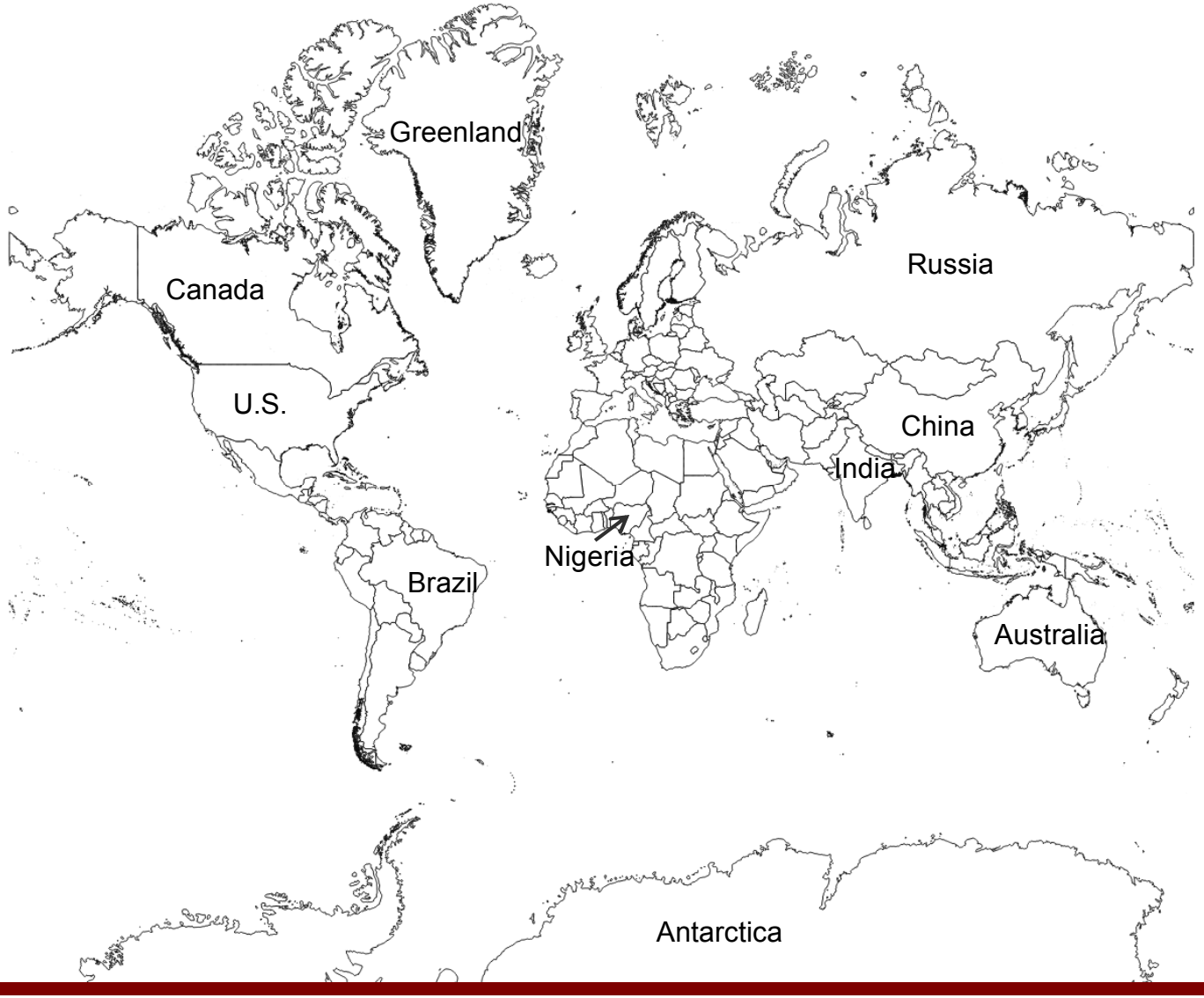
Potential Security Issues

- *Resources:* U.S. and China must protect same resources & supply-chains in Africa & Southern Asia
- *Roles:* Russia, Europe, U.S., have diminished global influence
- *Migration:* Magnitude is unprecedented
- *Proliferation/Deterrence:* Challenges to assurances of U.S. Nuclear Umbrella
- *Instability:* Cascading tensions increase potential for conflict, including tactical NW escalation
- *Alliances:* Benefits, values, and motivations are complex and changing

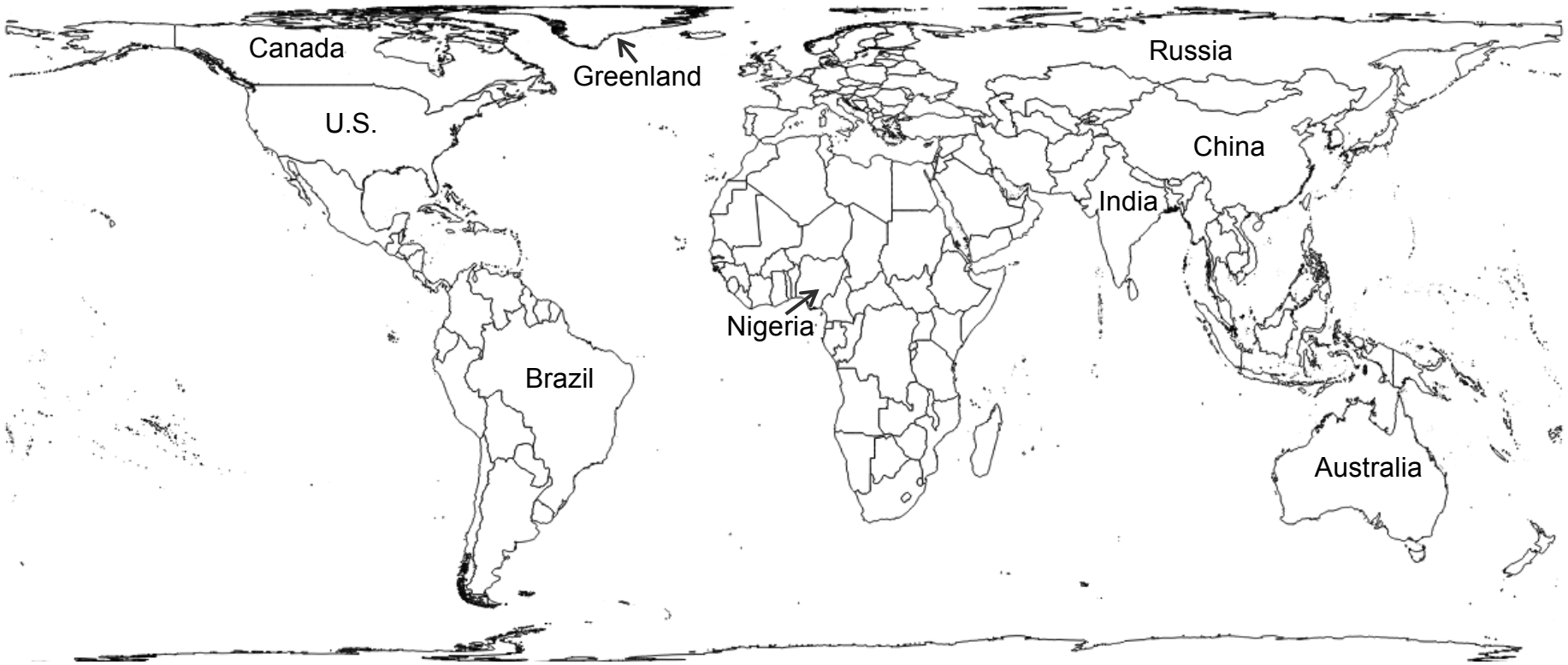


BACKUP SLIDES

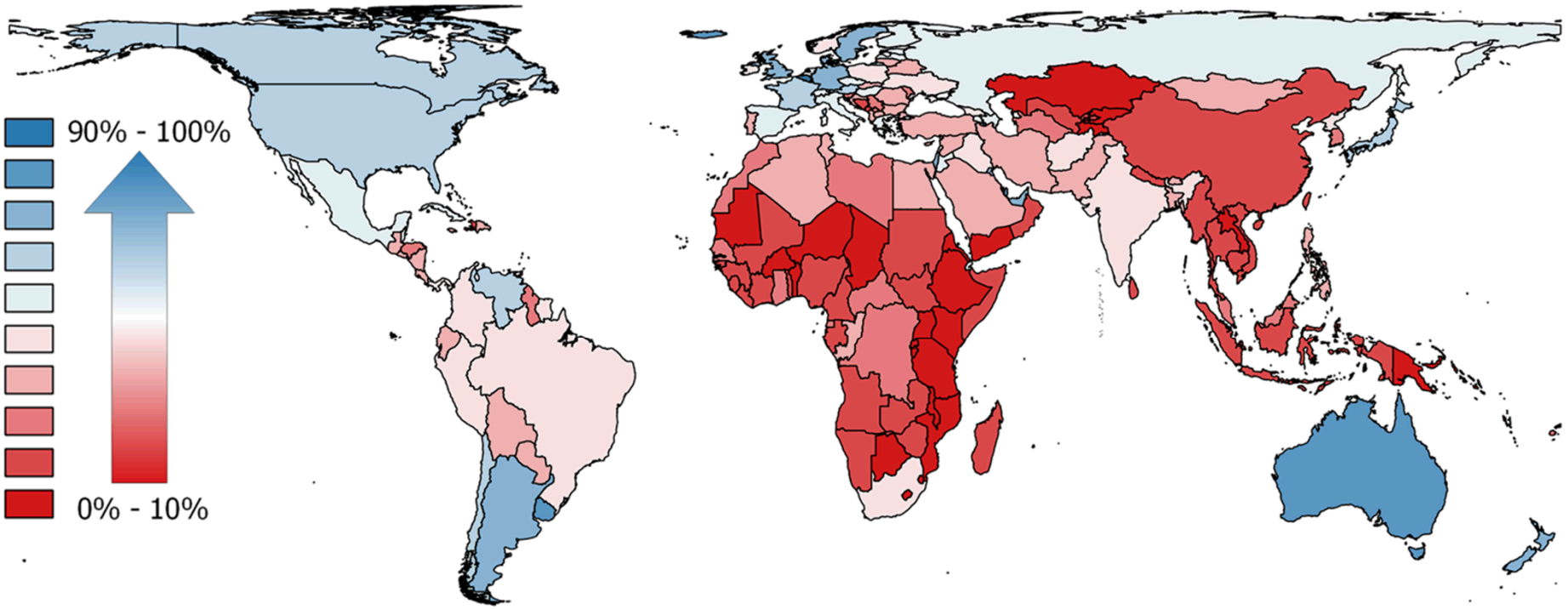
World Map: Mercator (shape)



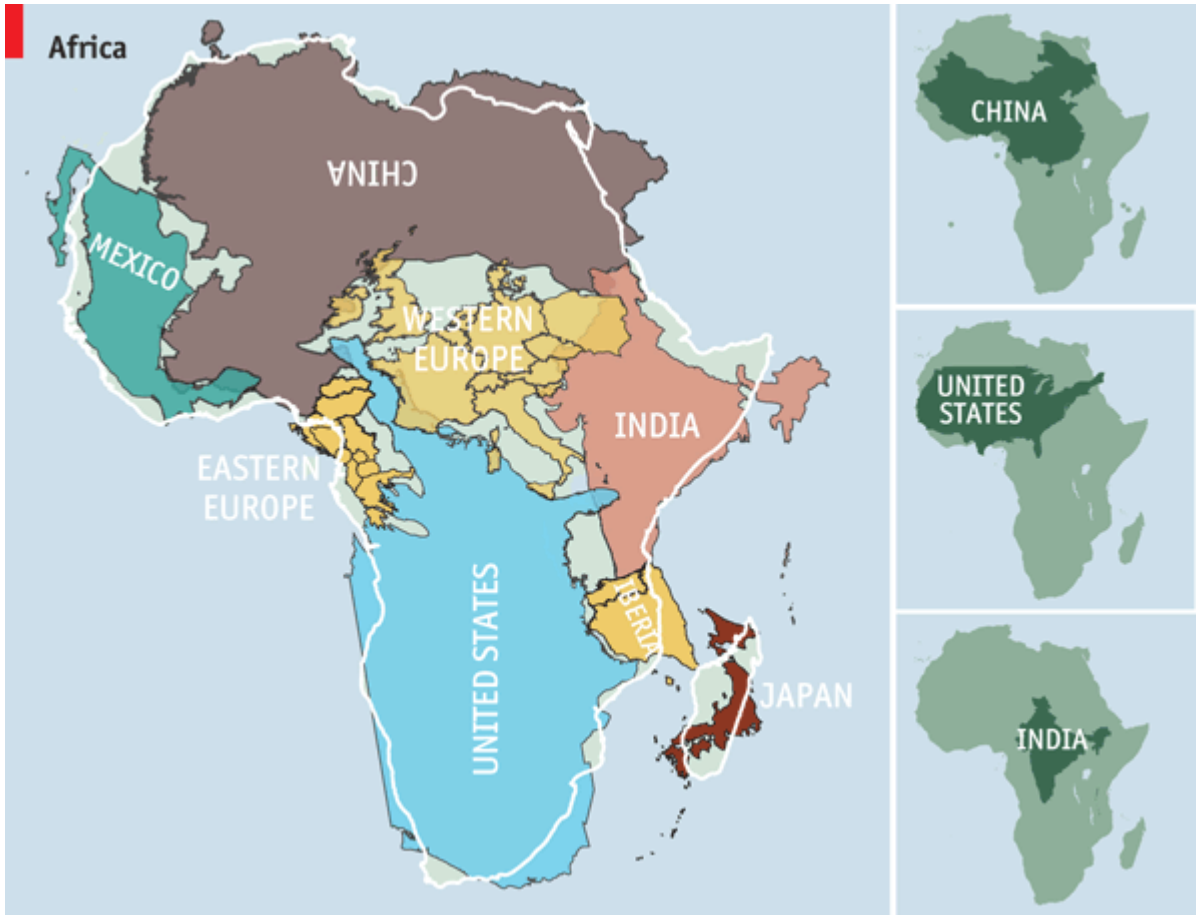
World Map: Relative Area (size)



World Map: Area (size) & Urbanization (color)



Africa is Big



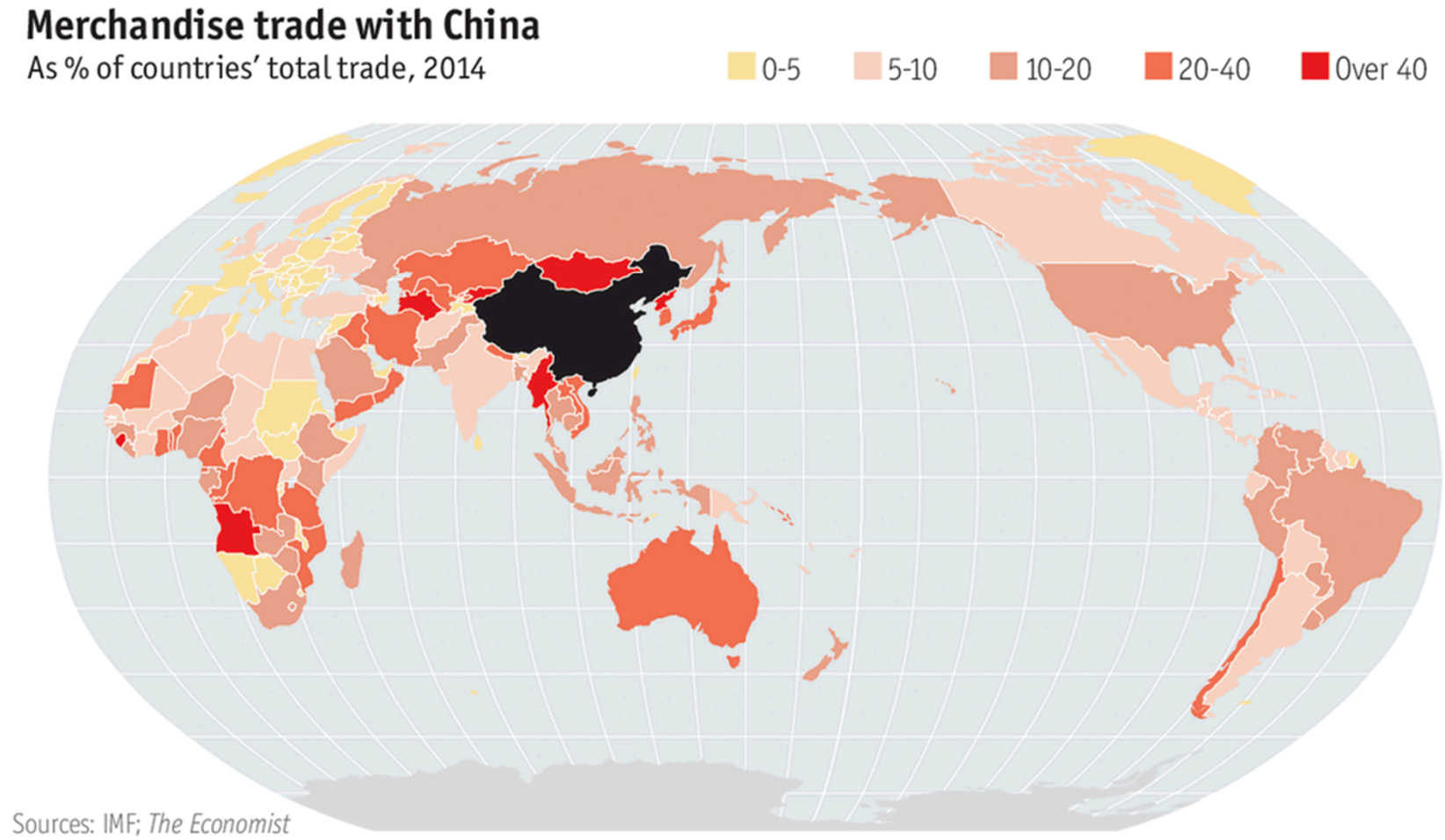
Instances of Divergence between Neighbors

Economic Growth

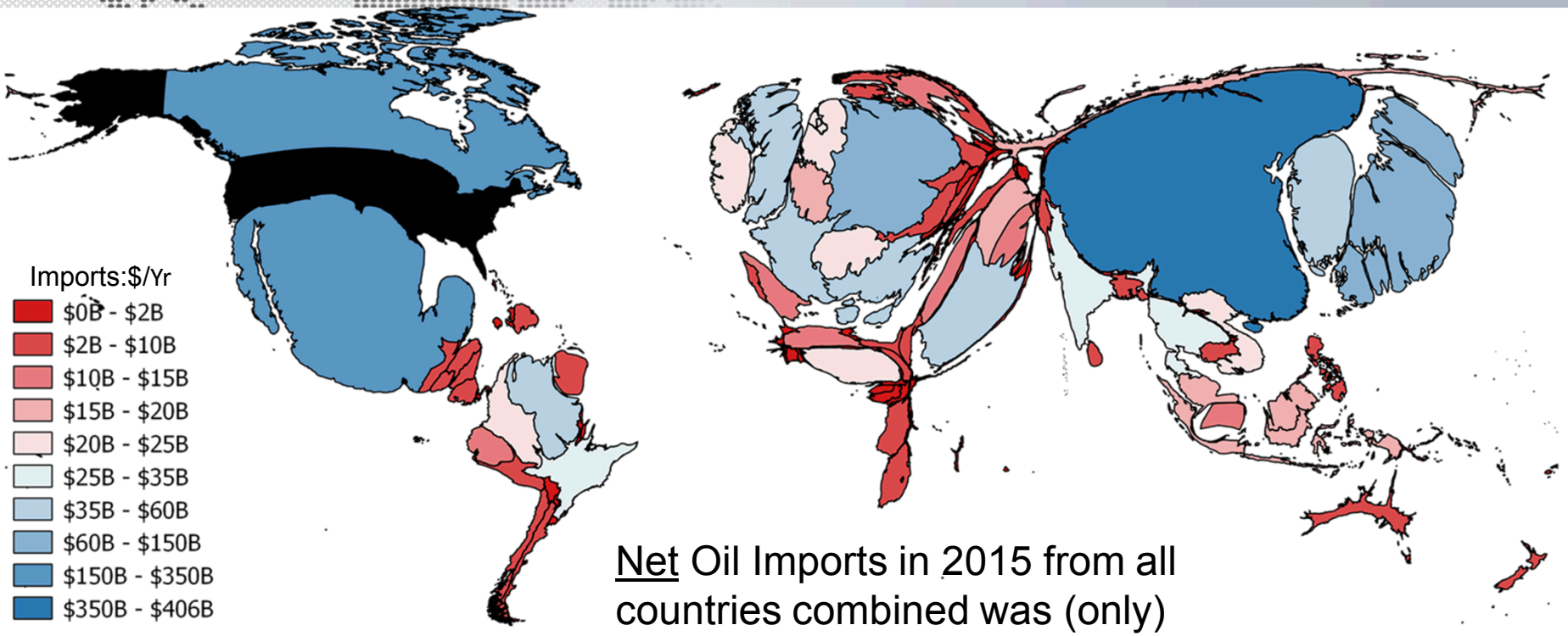
Fast Country	Growth	Slow Country	Growth	2014-2044 Growth Difference
Mozambique	600%	Swaziland	103%	497%
Cambodia	654%	Thailand	203%	451%
Ethiopia	511%	Somalia	77%	434%
Kenya	477%	Somalia	77%	400%
Mozambique	600%	Botswana	204%	397%
Ethiopia	511%	Yemen	133%	378%
Ethiopia	511%	Sudan	149%	362%
Mozambique	600%	Zimbabwe	257%	343%
Cambodia	654%	Myanmar	321%	333%
Mozambique	600%	South Africa	280%	321%

Trade Entrainment (Global Interdependency)

Trade dependency is vital to economic health & the key threat to it.

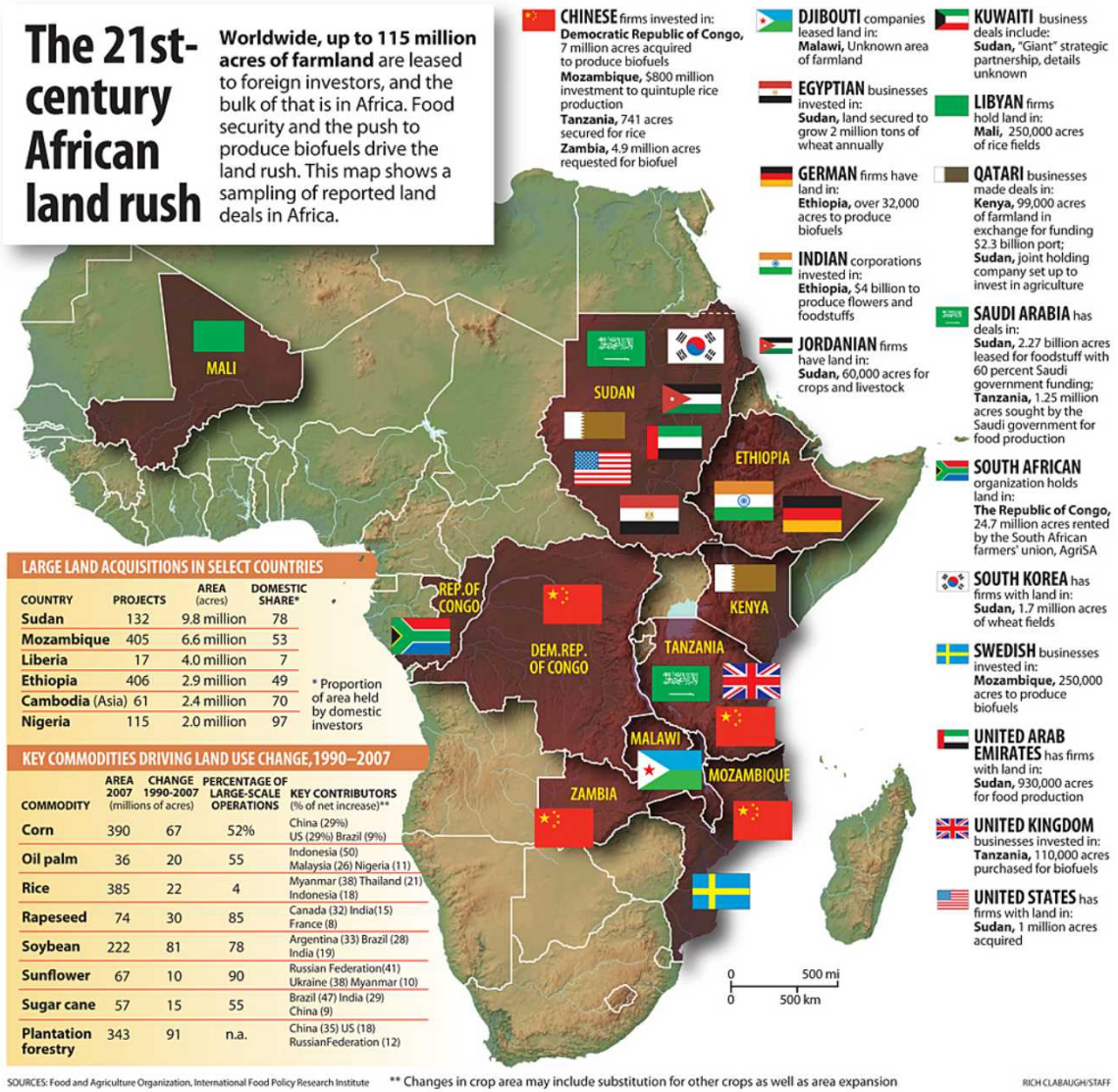


U.S. Imports

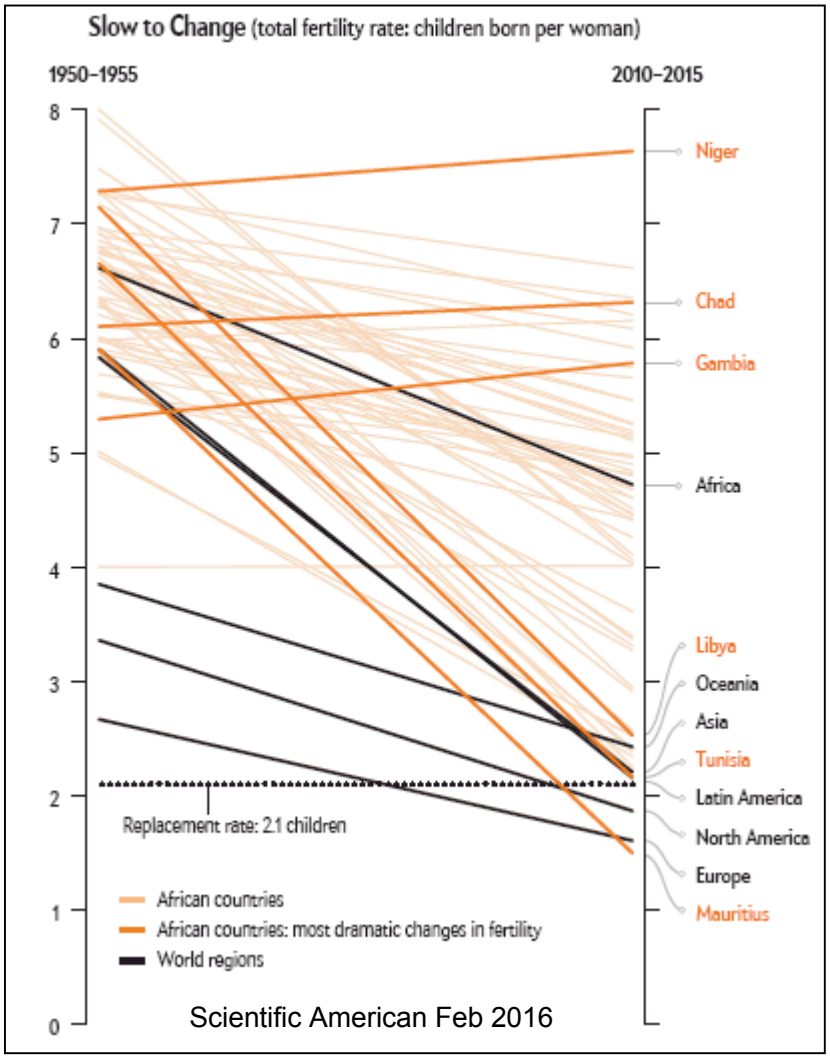


Net Oil Imports in 2015 from all countries combined was (only) $65B/Yr. Several countries embody $15B/Yr of critical resources (titanium, chrome, platinum, uranium).

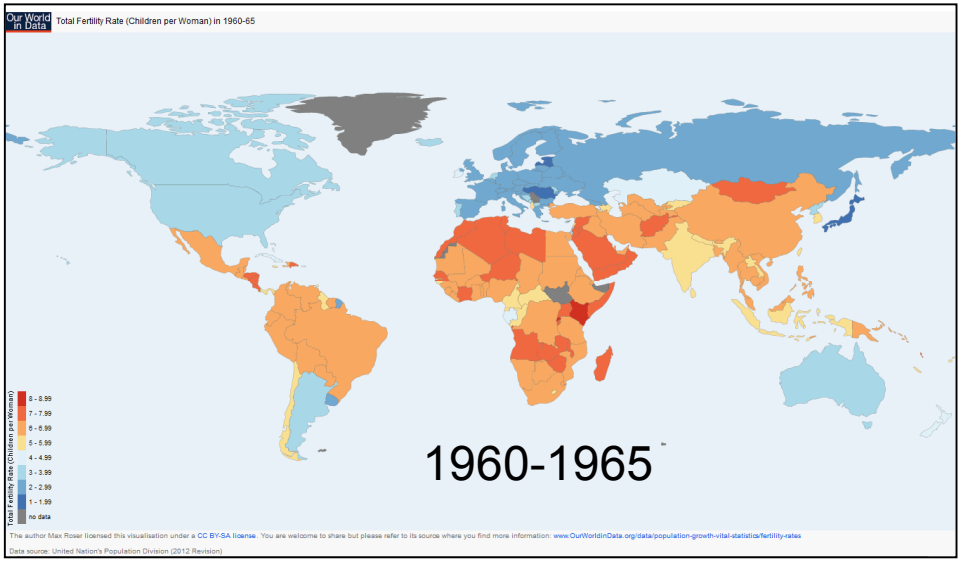
Foreign Investment in Africa's Resources

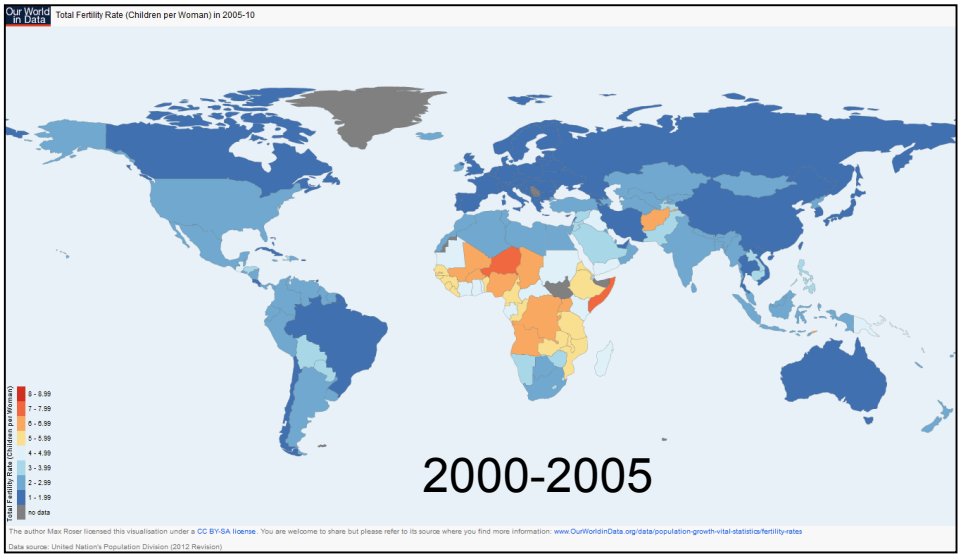


Global Fertility Rates

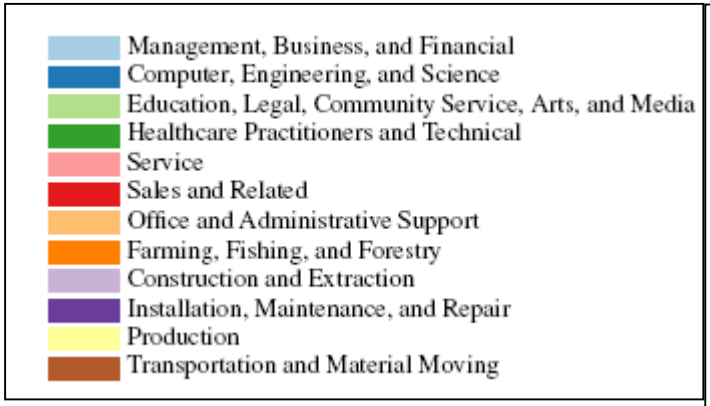


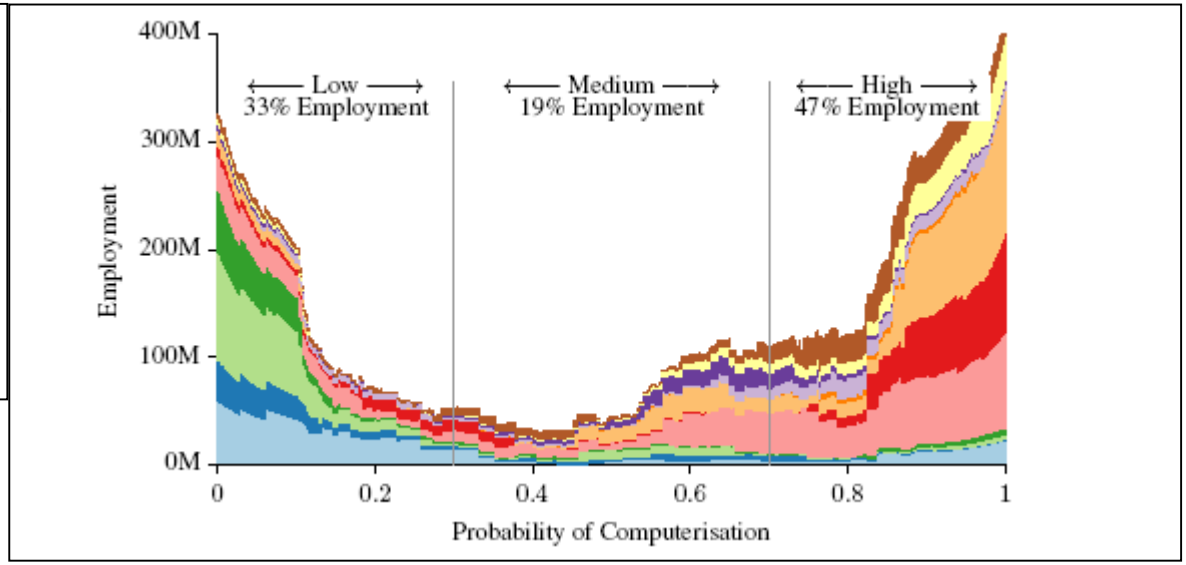
Scientific American Feb 2016



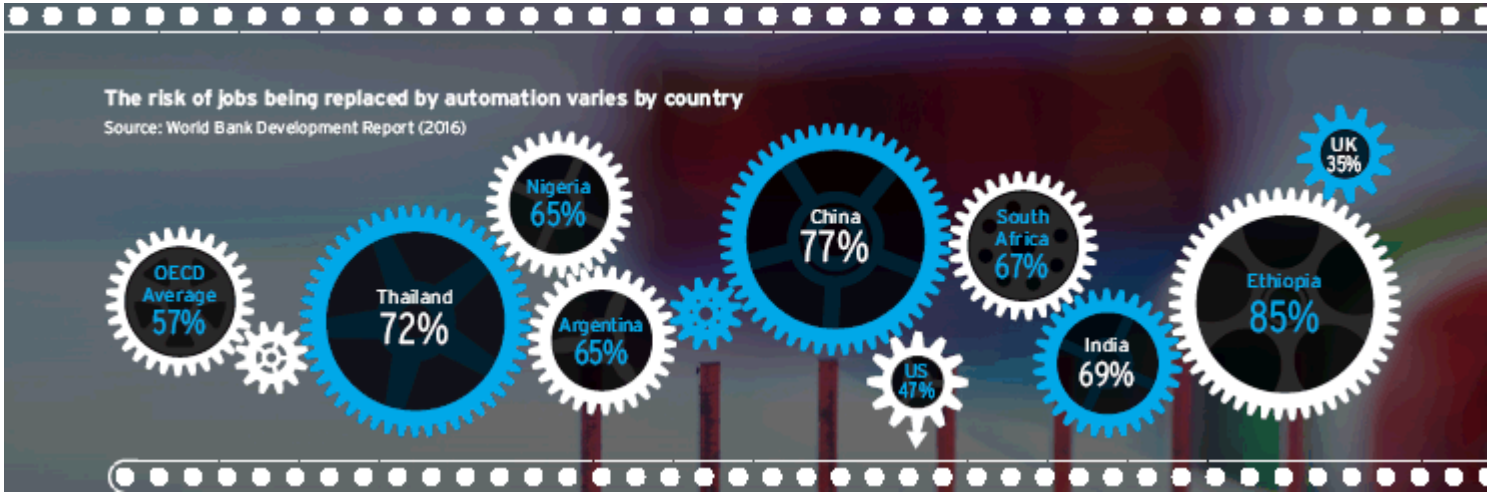


Job-type loss over the next decade



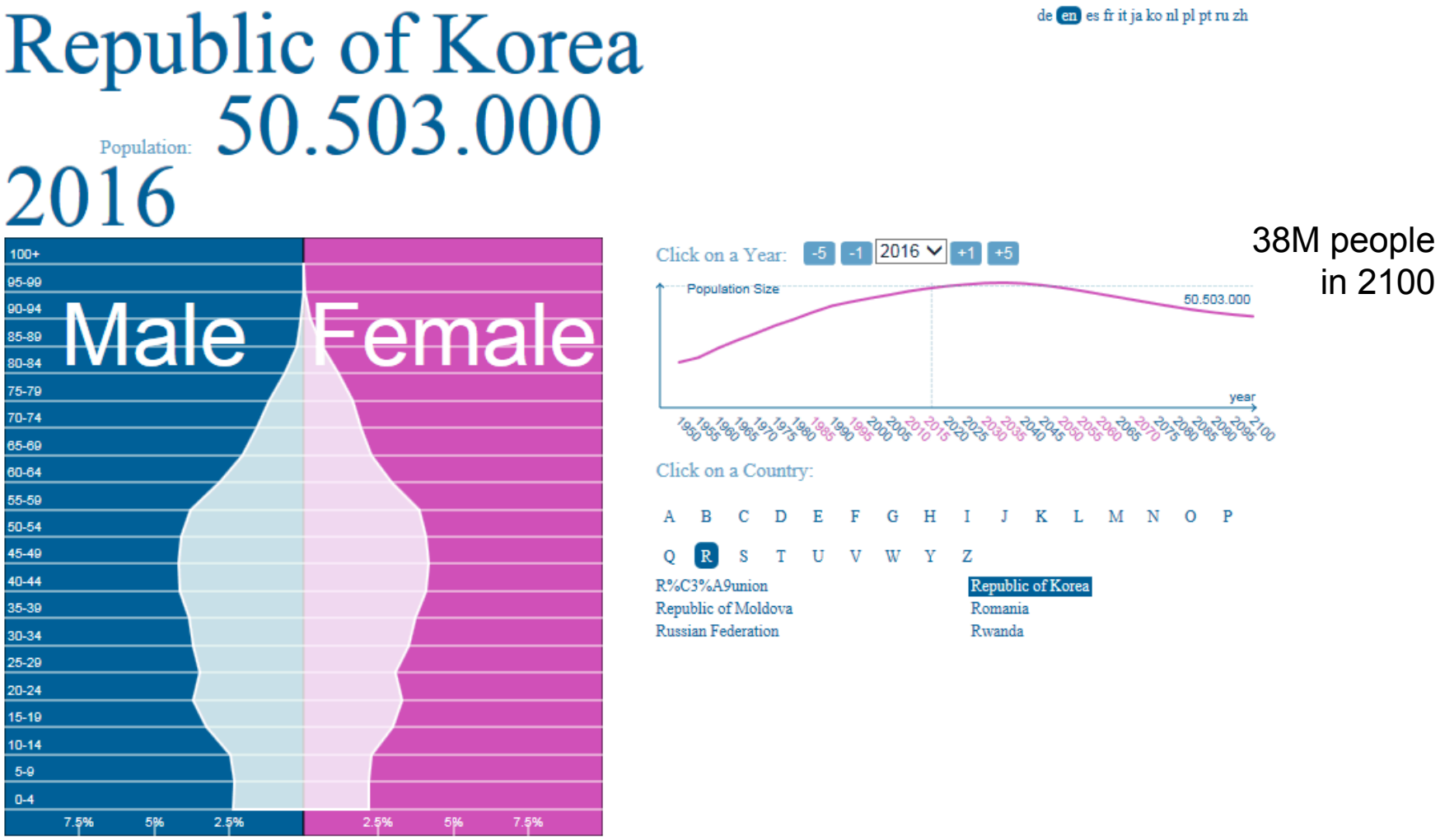


The Future of Employment, 2013



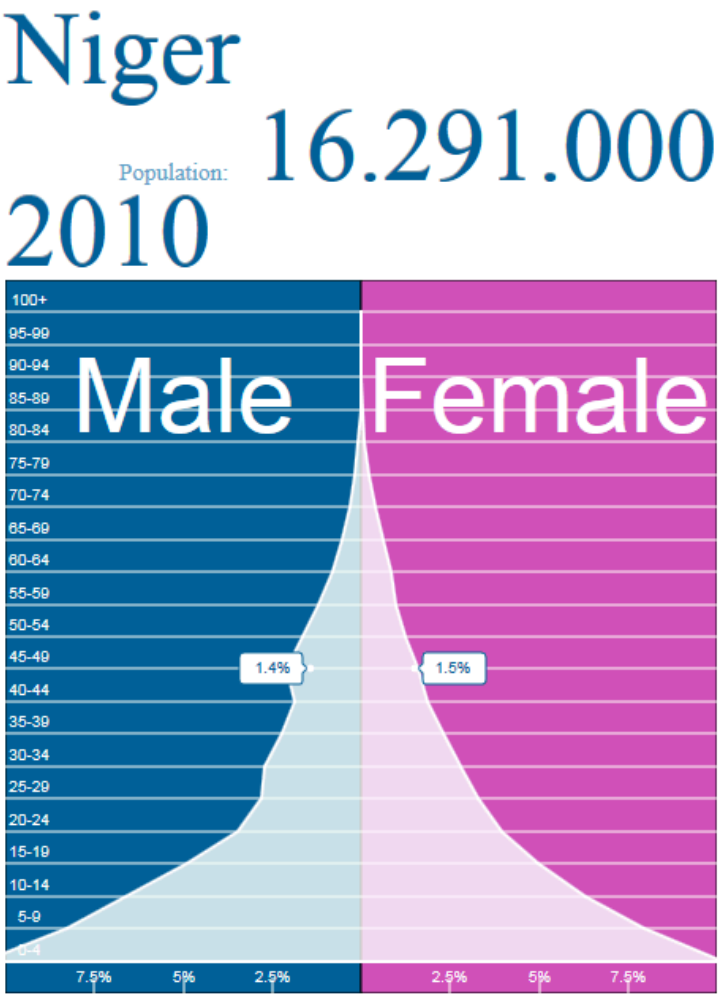
Technology at Work v2.0. 2016

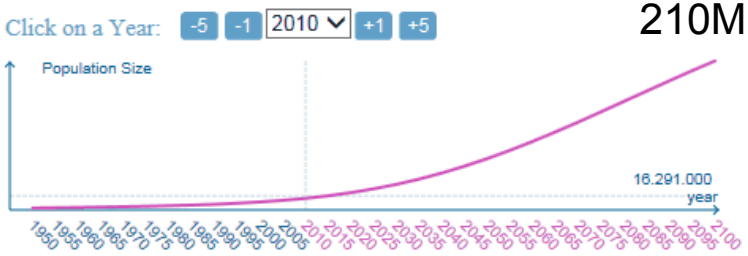
Population Pyramid: South Korea



38M people in 2100

Population Pyramid: Niger





210M people in 2100

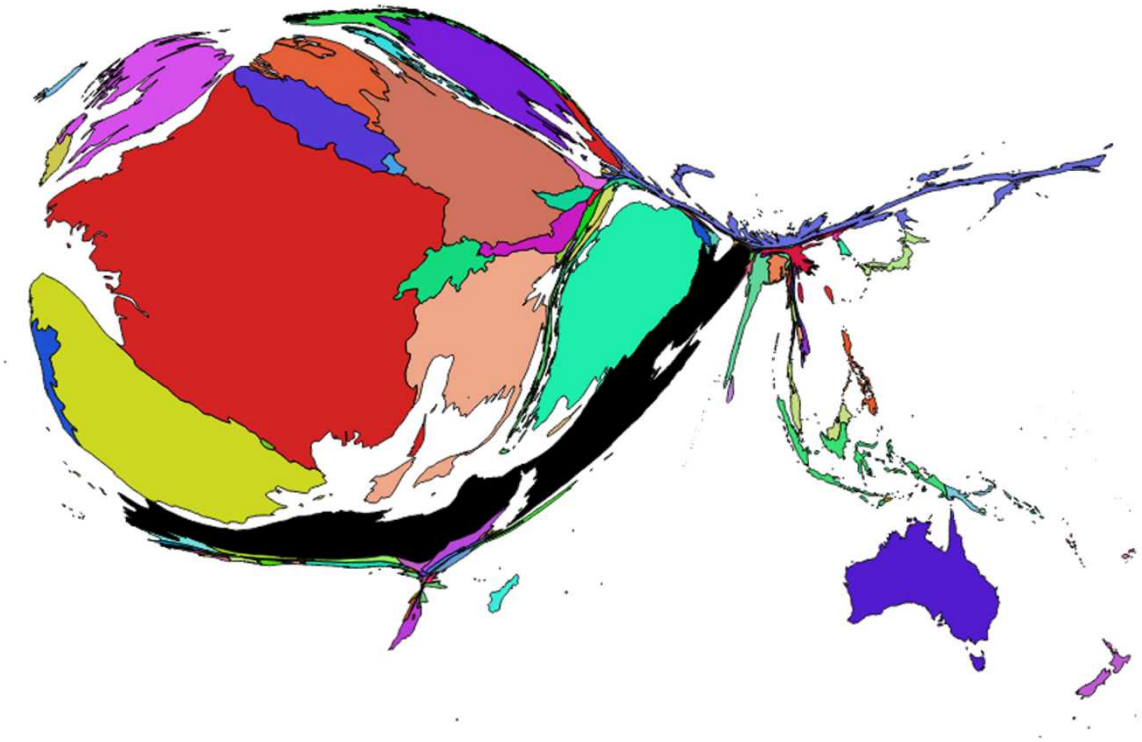
Click on a Country:

A B C D E F G H I J K L M N O P

Q R S T U V W Y Z

Namibia
Netherlands
New Zealand
Niger
Northern Africa
Northern Europe
Nepal
New Caledonia
Nicaragua
Nigeria
NORTHERN AMERICA
Norway

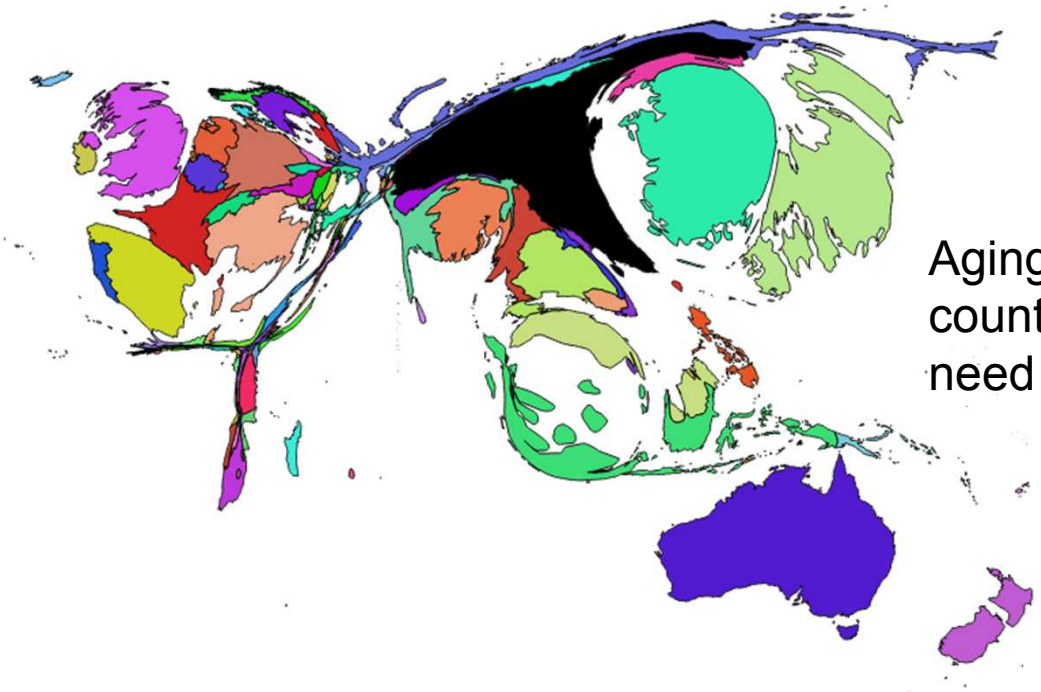
Middle East/N. Africa Out-migrants (Eastern Hemisphere) -- 2013



Aging, developed countries easily overwhelmed by unskilled immigrants.

The migrants are largely unskilled and provide
<< 1.0 benefit per person to skilled host countries.
10.2M total out-migrants (France: 2.9M)

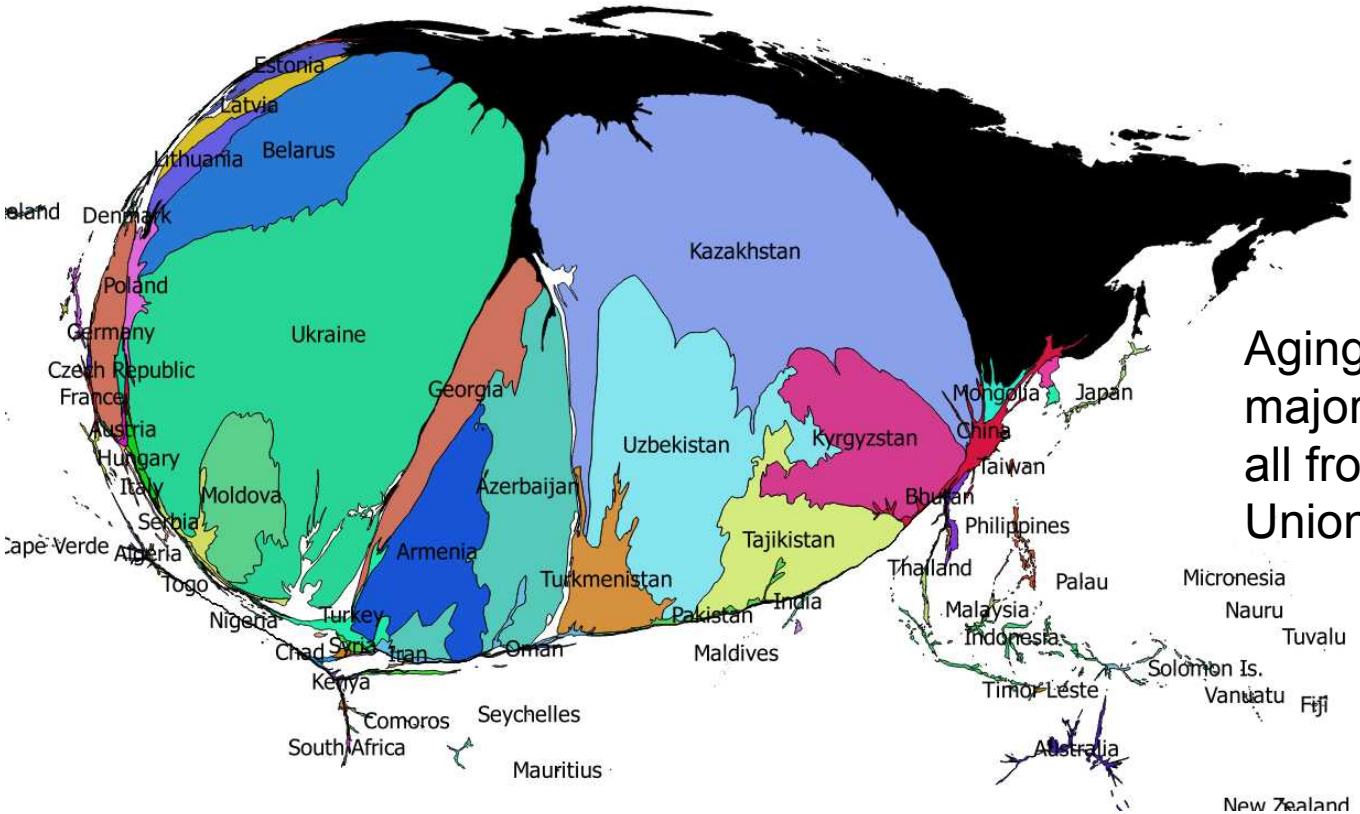
China Out-migrants -- 2013 (Eastern Hemisphere)



Aging developed countries desperately need skilled immigrants.

Chinese emigrants are highly skilled and provide
>100 benefit per person to low-skilled host countries;
>1.0 benefit to skilled host countries.
10.6M total out-migrants (Indonesia 63K)

Russia In-migrants -- 2013

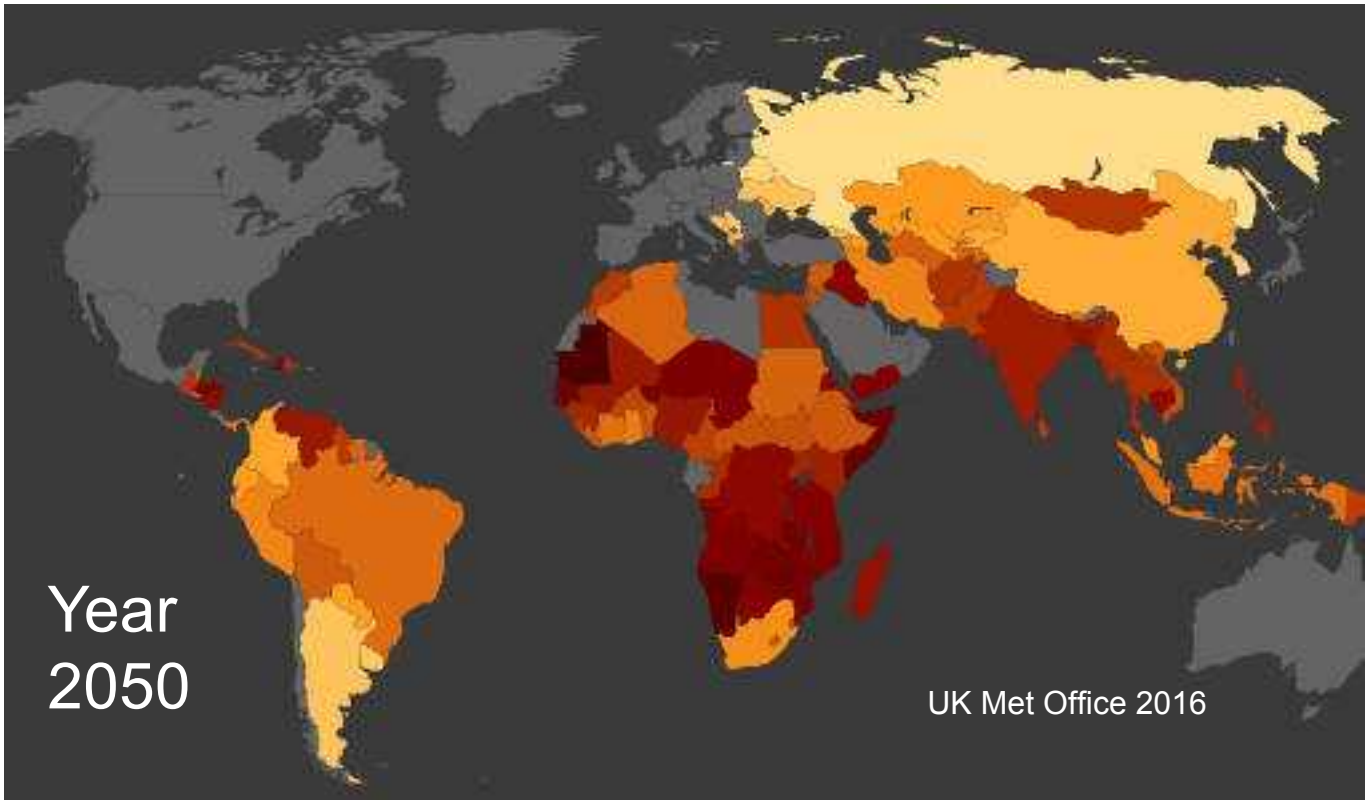


Aging Russia faces major ethnic transition, all from Former Soviet Union migration

11.0M total in-migrants (Ukraine: 2.9M)

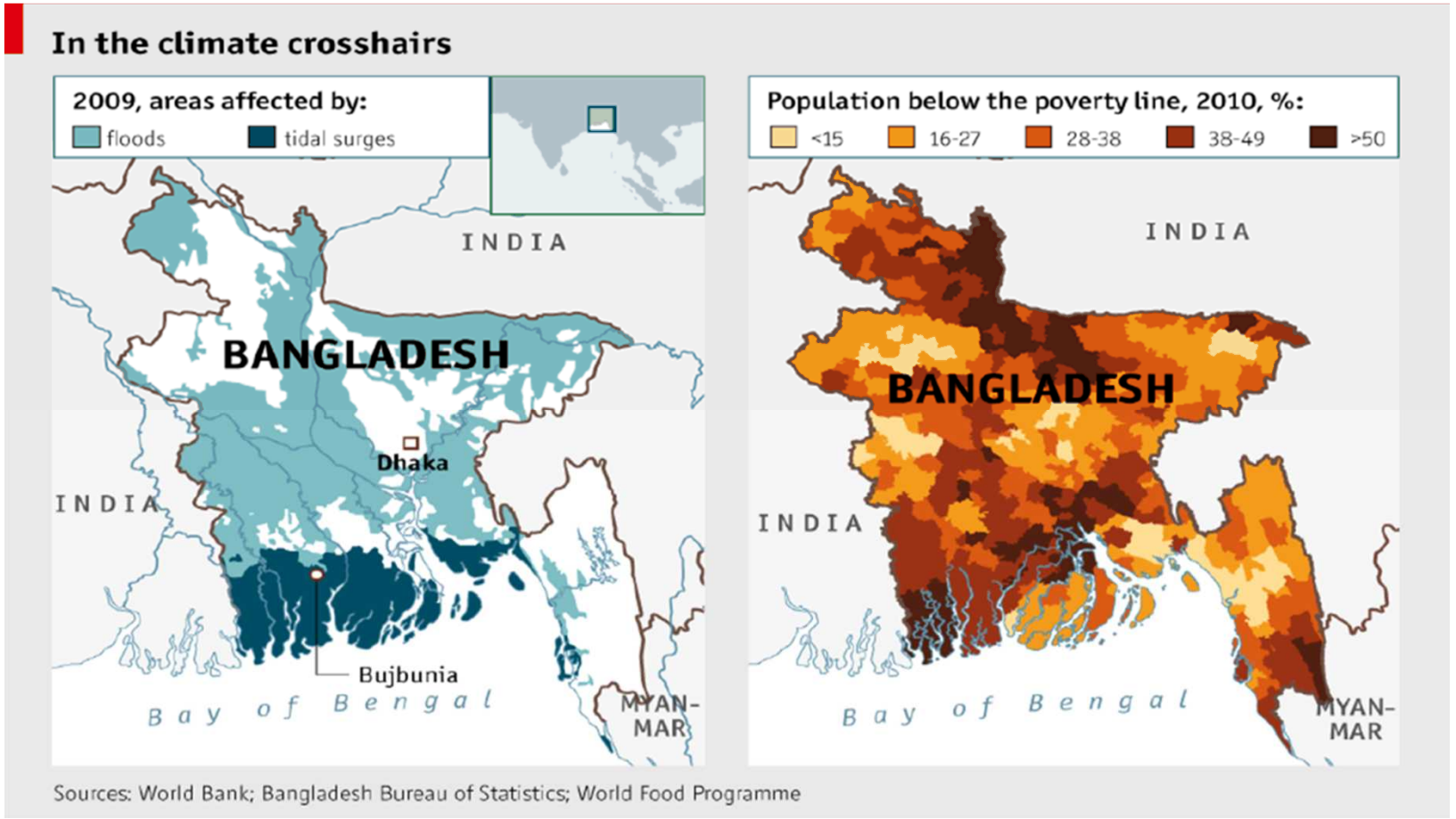
Food/Water Disruptions & Climate Change

The population and economic projections ignore everything else.

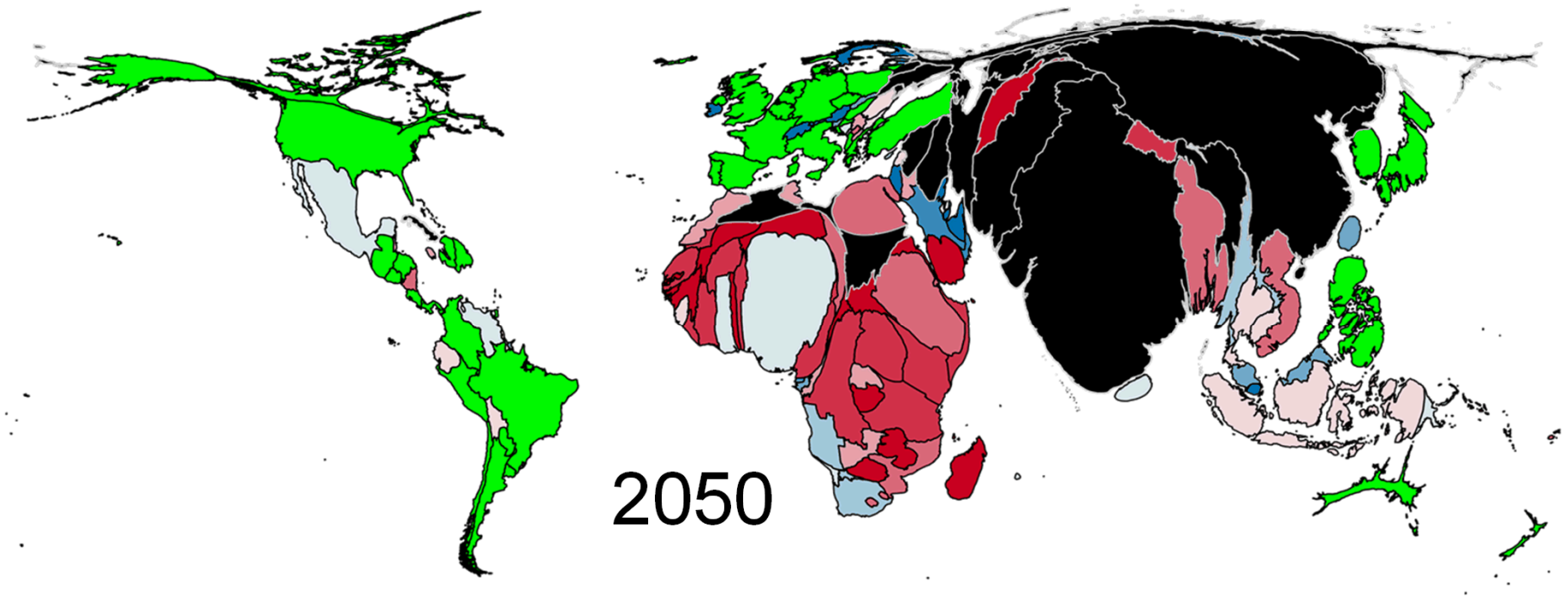


Red designates: *Food shortage ≥ 30%*

Flood-driven Migration From Climate Change

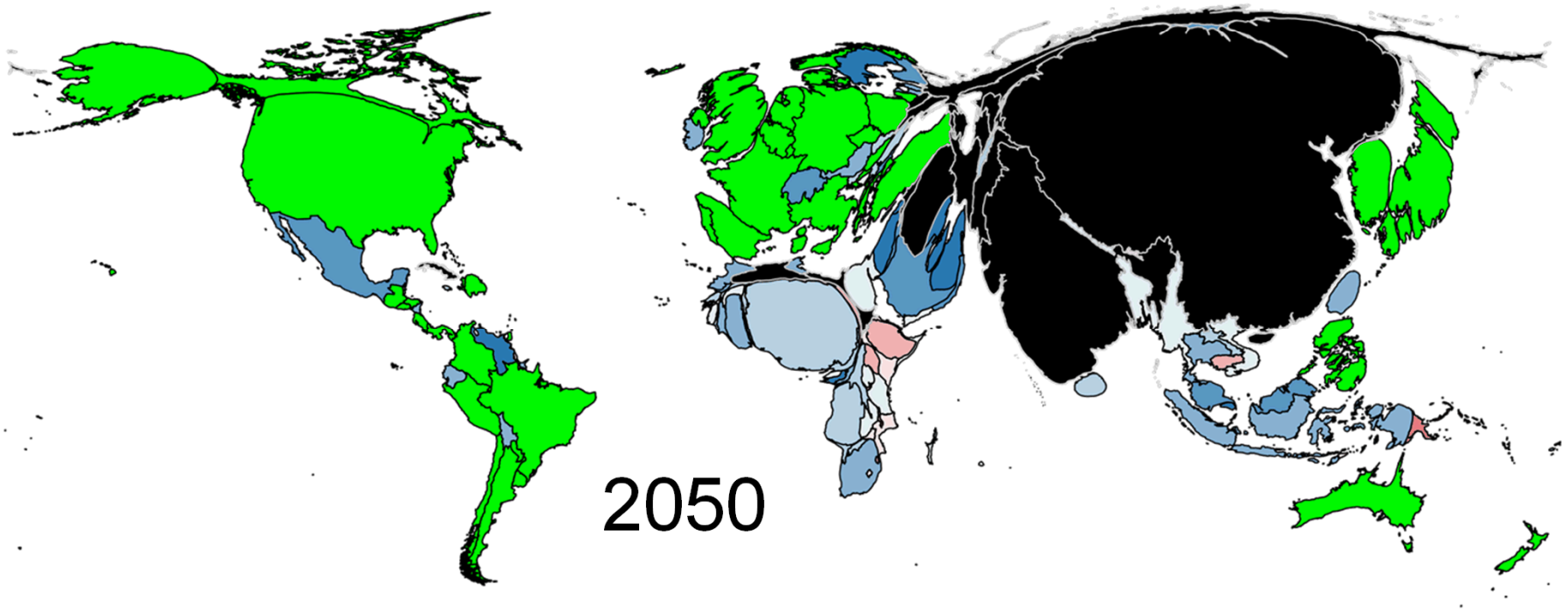


Population, GDP/Capita, Ally & Not Ally



- Green = Collective Security Alliances (2015)
- Black = Sensitive Countries (public version - 2015)

GDP, Urbanization %, 2016 Ally & Foe



- Green = Allies
- Black = Sensitive Countries (public version)

National security as a complicated system

Too many threats, too much surprise

National Security Goals*

Prevent

Mitigate threats as they form

Defeat

Strengthen ability to counter threats

Recover

Resilient to the many and varied consequences

Agile Adaptation

Evolving complexity and ease of empowerment require new culture of adaptability and security

*From Technology-Empowerment GF

National security as a complex system

Symantec

Too many threats, too much surprise, no assurances

National Security Goals*

Detect/ Dissipate

Mitigate threats as they form

Isolate/ Secure

Strengthen ability to counter threats

Reengage

Resilient to the many and varied consequences

Agile Adaptation

Evolving complexity and ease of empowerment require new culture of adaptability and security

*From Technology-Empowerment GF

Complexity and National Security

- **Sandia knows complexity-science: 1400, 5600, 6100, 8900.**
- **It is not possible to predict the outcomes of a complex system.**
  - **It is possible to identify undeniable and unacceptable risks.**
  - **It is possible to characterize the means to manage those risks.**
- **Sandia has the technical capabilities for managing the risks.**