

Exceptional service in the national interest



Global Futures: Demographic & Economic Divergence

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

Presenters: Thomas Nelson/George Backus

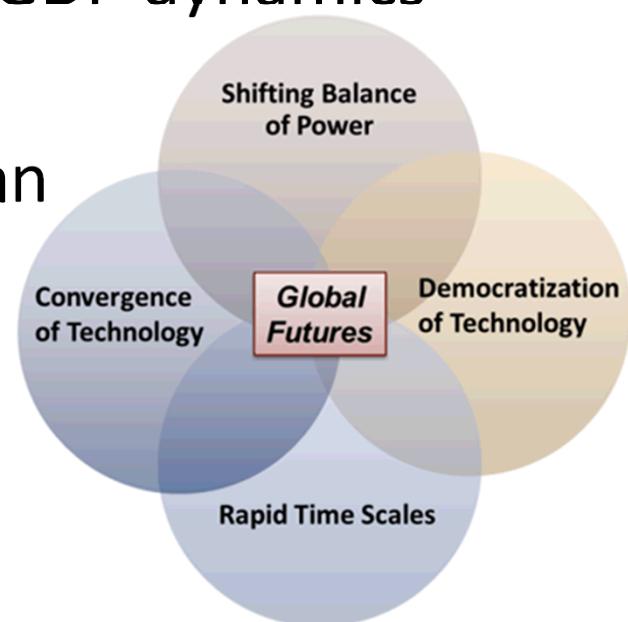
Contributors: Sandia Center 100, Senior Scientists and Engineers



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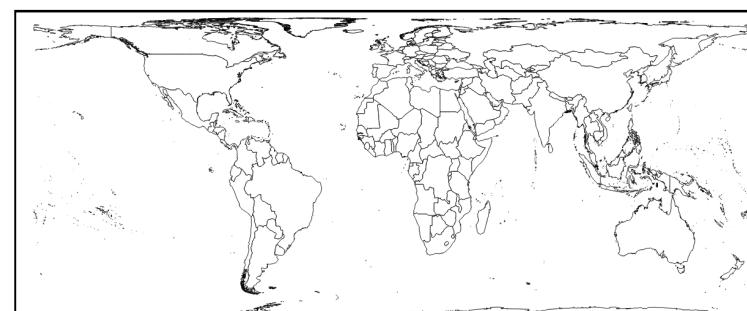
Characterization of the System

- 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

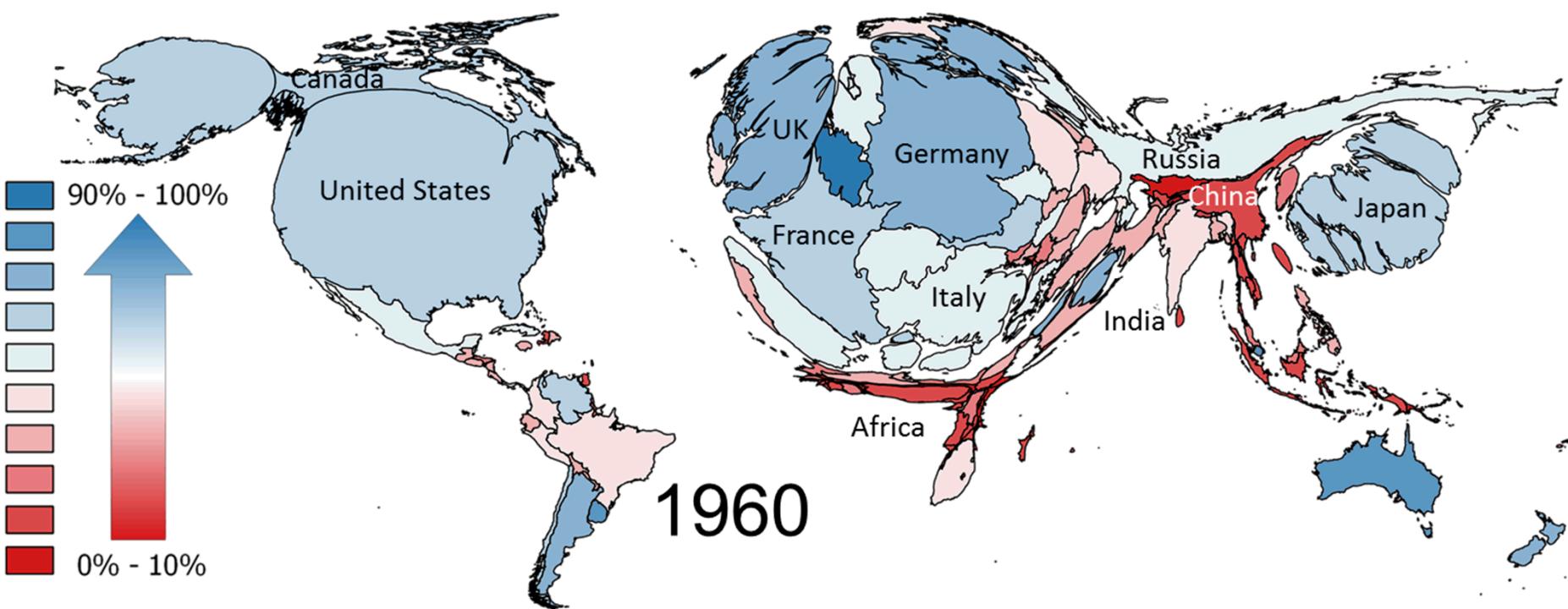


- Considered the same data and estimates (1960-2050) that inform domestic and international policy
- All optimistically assume world
 - 1) converges to Western Fertility Rates (Future of 1.85 vs 7.6)
 - 2) converges to Western Quality of Life (Industrialized)
- Explored additional effects of technology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

Sources and background in slide notes

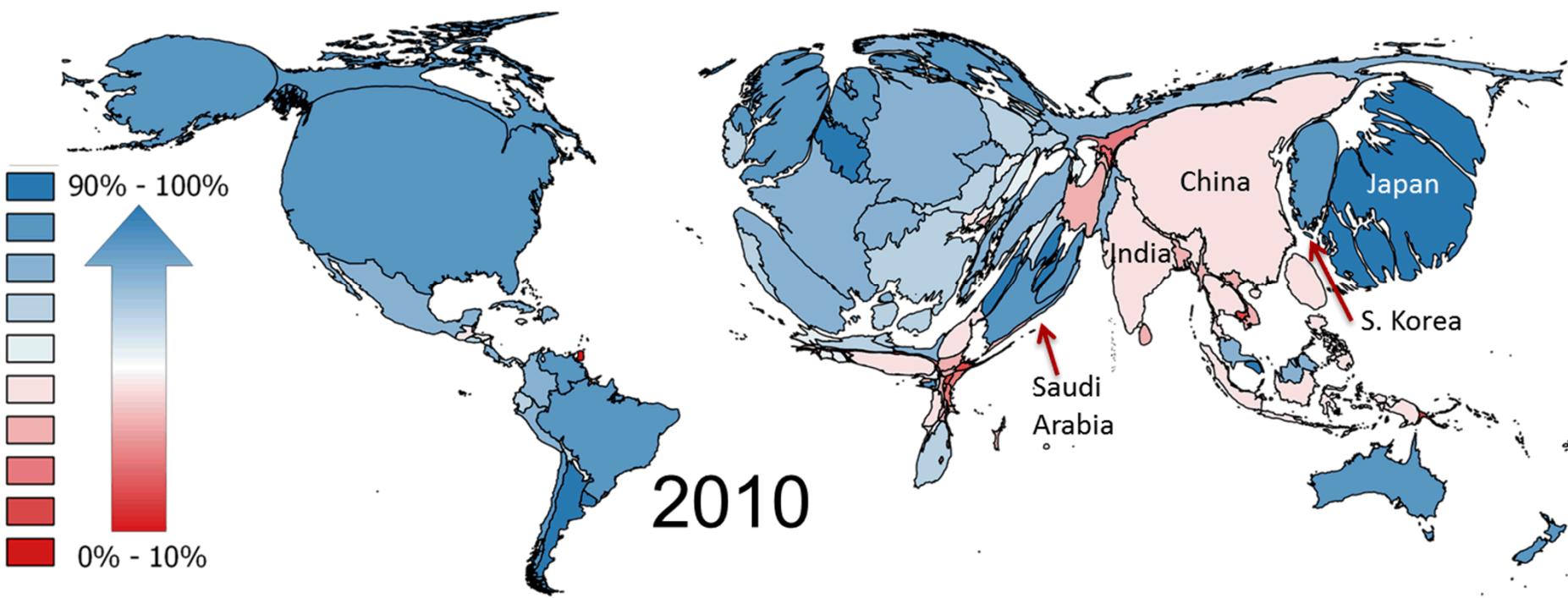


GDP (size) & Urban Percentage (color)



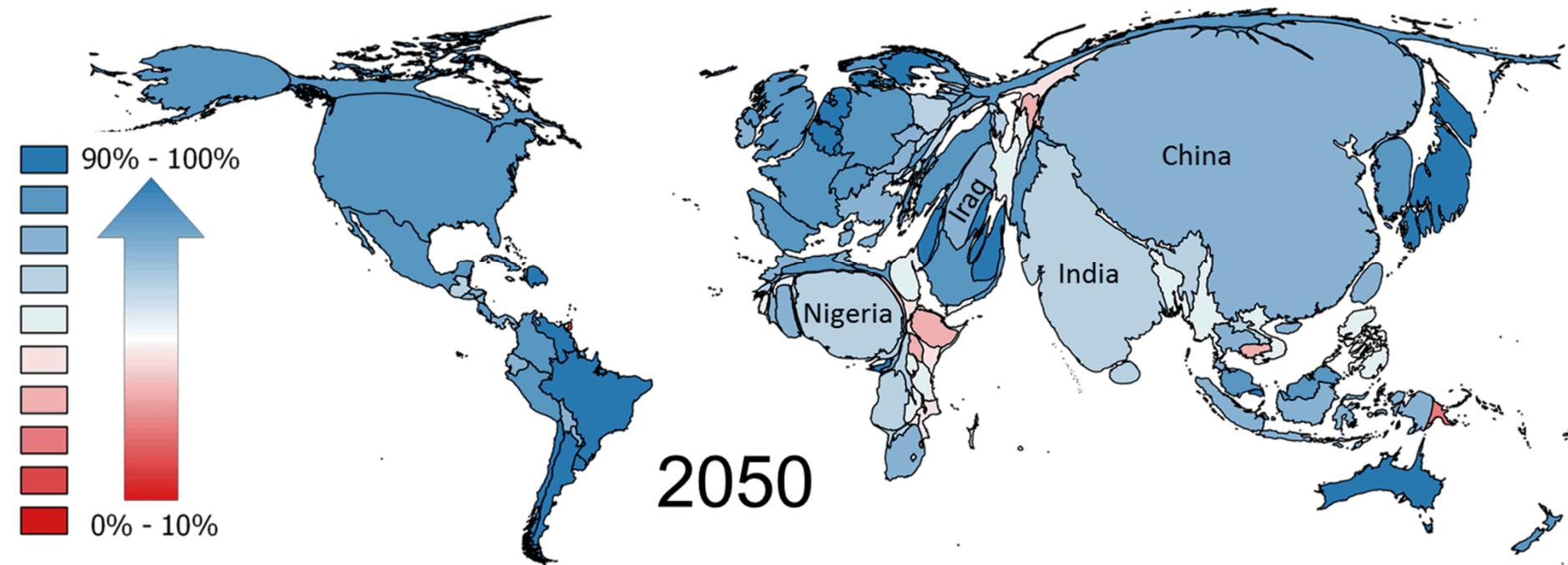
- Urbanized, developed countries dominate the map
- Urbanization from industrialization, workers pulled into the city for jobs
- Most urban areas are ports or centers of (international) trade

GDP (size) & Urban Percentage (color)



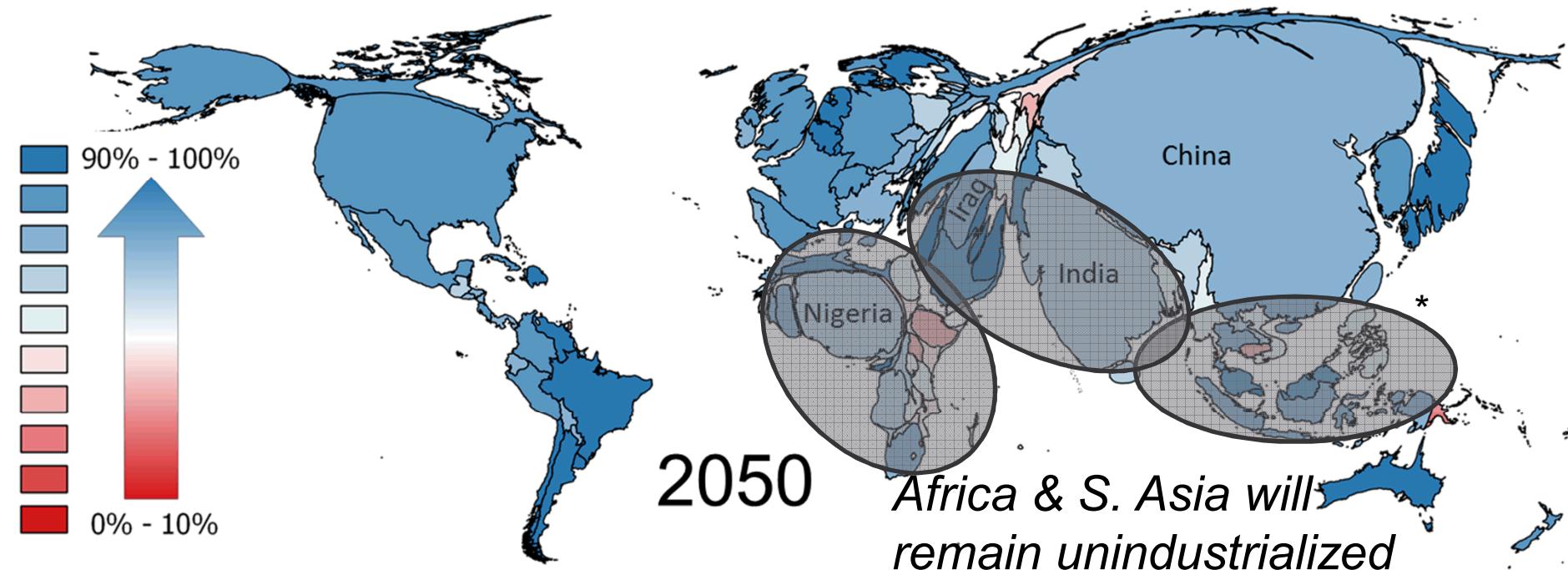
- Globally increased urban percentage, but GDP growth lags
- China, S. Korea, & Japan industrialize
- “Blue” Africa economies reflect oil “development”

GDP (size) & Urban Percentage (color)



Forecast optimistically assumes continued global industrialization
➤ Used for policy

GDP (size) & Urban Percentage (color)

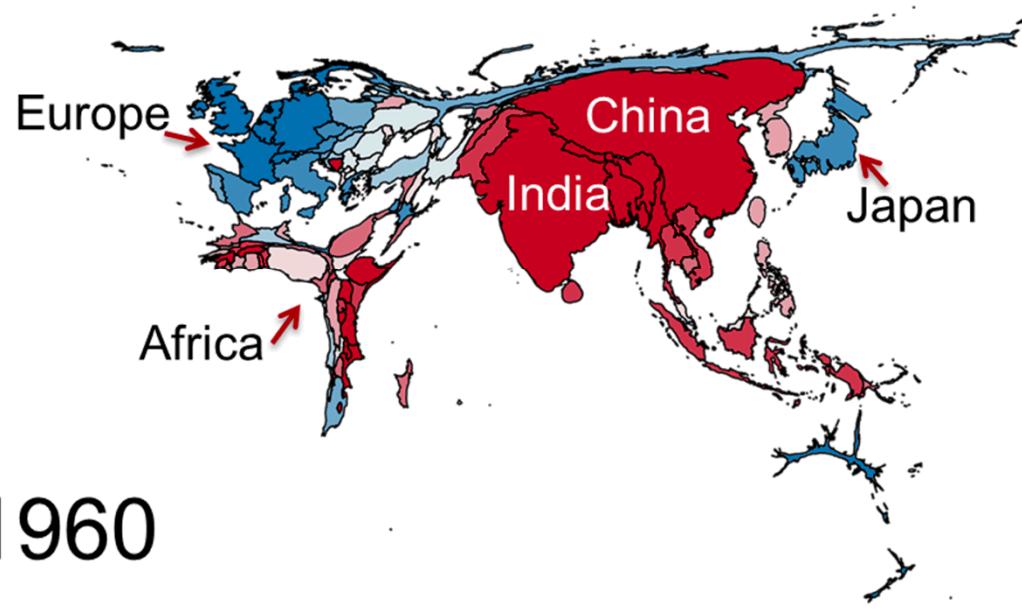
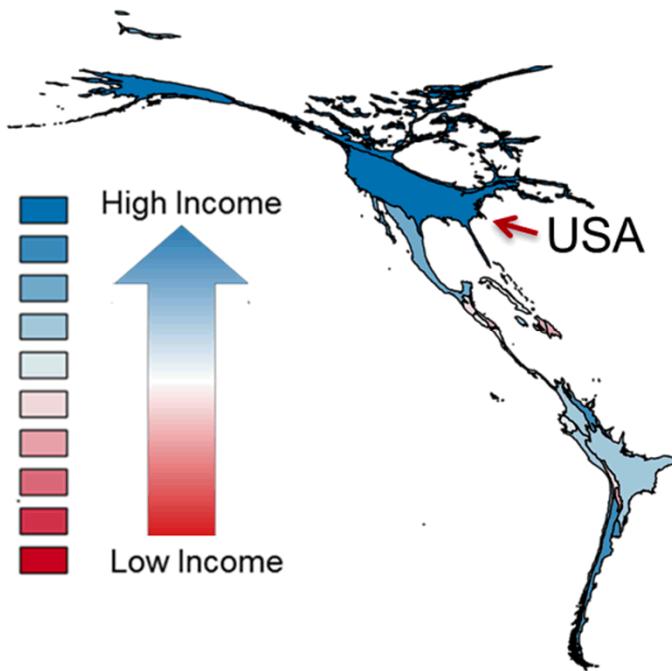


Adding missing effects:

- 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.

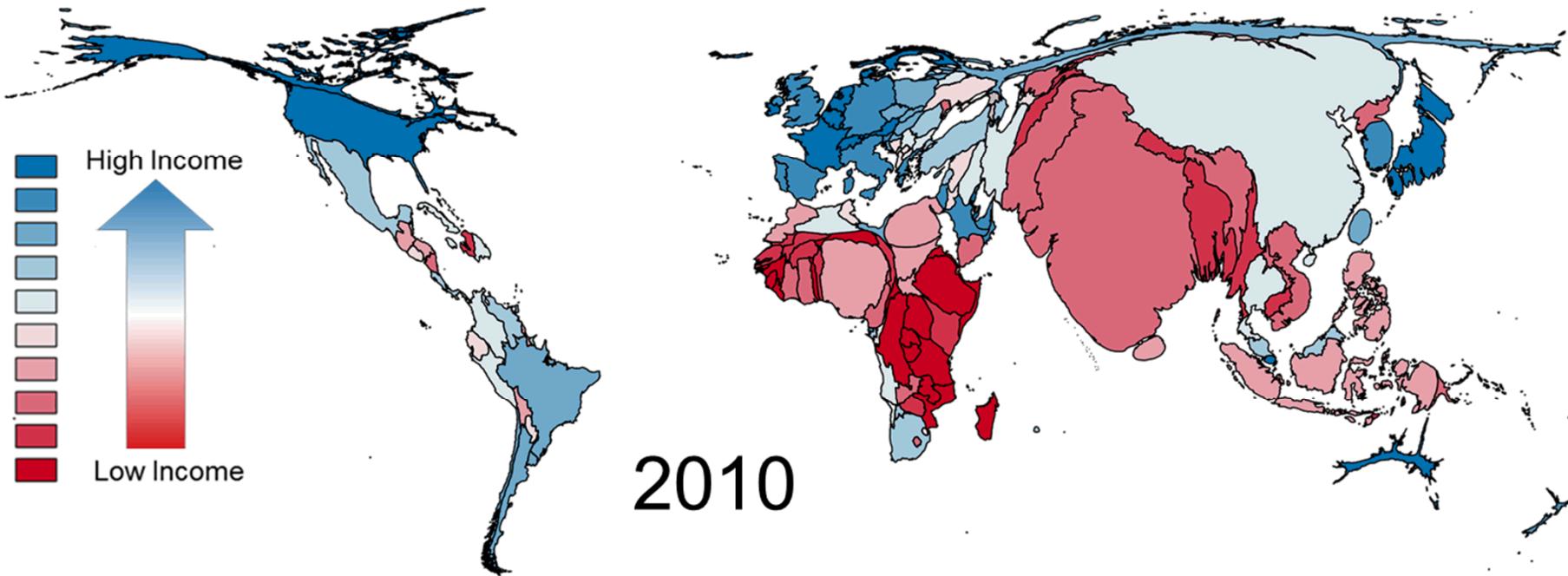
Population (size) & GDP Per Capita (color)



1960

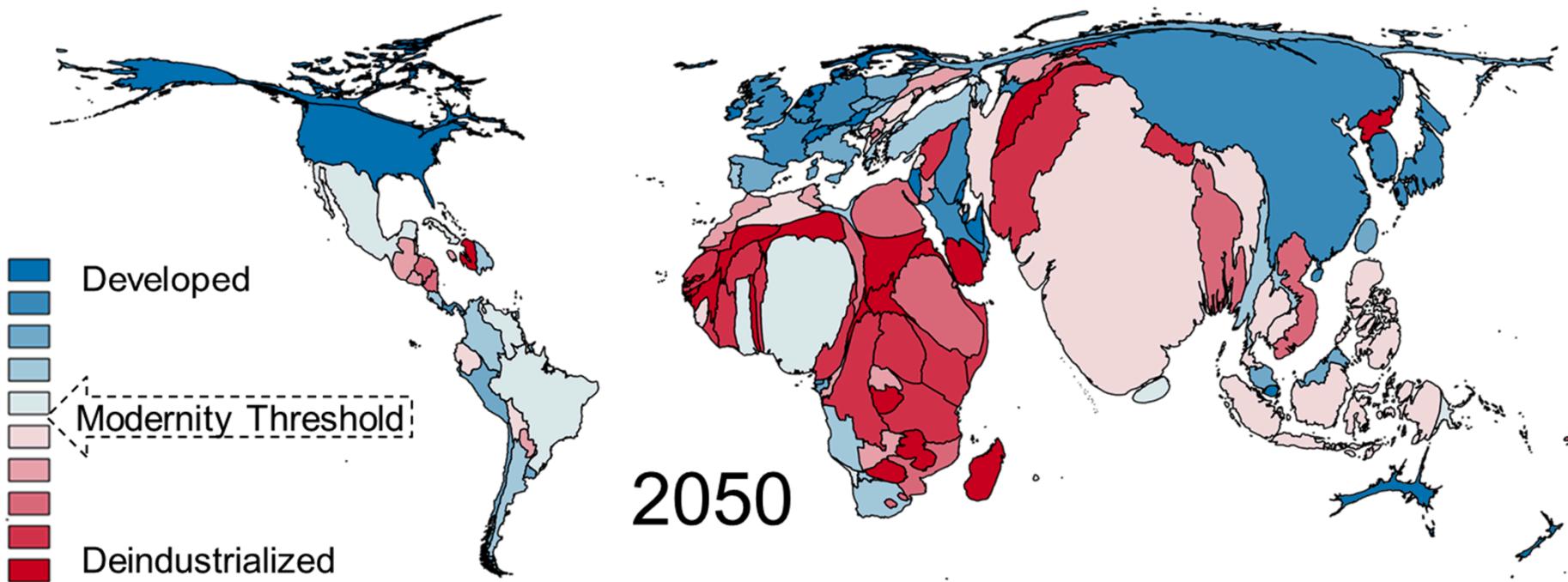
- Developed and developing world have comparable populations
- Color pattern looks like the previous 1960 map...

Population (size) & GDP Per Capita (color)



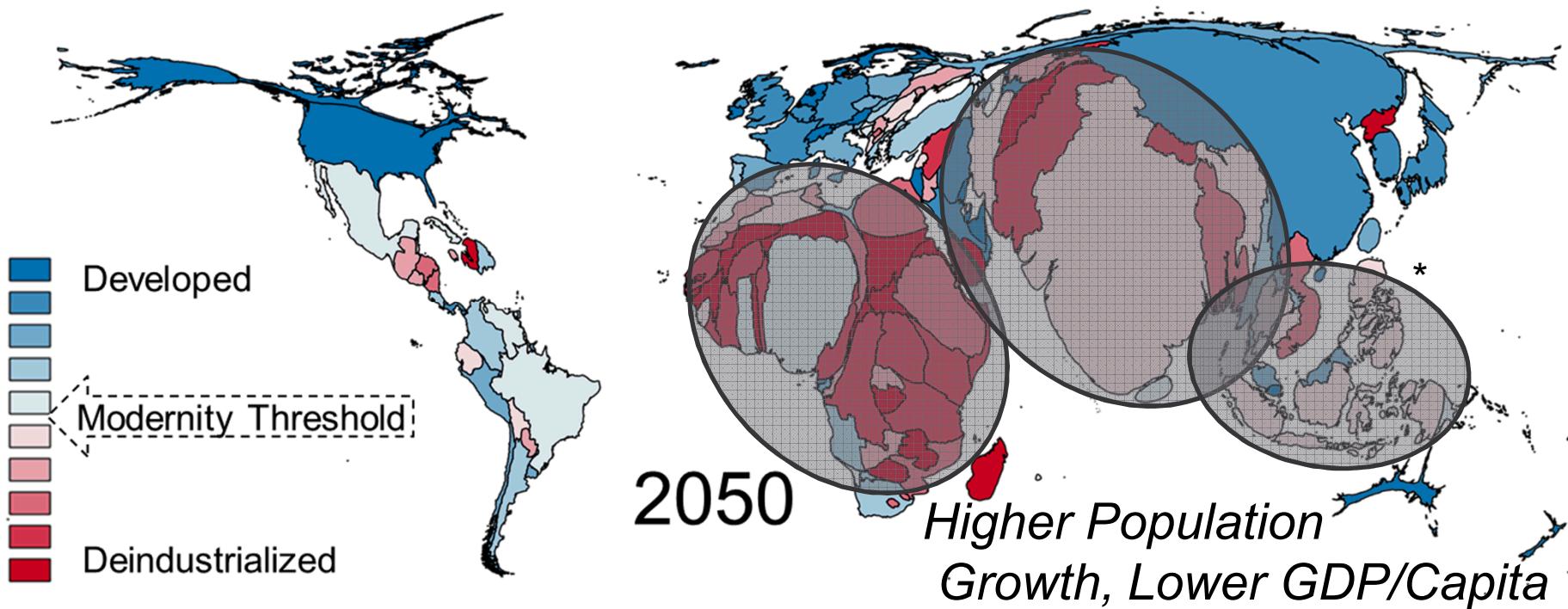
- The global population centroid is moving South and East
- China is improving, but data show no convergence in GDP/Capita for Africa and Southern Asia to industrialized levels

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)

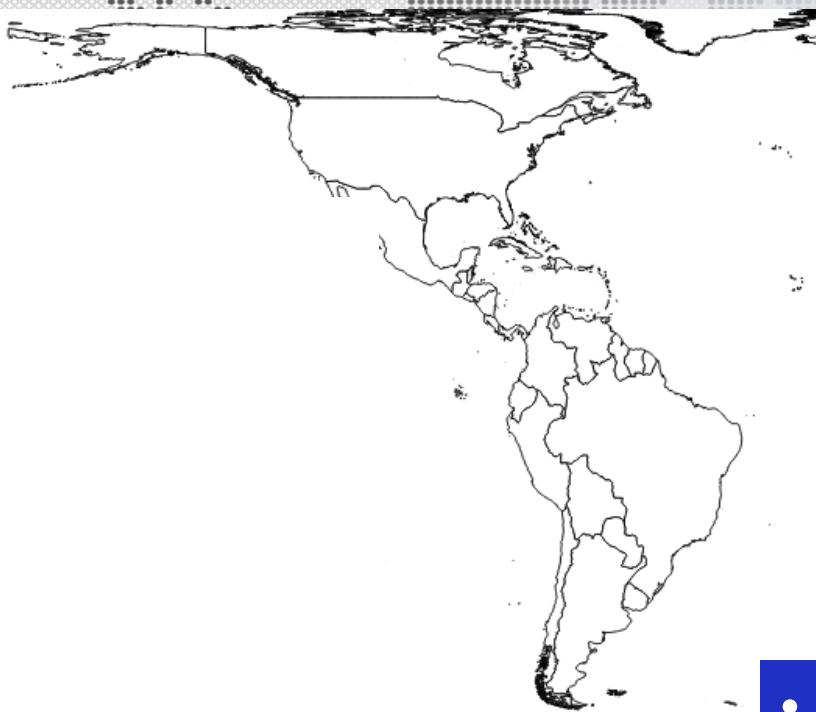


Adding missing effects:

- 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



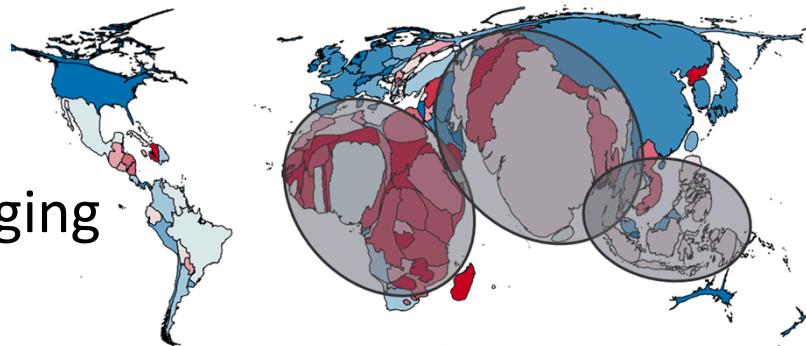
Regions Under Stress:

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

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

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

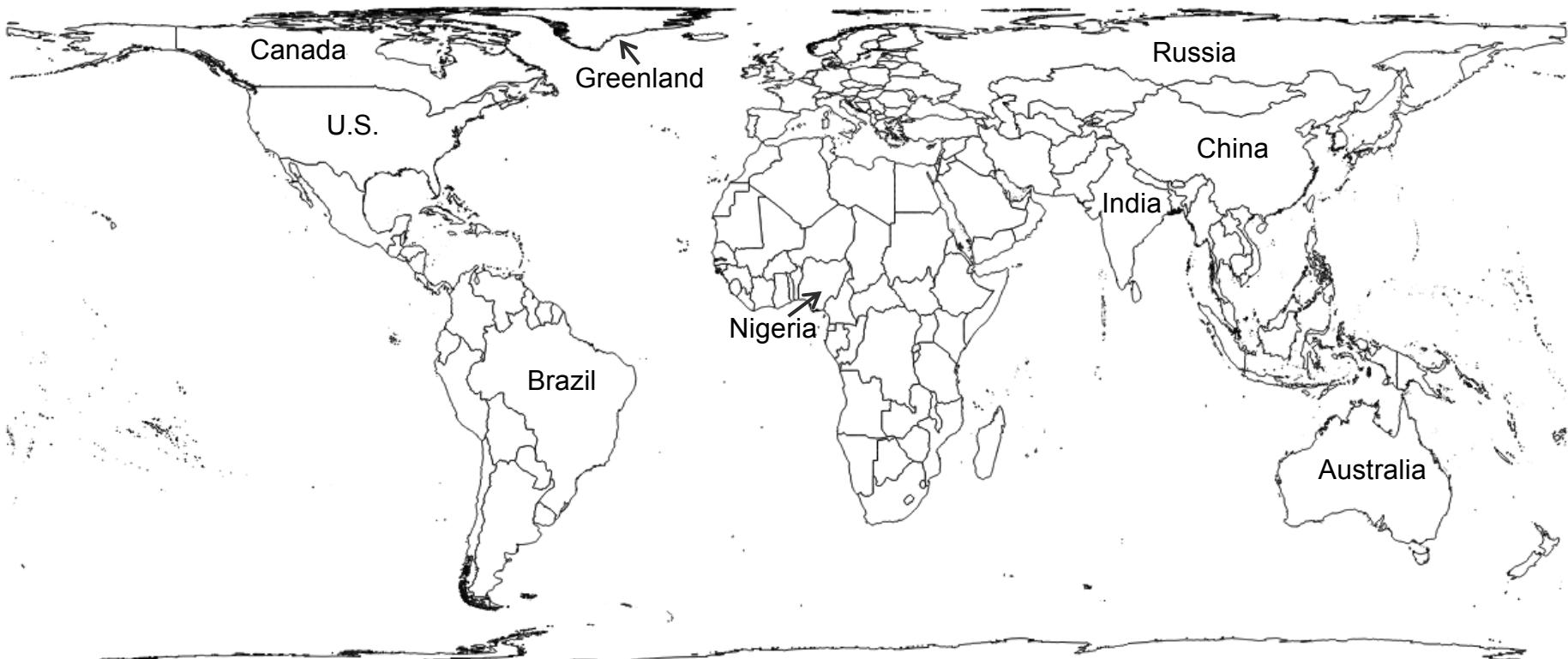


BACKUP SLIDES

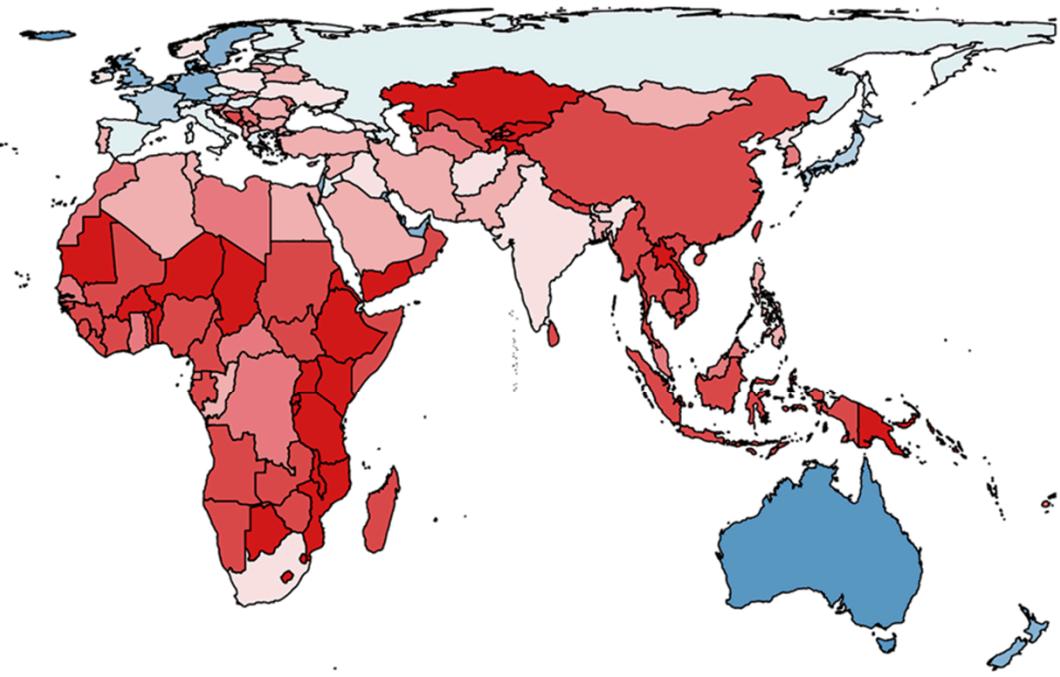
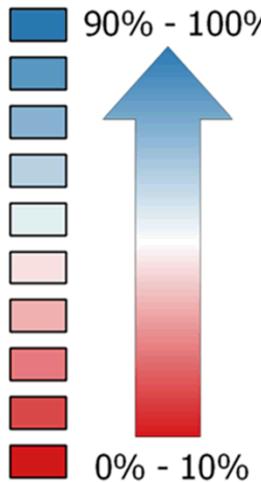
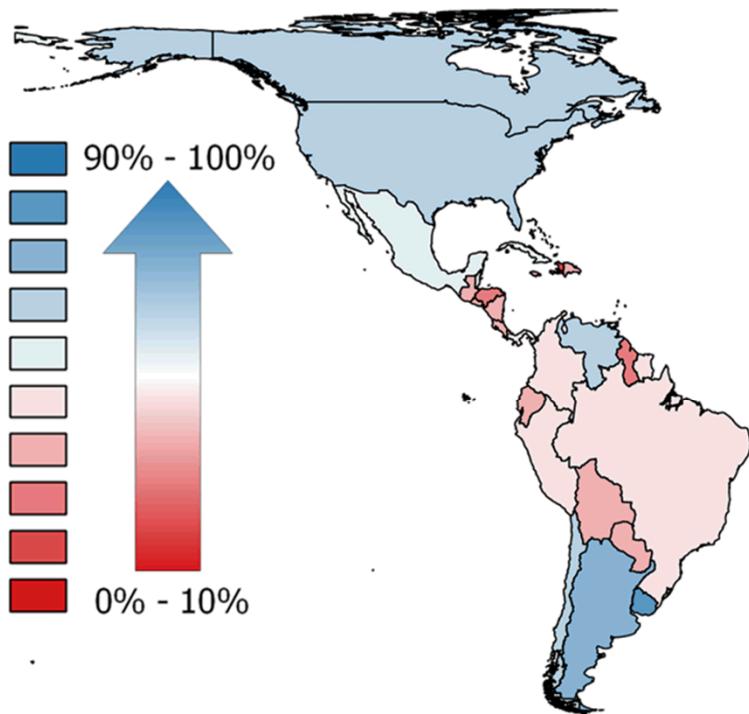
World Map: Mercator (shape)



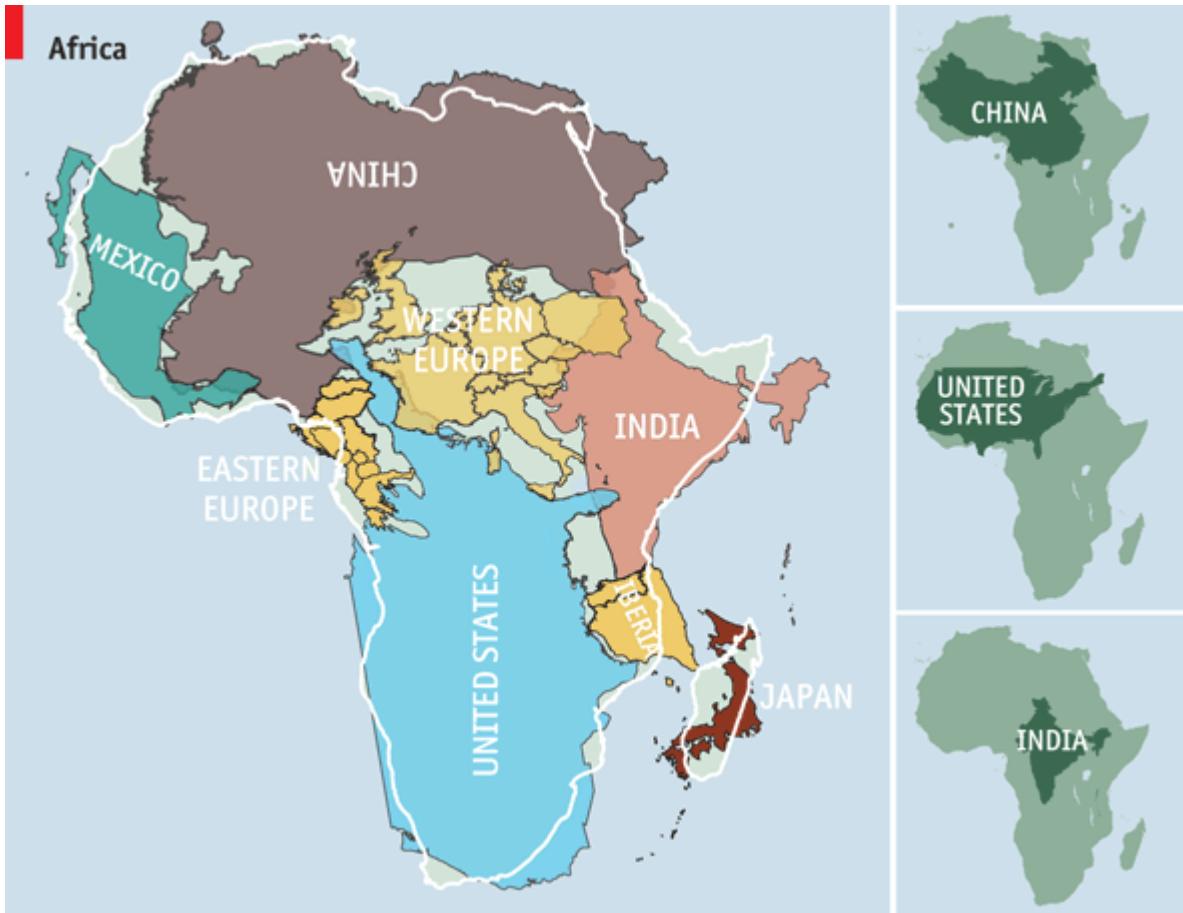
World Map: Relative Area (size)



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%

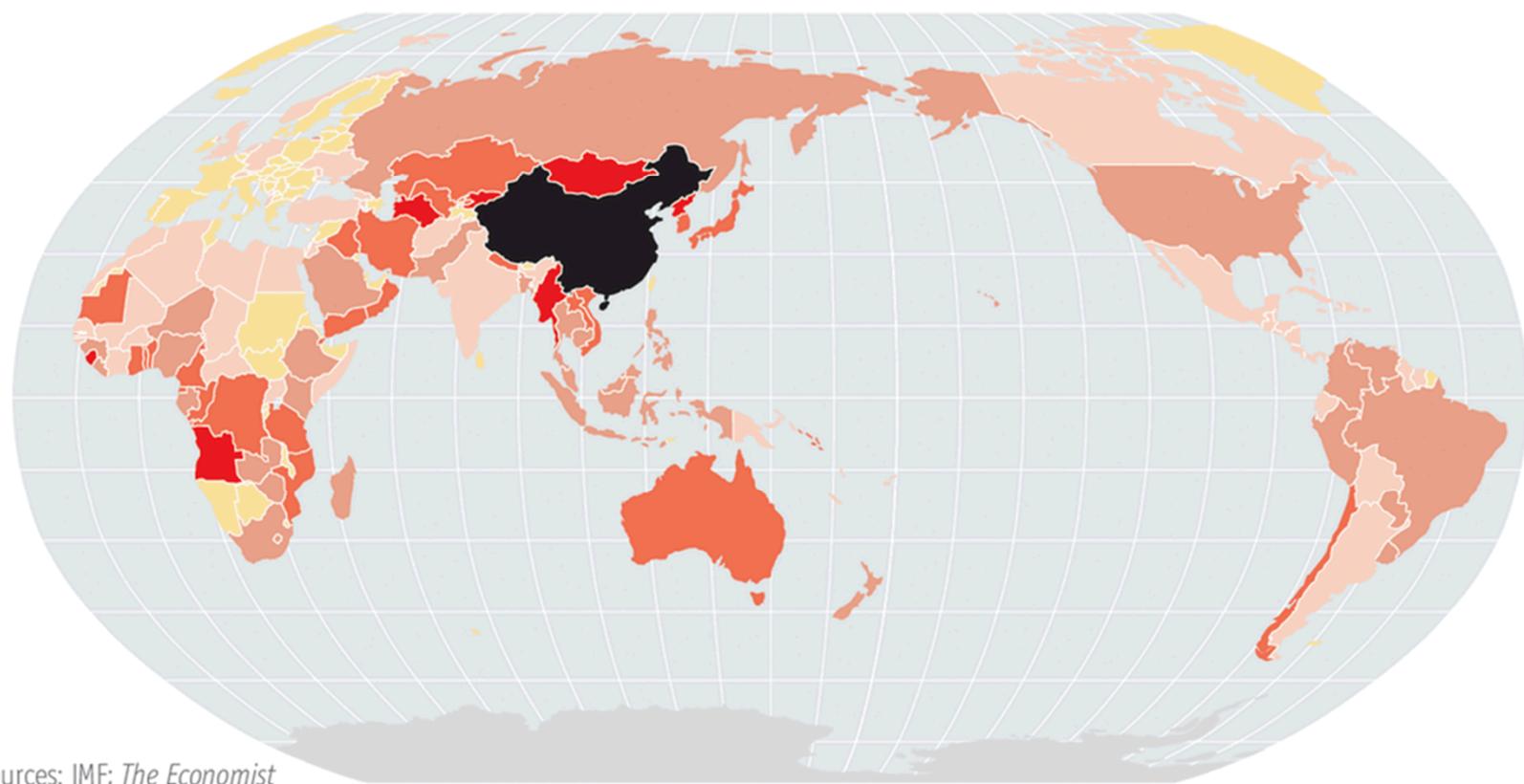
Trade Entrainment (Global Interdependency)

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

Merchandise trade with China

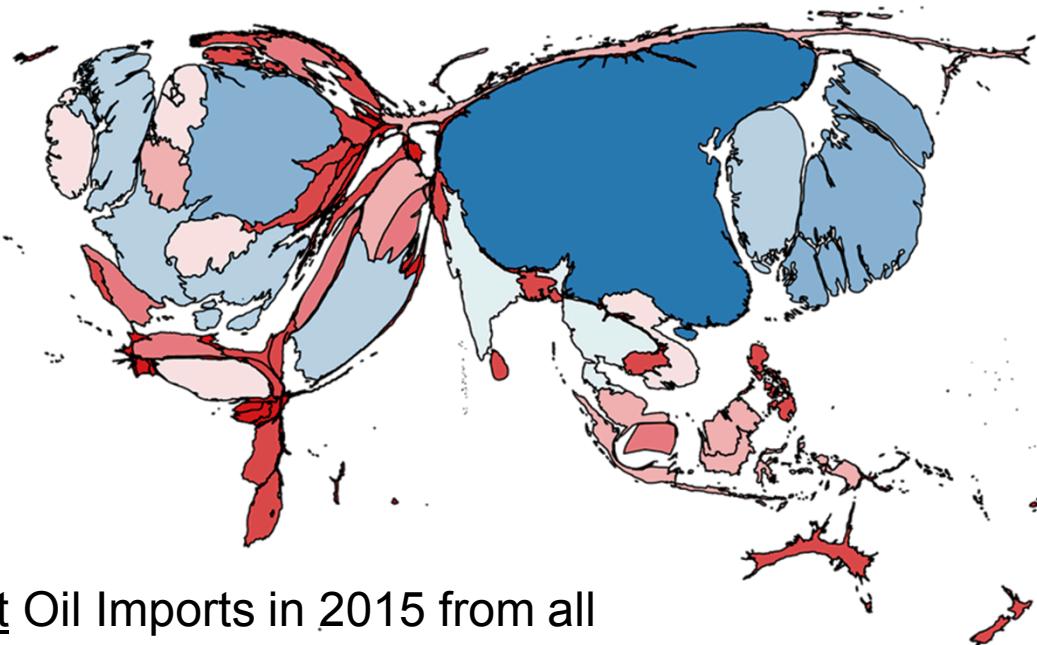
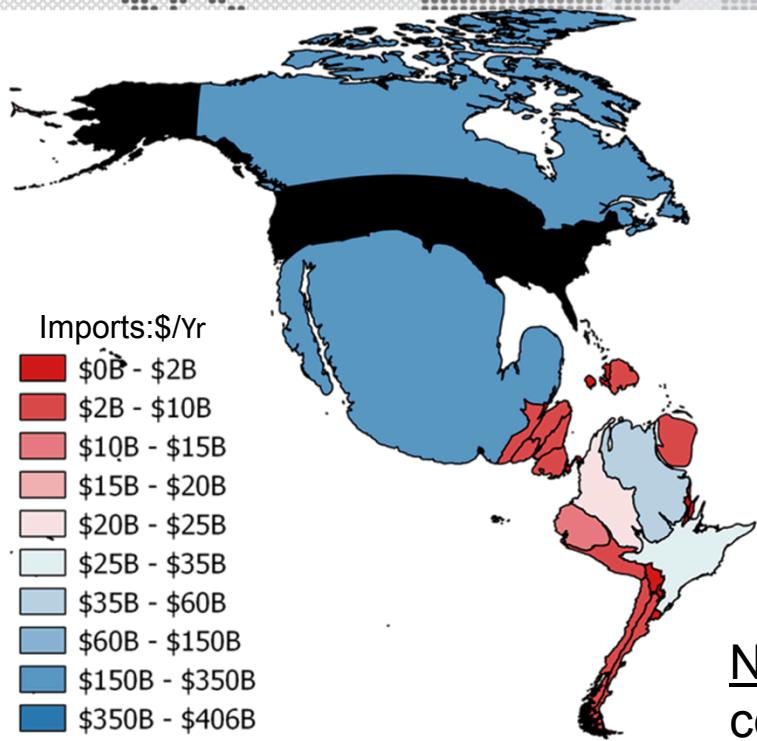
As % of countries' total trade, 2014

0-5 5-10 10-20 20-40 Over 40



Sources: IMF; *The Economist*

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

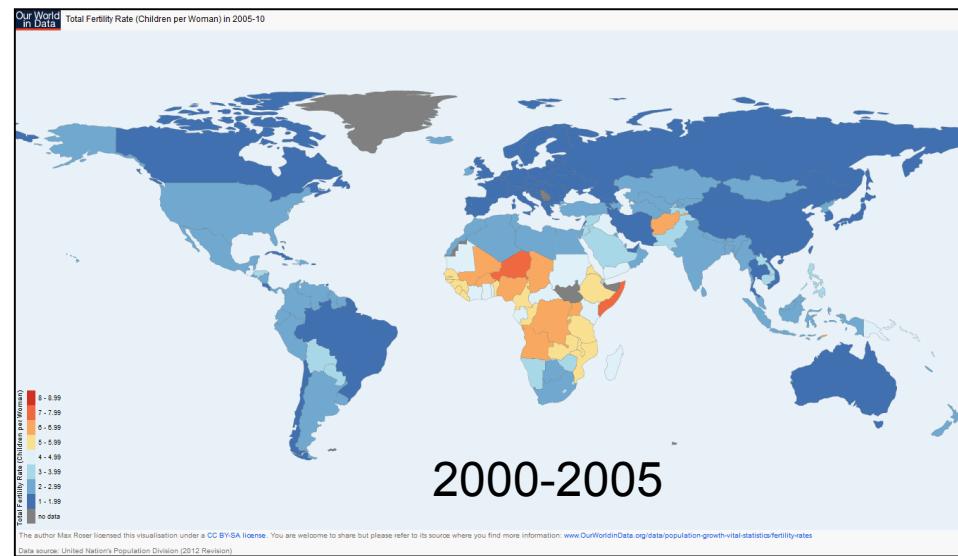
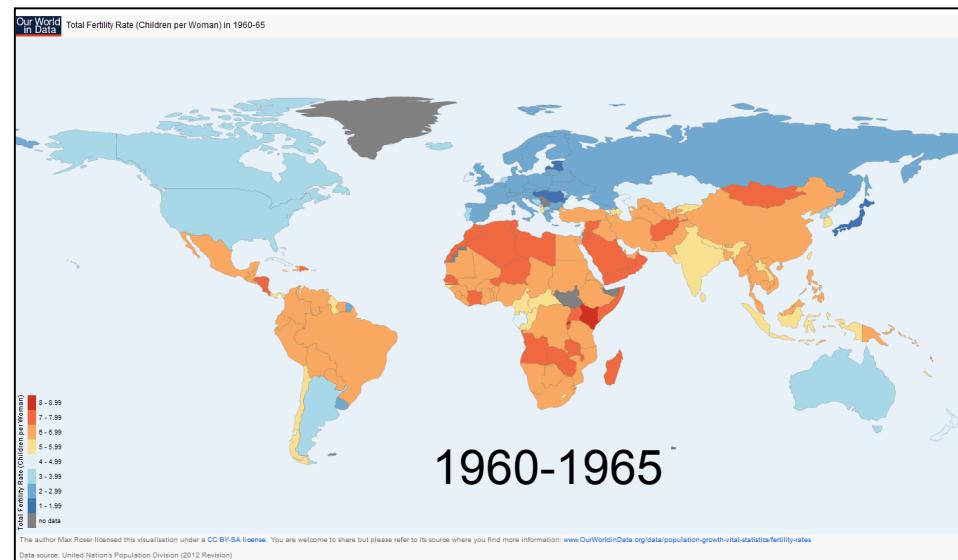
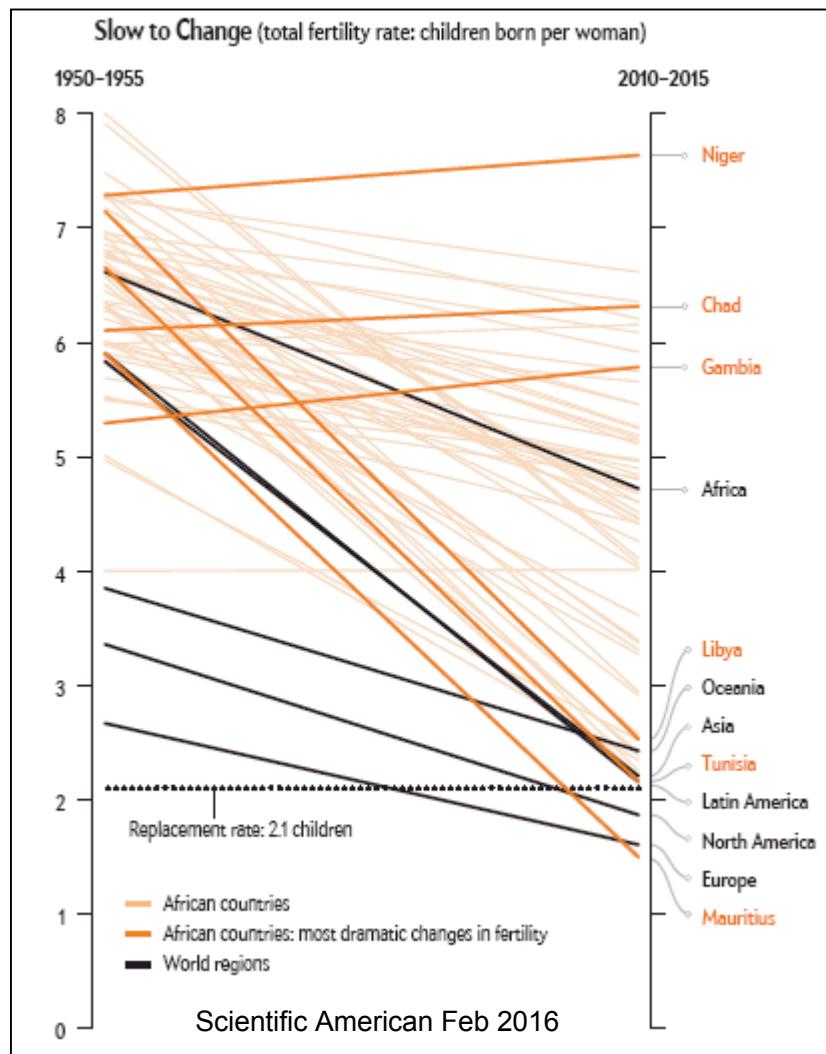
The 21st-century African land rush

Worldwide, up to 115 million acres of farmland are leased to foreign investors, and the bulk of that is in Africa. Food security and the push to produce biofuels drive the land rush. This map shows a sampling of reported land deals in Africa.



- CHINESE** firms invested in: Democratic Republic of Congo, 7 million acres acquired to produce biofuels
Mozambique, \$800 million investment to quintuple rice production
Tanzania, 741 acres secured for rice
Zambia, 4.9 million acres requested for biofuel
- DJIBOUTI** companies leased land in: Malawi, Unknown area of farmland
- EGYPTIAN** businesses invested in: Sudan, land secured to grow 2 million tons of wheat annually
- GERMAN** firms have land in: Ethiopia, over 32,000 acres to produce biofuels
- INDIAN** corporations invested in: Ethiopia, \$4 billion to produce flowers and foodstuffs
- JORDANIAN** firms have land in: Sudan, 60,000 acres for crops and livestock
- QATAR** businesses made deals in: Kenya, 99,000 acres of farmland in exchange for funding \$2.3 billion port
- SAUDI ARABIA** has deals in: Sudan, 2.27 billion acres leased for foodstuff with 60 percent Saudi government funding; Tanzania, 1.25 million acres sought by the Saudi government for food production
- SOUTH AFRICAN** organization holds land in: The Republic of Congo, 24.7 million acres rented by the South African farmers' union, AgrISA
- SOUTH KOREA** has firms with land in: Sudan, 1.7 million acres of wheat fields
- SWEDISH** businesses invested in: Mozambique, 250,000 acres to produce biofuels
- UNITED ARAB EMIRATES** has firms with land in: Sudan, 930,000 acres for food production
- UNITED KINGDOM** businesses invested in: Tanzania, 110,000 acres purchased for biofuels
- UNITED STATES** has firms with land in: Sudan, 1 million acres acquired

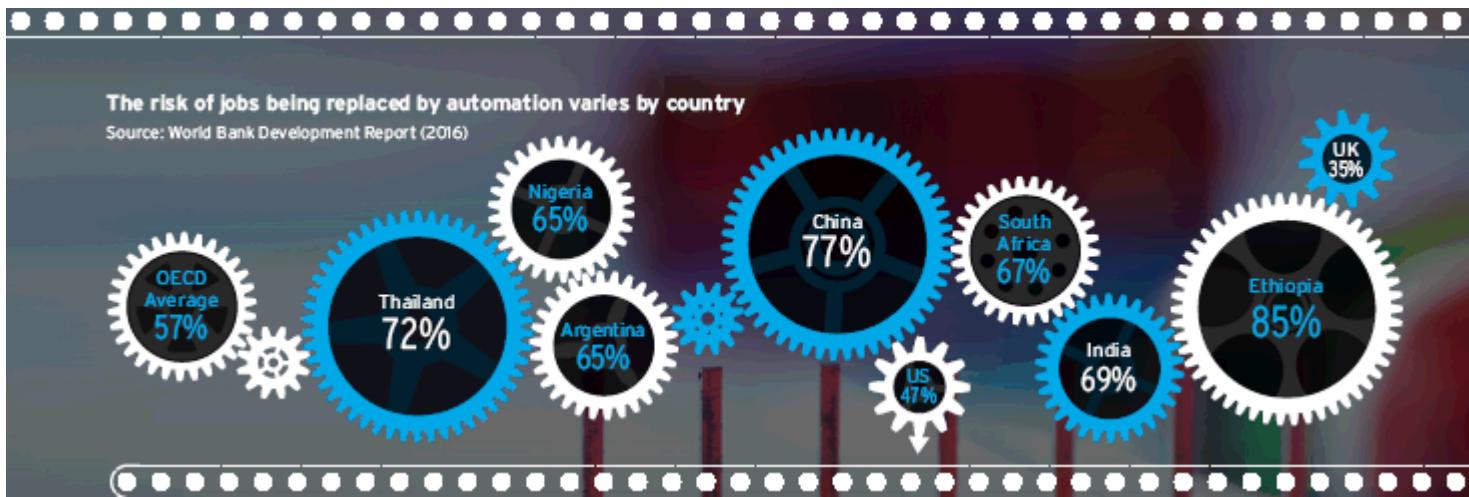
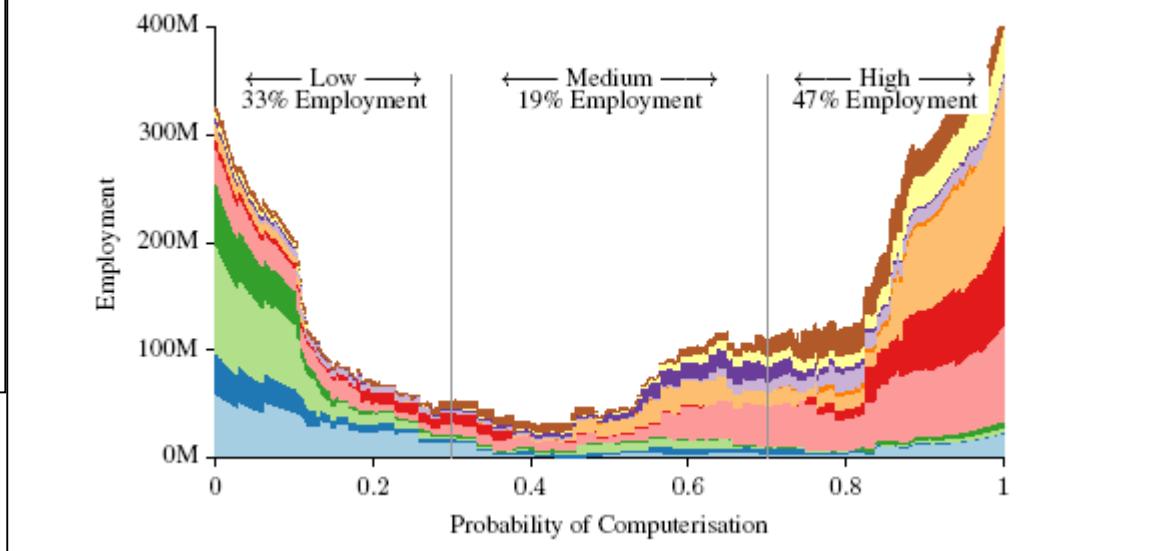
Global Fertility Rates



Job-type loss over the next decade



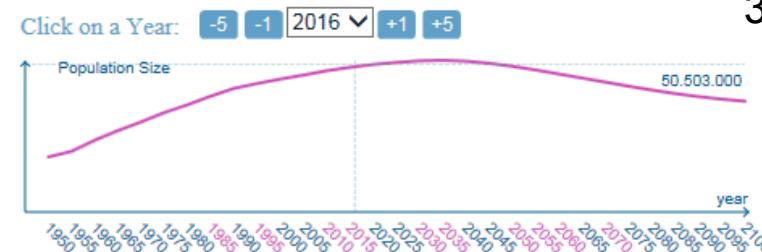
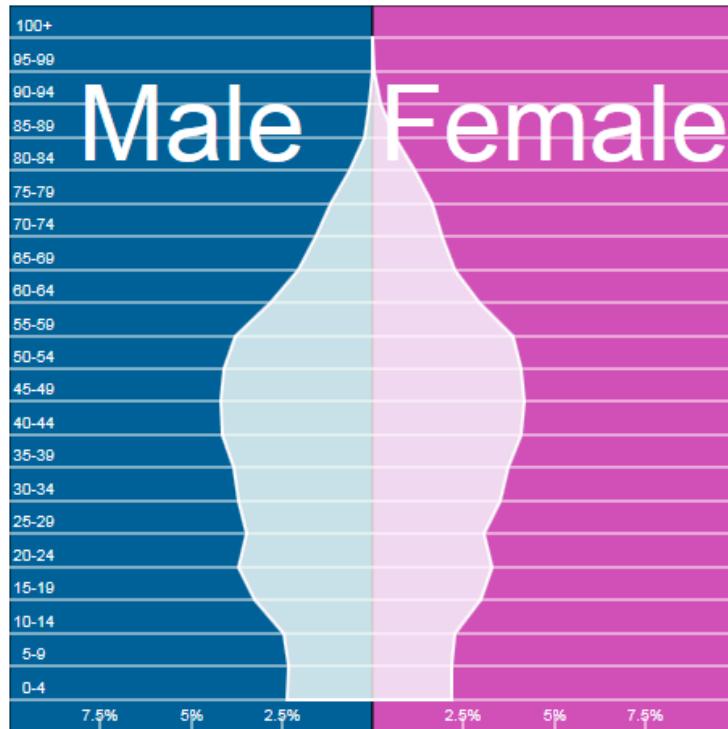
The Future of Employment, 2013



Technology at Work v2.0. 2016

Population Pyramid: South Korea

Republic of Korea
Population: 50.503.000
2016



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

R%C3%A9publique

Republic of Moldova

Russian Federation

Republic of Korea

Romania

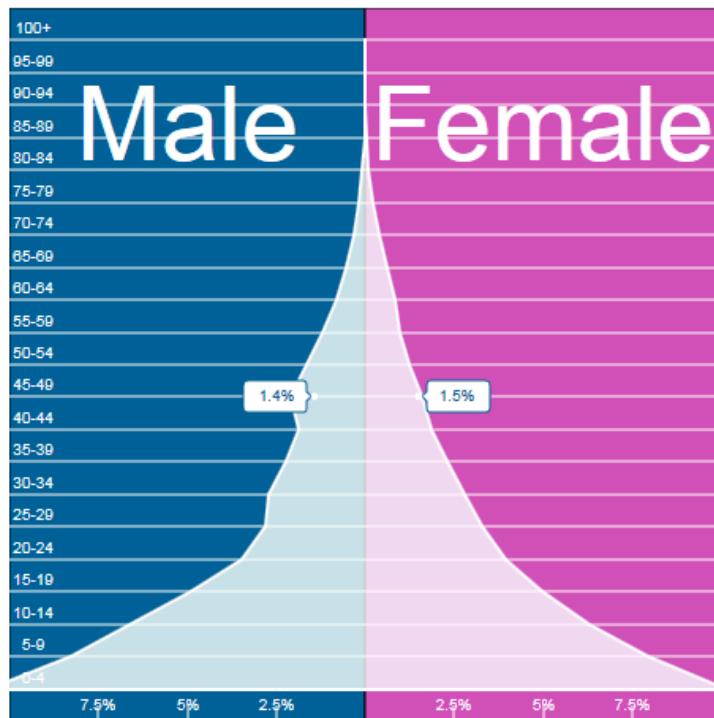
Rwanda

38M people
in 2100

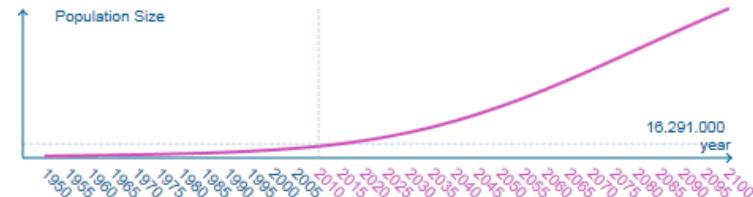
Population Pyramid: Niger

Niger

Population: 16.291.000
2010



Click on a Year: -5 -1 2010 +1 +5



210M people
in 2100

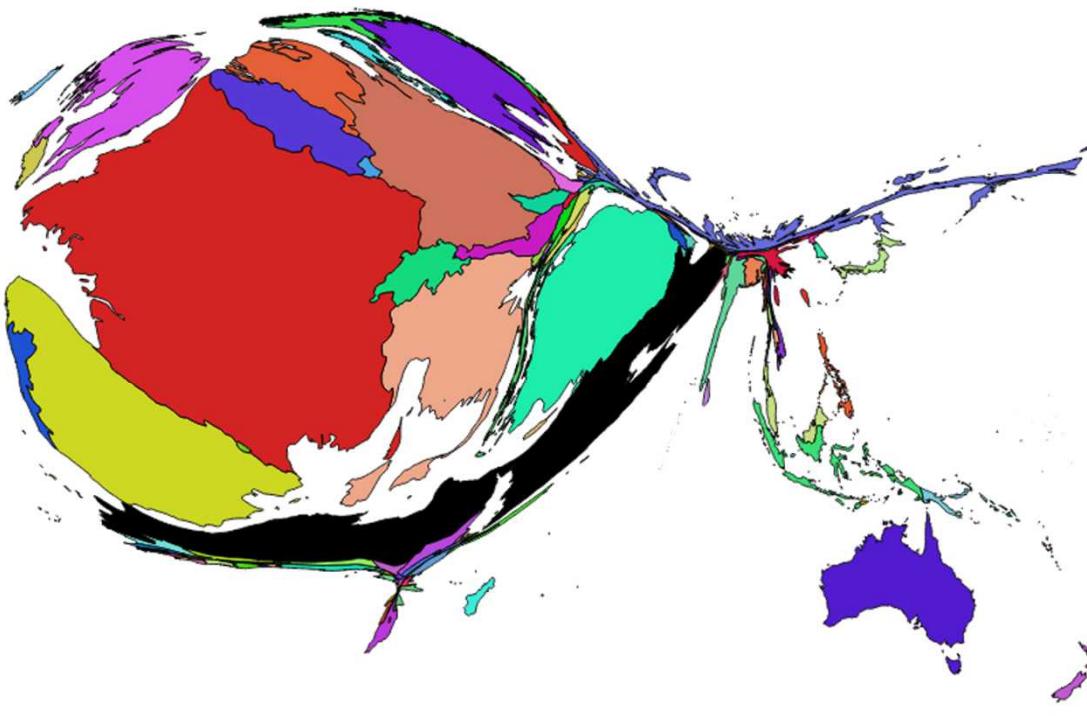
Click on a Country:

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

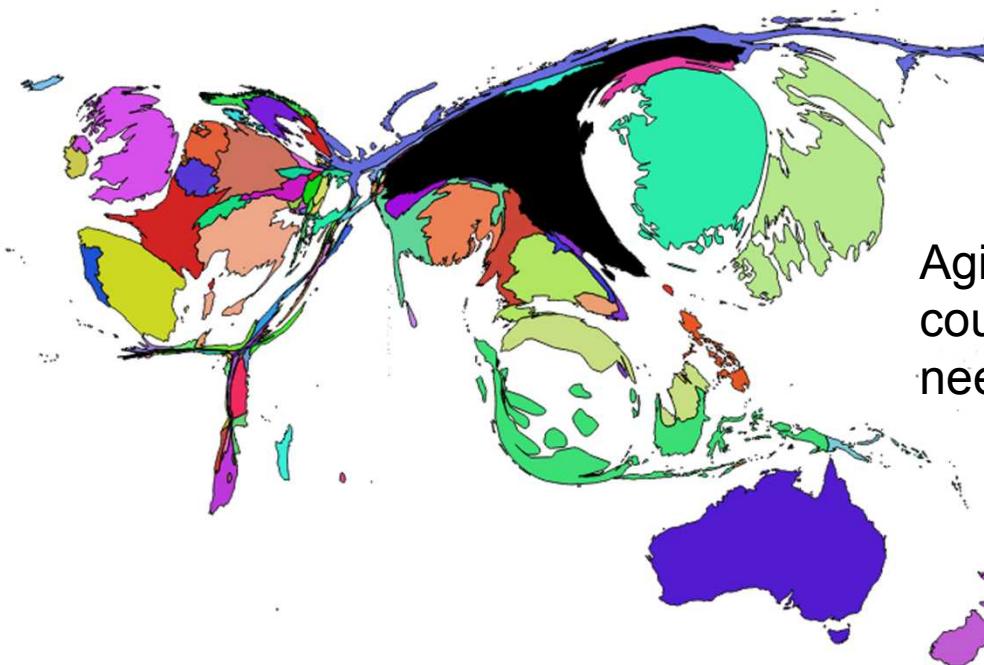
Middle East/N. Africa Out-migrants (Eastern Hemisphere) -- 2013



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)

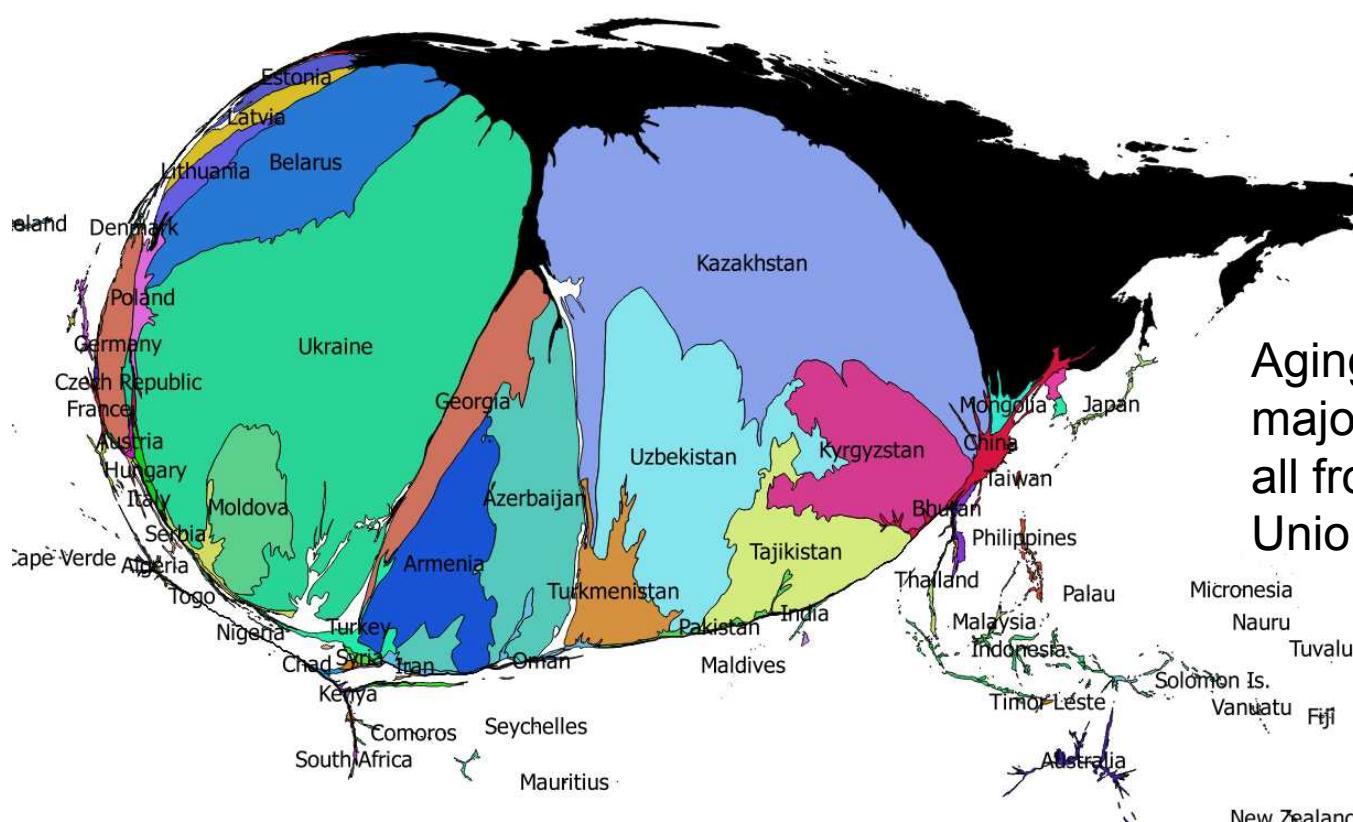
China Out-migrants -- 2013 (Eastern Hemisphere)



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

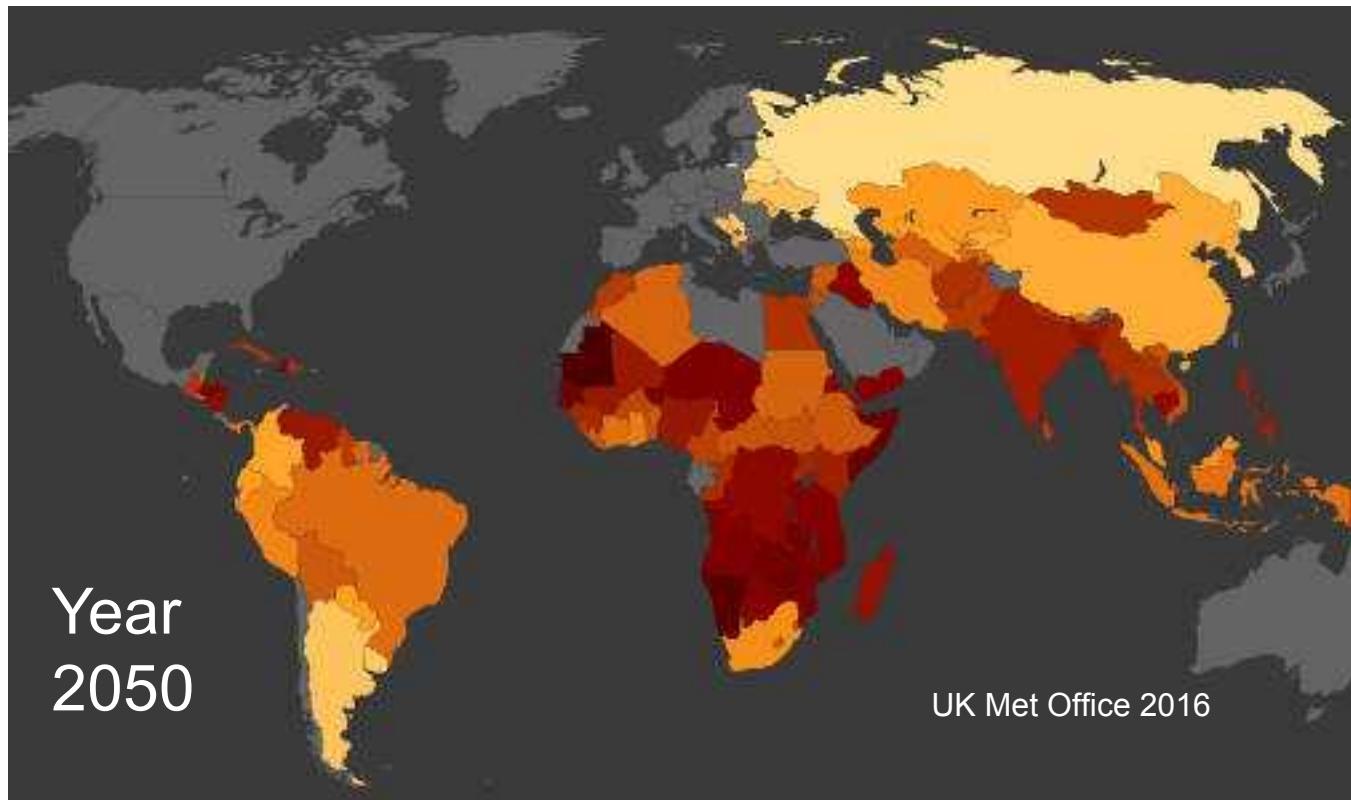


Aging Russia faces major ethnic transition, all from Former Soviet Union migration

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

Food/Water Disruptions & Climate Change

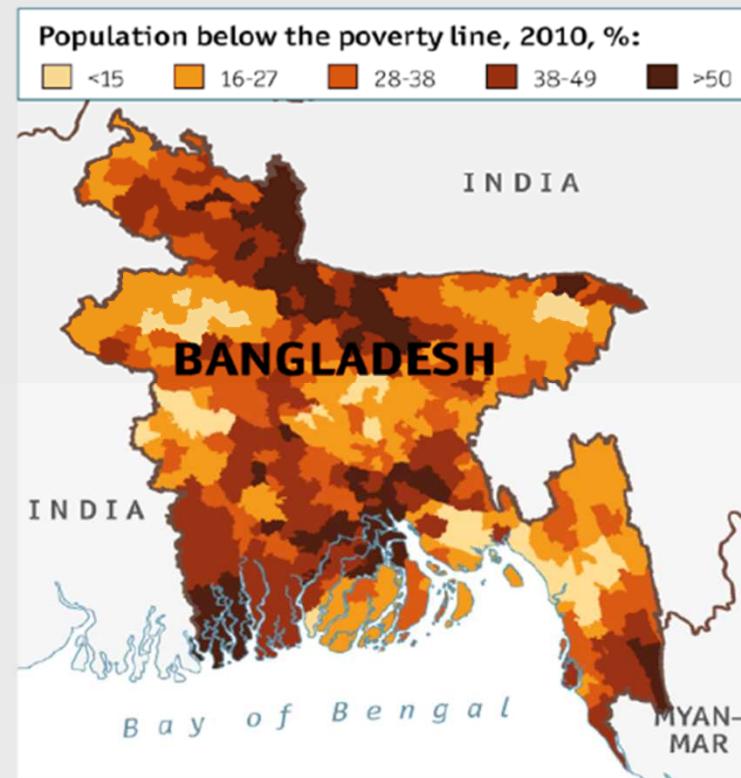
The population and economic projections ignore everything else.



Red designates: *Food shortage $\geq 30\%$*

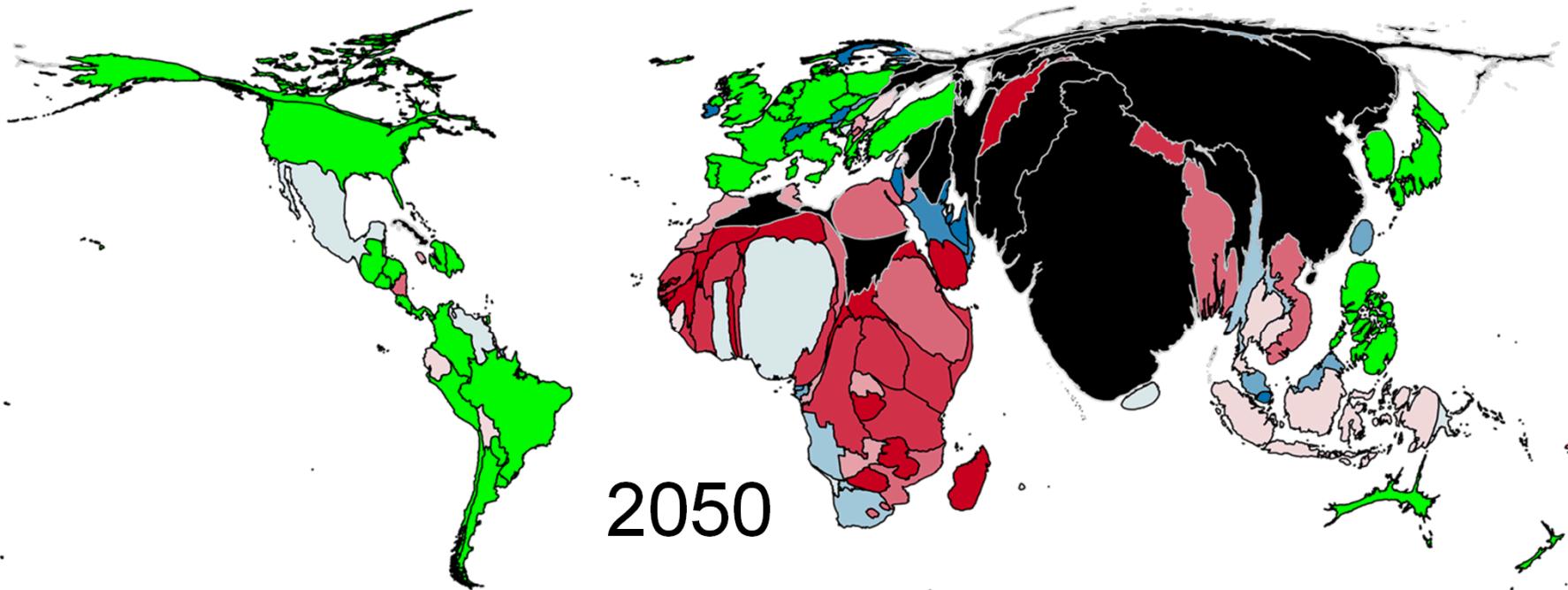
Flood-driven Migration From Climate Change

In the climate crosshairs



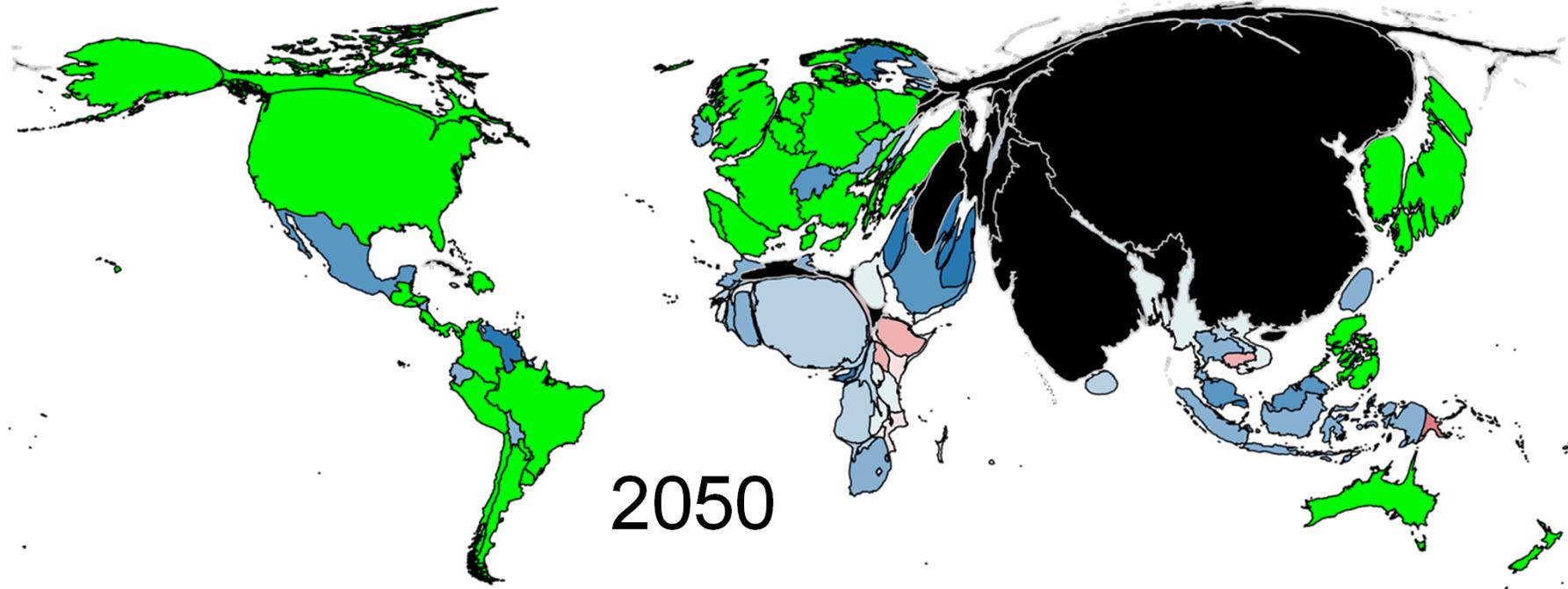
Sources: World Bank; Bangladesh Bureau of Statistics; World Food Programme

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.**