Scaling Sustainable Practices

From Person to Planet:

Mark S. McCaffrey- Focal Point

ECOS

Education, Communication and Outreach Stakeholders- a UNFCCC Community

Based in Budapest, Hungary

-Senior Research Fellow
-Institute for Sustainable Development Studies
-National University for Public Service

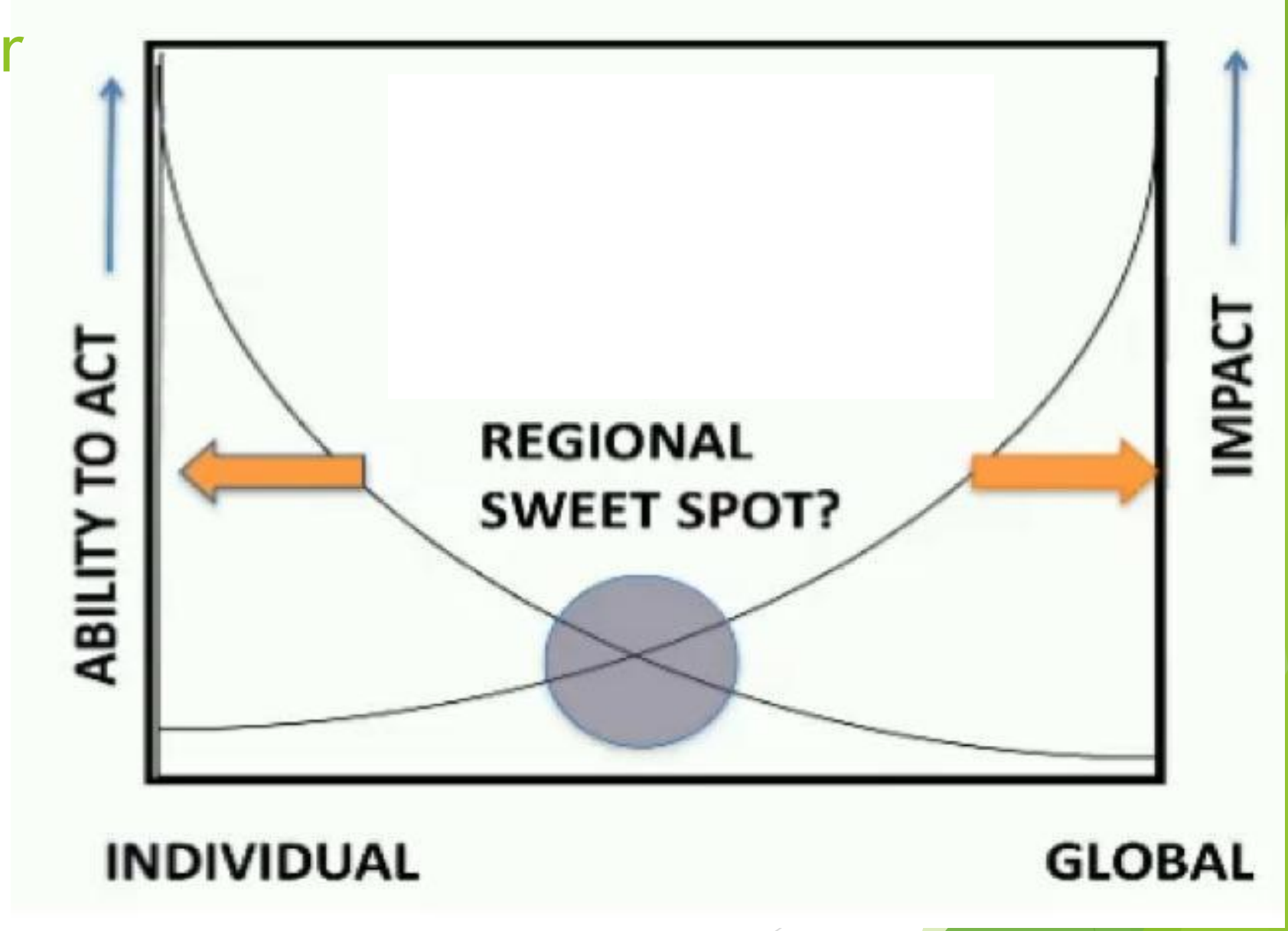
November 9, 2016

- Launched ECOS (Education, Communication and Outreach Stakeholder Community)

- Evaluating Maribor, Slovenia Climate-KIC Project

Early December 2016

- **Presentation on GHG emission reductions by Dr. Jane Long, Fall AGU 2016**



Mid-December 2016
Workshop on Social Tipping Points for Deep Decarbonization at Stockholm Resilience Centre

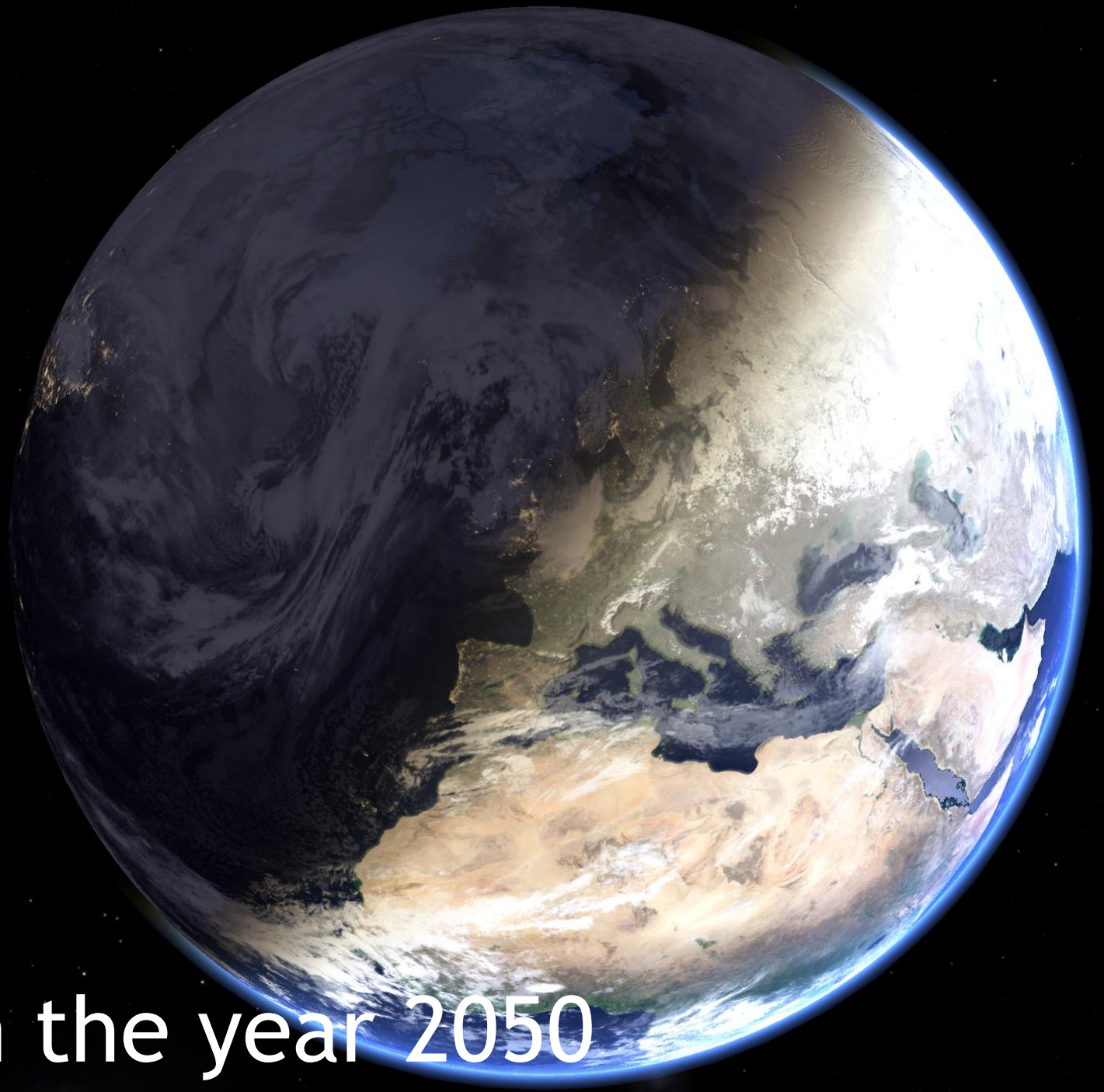
Stockholm Resilience Centre
Sustainability Science for Biosphere Stewardship

Stockholm University

Could education and engagement at “sweet spot” help provide a social tipping point for rapid reduction of greenhouse gases?

If so, where is the sweet spot?

The Confluence of Climate Action, Quality Education and Affordable Clean Energy in Accelerating Societal Transformation & Justice



Looking back from the year 2050

February 2016

- Most teachers spend 1-2 hours a semester on climate change
  - Many suggest scientists uncertain about how serious it is

SCIENCE EDUCATION

Climate confusion among U.S. teachers

Teachers' knowledge and values can hinder climate education

By Eric Plutzer,[1] Mark McCaffrey,[2] A. Lee Hannah,[3] Joshua Rosenau,[3] Minda Berbeco,[3] Ann H. Reid[3]

Although more than 96% of active climate scientists attribute recent global warming to human causes (*1*, *2*) and most of the general public accepts that climate change is occurring, only about half of U.S. adults believe that human activity is the predominant cause (*3*), which is the lowest among 20 nations polled in 2014 (*4*). We examine how this societal debate affects science classrooms and find that, whereas most U.S. science teachers include climate science in their courses, their insufficient grasp of the science may hinder effective teaching. Mirroring some actors in the societal debate over climate change, many teachers repeat scientifically unsupported claims in class. Greater attention to teachers' knowledge, but also values, is critical.

EDUCATION

Prior surveys [e.g., (*5*, *6*)] suggest that many teachers devote class time to climate change. Although these surveys are suggestive, their use of nonprobability sampling undermines the validity of their results. None quantified the amount of class time or the specific topics covered in class. We undertook the first nationally representative survey of science teachers focused on climate change. Working from a commercial database of 3.9 million teachers, we drew a stratified probability sample of 5000 names and implemented a multiple-contact paper and Web survey protocol during academic year 2014–15. We collected data from 1500 public middle- and high-school science teachers from all 50 U.S. states, representative of the population of science teachers in terms of school size, student socioeconomic status, and community economic and political characteristics. See supplemental materials (SM) for details.

INTRODUCING THE BASICS. Three in four science teachers allocate at least an hour to discussing recent global warming in their formal lesson plans, including 70% of middle-school science teachers and 67% of high-school biology teachers (table S7). Because virtually all students take middle-school science and 97% enroll in a general biology class (*7*, *8*), the likelihood of any student missing instruction in climate change altogether is low—on the order of 3 to 4%. Most teachers reported covering the greenhouse effect (66%), the carbon cycle (63%), and four or more observable consequences, such as sea-level rise, or changes in seasonal patterns, like the flowering of plants and animal migrations. Teachers also discuss responses to climate change and careers addressing the challenges it poses.

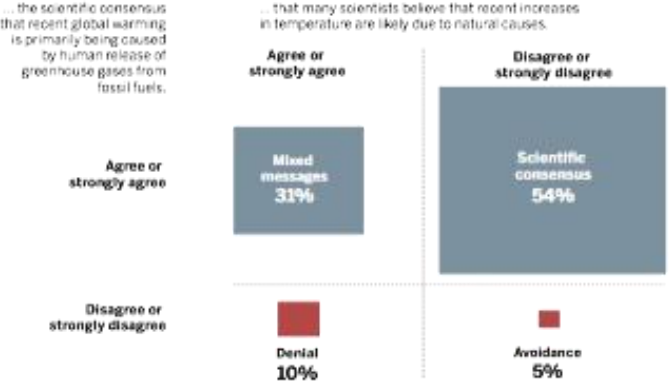
Although most students will hear something about climate change in a science class, the median teacher devotes only 1 to 2 hours to the topic (table S7), inconsistent with guidance from leading science and education bodies [e.g., (*9*)]. Of course, quality of instruction is more important than quantity, so we turn to how students are introduced to climate change science.

MIXING MESSAGES. Notably, 30% of teachers emphasize that recent global warming "is likely due to natural causes," and 12% do not emphasize human causes (half of whom do not emphasize any explanation and thereby avoid the topic altogether). Of teachers who teach climate change, 31% report sending explicitly contradictory messages, emphasizing both the scientific consensus that recent global warming is due to human activity and that many scientists believe recent increases in temperature are due to natural causes (see the first chart). Why might this be the case? Some teachers may wish to teach "both sides" to accommodate values and perspectives that students bring to the classroom (*6*, *10*). Beyond that, the survey data allow us to evaluate three explanations.

First, teachers might experience overt pressure from parents, community leaders, or school administrators not to teach climate change. Only 4.4% of teachers reported such pressure (6.1% reported pressure to teach it, mostly from fellow teachers). This is less than the 15% reporting pressure in Wise's pioneering survey (*6*), and far less than biology teachers reported in a survey on teaching evolution (*10*).

Second, teachers also may not be very knowledgeable about a wide range of evidence—e.g., CO_2 measurements from ice cores and from direct measures at Mauna Loa—and how climate models work. Given the relative novelty of the topic in classrooms, instructional materials, and preservice training, this would not be surprising, and nearly 50% said that they would prioritize one or

"When I do teach about climate change, I emphasize ..."



Teachers' emphasis. Teachers reported emphasis on causes of global warming, among those devoting an hour or more to the topic (see SM for details on calculation).

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YALE PROGRAM ON
Climate Change
Communication

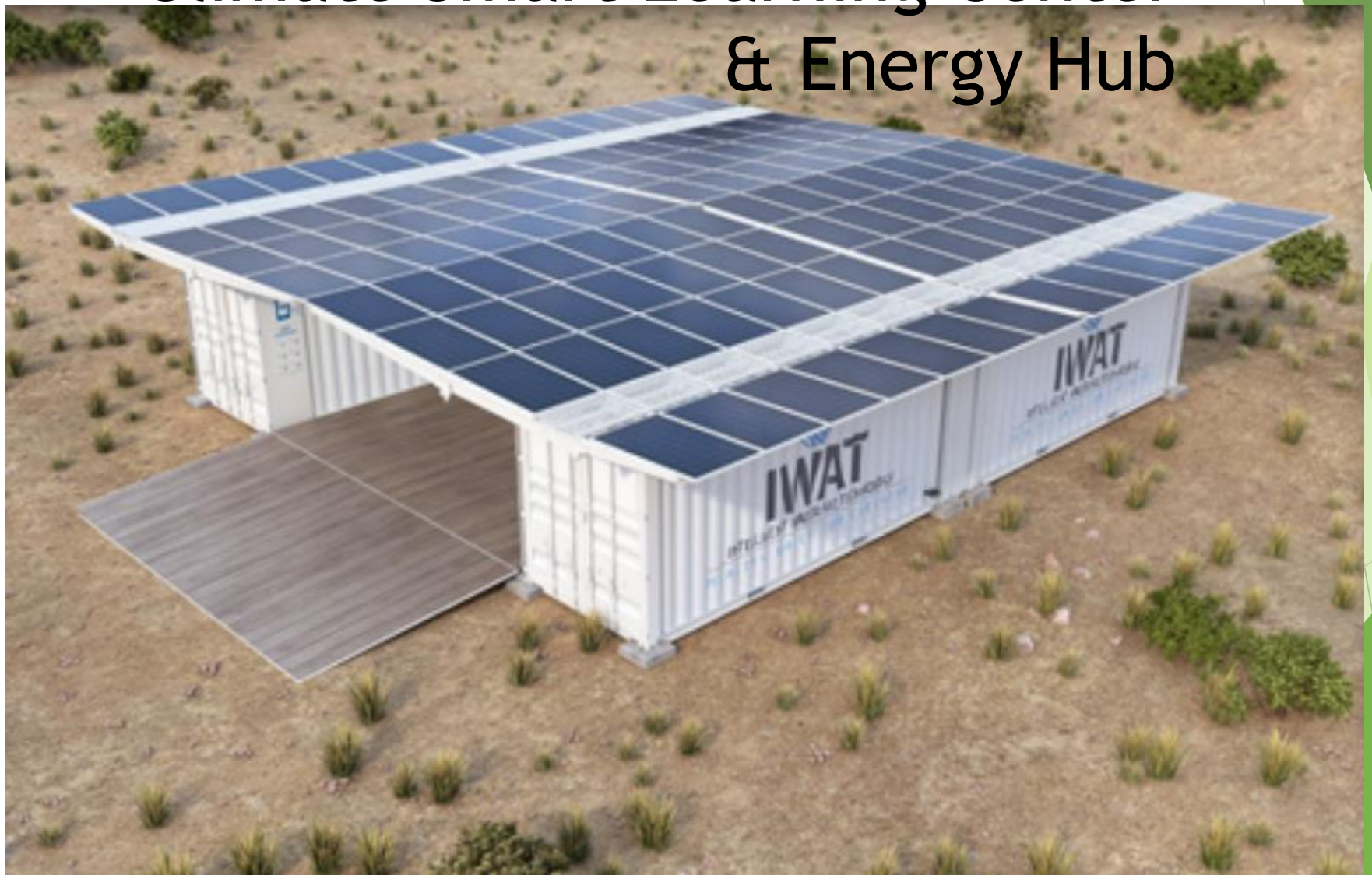
- Globally, education level tends to be the single strongest predictor of public awareness of climate change.
- 40 percent of adults worldwide have never heard of climate change

"Improving basic education, climate literacy and public understanding of the local dimensions of climate change are vital for public engagement and support for climate action"

Transforming Schools into Learning Laboratories and Energy Hubs

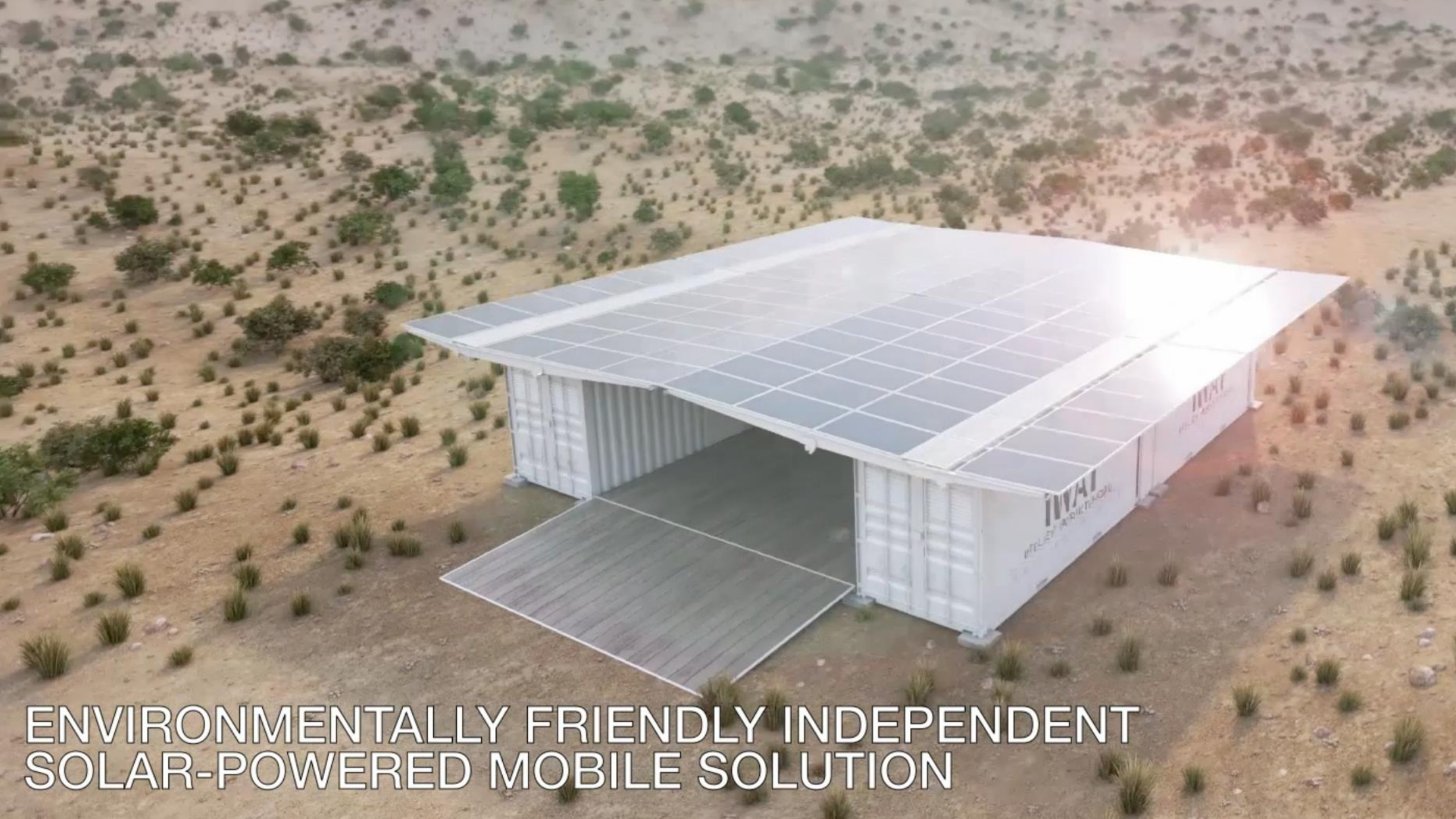
Casey Middle School in Boulder, Colorado

The Hive:
Climate Smart Learning Center & Energy Hub



Solar powered clean water

Super Efficient Solar PV


ENVIRONMENTALLY FRIENDLY INDEPENDENT
SOLAR-POWERED MOBILE SOLUTION


INAT


First Aid room
FREE
INTERNET
IWAT
Internet Spot
FREE
CHARGING
1 2
3 4
5 6
Phone charging

Medical Center, Living Lab and Classroom

State of the Art Energy Storage


World First Eco-Friendly Battery
Non-flammable, Non-toxic
Maintenance-Free

How Was It Funded?

- Smart Solar Learning Centers at every school and village over 1,000 inhabitants around the world
- 10 million Centers @ half a million USD (including training, curriculum, customization) = Five Trillion USD
- Self-sustaining but required initial investment

United Nations Framework Convention on Climate Change (UNFCCC) 1992

(i) **...Educational and public awareness** programmes on climate change and its effects;

(ii) **Public access to information** on climate change and its effects;

(iii) **Public participation** in addressing climate change and its effects and **developing adequate responses**

(iv) Training of scientific, technical and managerial personnel.

Article 6 of the Convention

United Nations
Framework Convention on
Climate Change

United Nations Framework Convention on Climate Change (UNFCCC) 1992

(i) **...Educational and public awareness**

(ii) **Public access to information**

(iii) **Public participation**
developing adequate responses

(iv) Training

Rebranded as ACE - Action for Climate Empowerment- in 2015

United Nations
Framework Convention on Climate Change

Paris Agreement Article 12: Capacity Building

Parties shall cooperate in taking measures…to

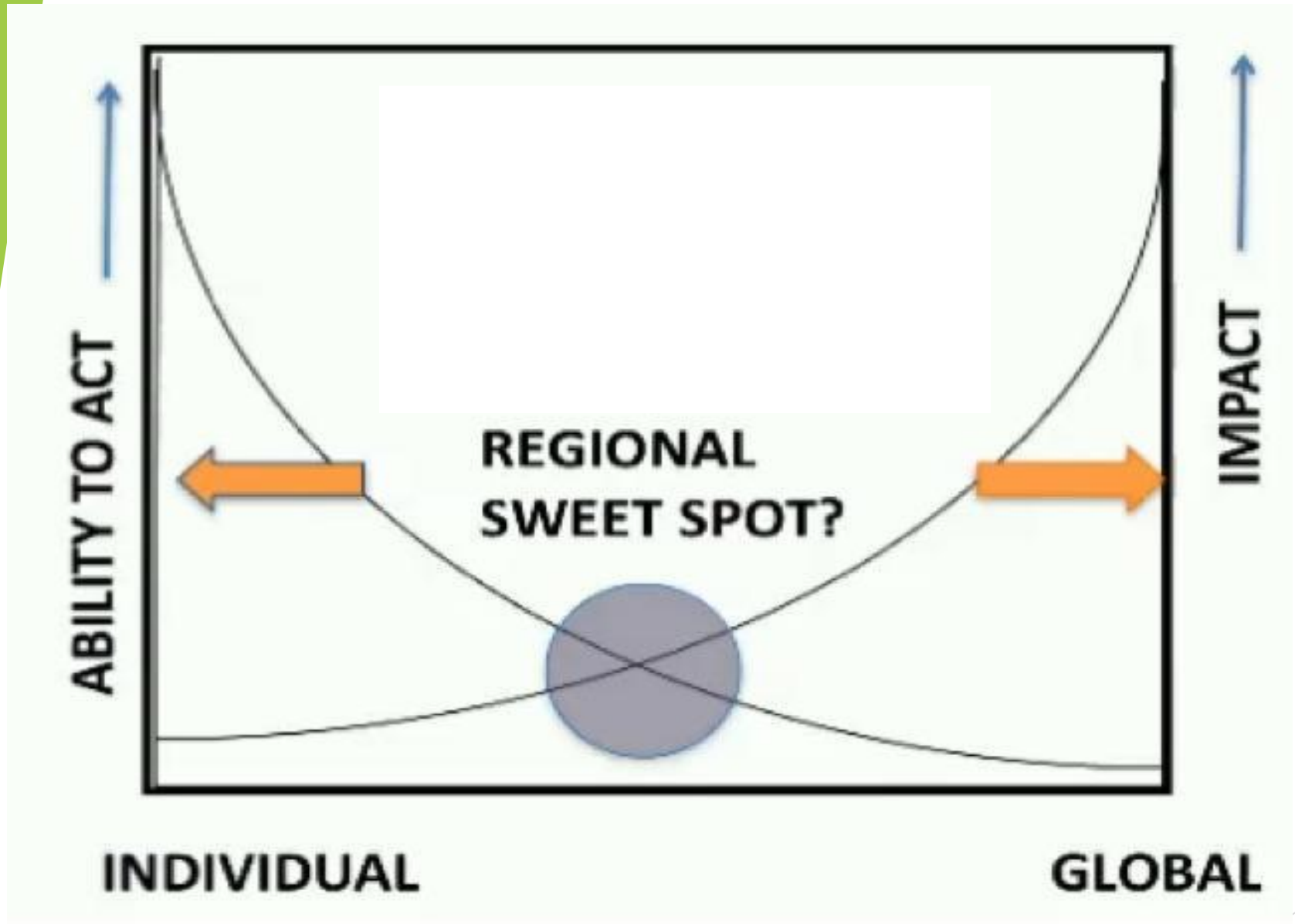
enhance climate change education, training, public awareness, public participation and public access to information,

recognizing the importance of these steps with respect to enhancing actions under this Agreement.

2015

COP21 · CMP11
PARIS 2015
UN CLIMATE CHANGE CONFERENCE

United Nations
Framework Convention on
Climate Change



P0 P1 P2 P3 P4 P5 P6 P7 P8 P9 P10

Other Cross-Scale Frameworks

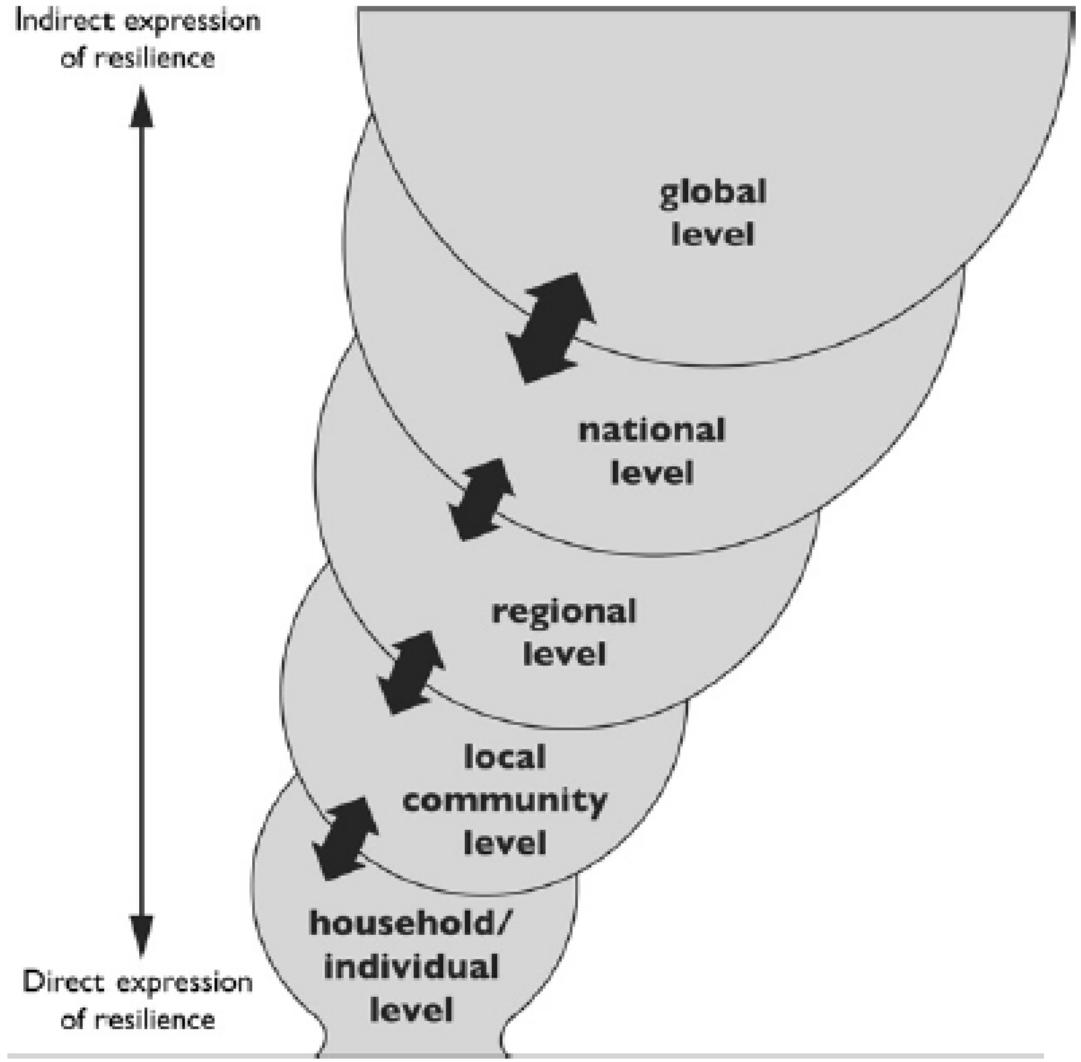
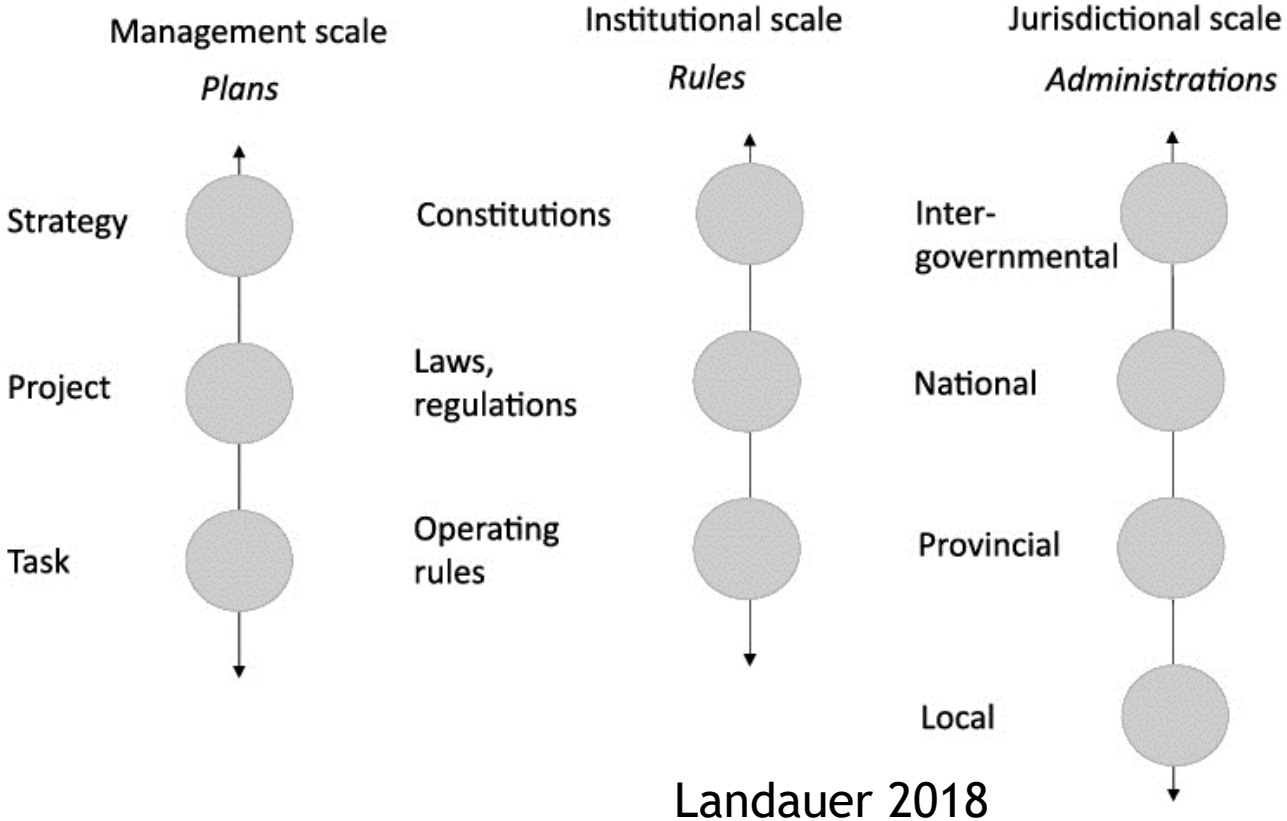


Fig. 1. The spatial scales of resilience. *Source*: Wilson (2012, p. 35).



Landauer 2018

Relative size of nation/states/cities

- USA (3rd largest nation) is one-third the size of India or China
- Average sized nation is about 38 million (Iraq or Poland)
- Median size is 8.8 million (Israel or Austria)
- ~40 megacities over 10 million
  - Combined total of more than double population of nations below median

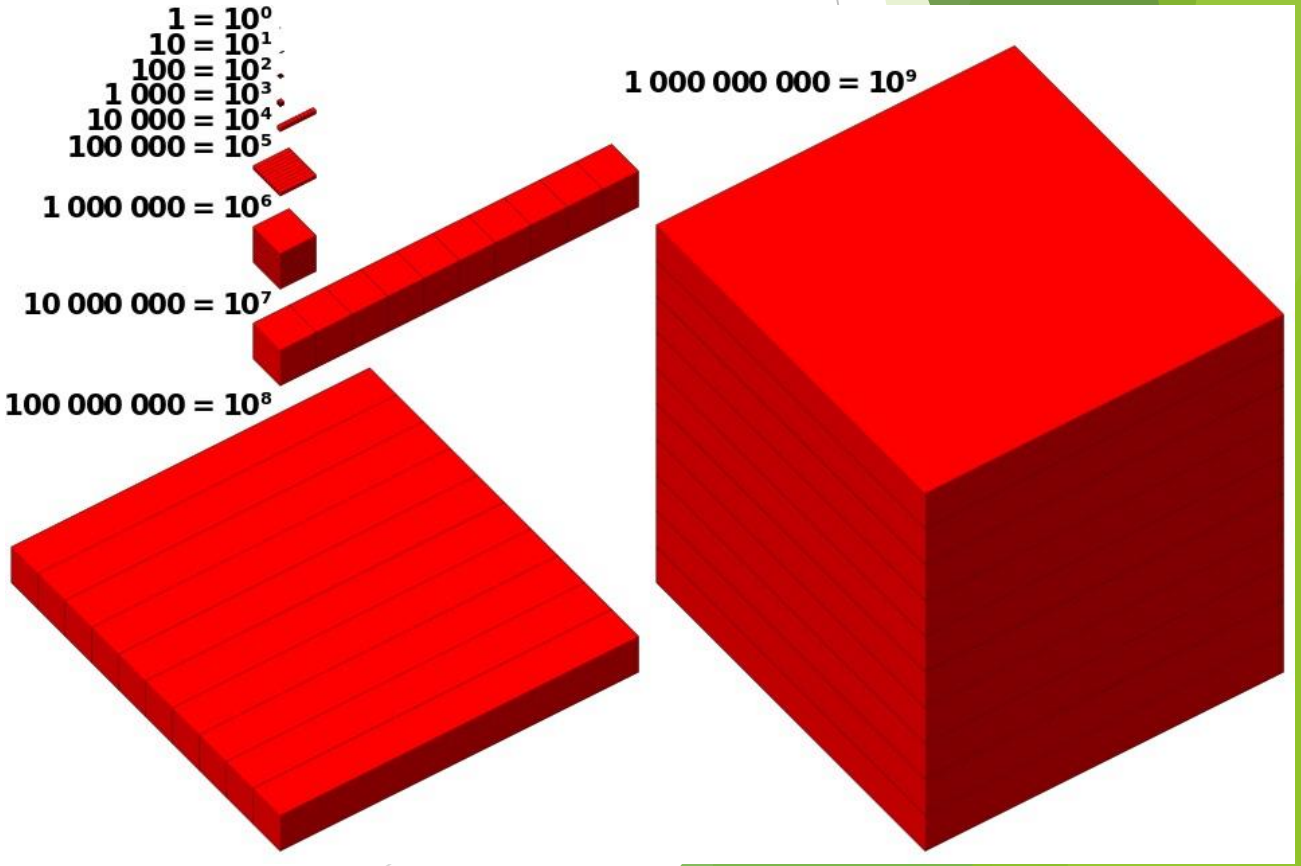
Relative size of cities/regions/communities

- Some cities larger than average-sized nation
- Regions are geo-spatial
  - Regional governance wide range
  - Vary widely (orders of magnitude) in size and population
- What do we mean by “community” in terms of number of people?

Exponents of 10
Used in Science, Taught in Math

Concept of scientific notation/powers of 10 used in scientific fields

We propose societal scaling framework from individual (10^0) to Ten Billion People (10^{10})



Human Population: Ten Orders of Magnitude

Cohort	Population Size	P10	Proposed Taxonomy (*Name:* Entities)
10^0	One	P0	***Individual***: each person on the planet
10^1	Ten	P1	***Family****:* couples, households, close friends, micro-business
10^2	One Hundred	P2	***Personal Network****:* extended family, near neighbours, peers at school/work, small-medium businesses, social network
10^3	One Thousand	P3	***Village*****:** rural towns, neighbourhoods and schools, colleges, farms
10^4	Ten Thousand	P4	***Community***: small municipalities, large companies, suburbs, universities
10^5	One Hundred Thousand	P5	***Metacommunity***: set of interacting communities, mid-sized municipalities, large enterprises
10^6	One Million	P6	***Urban****:* urban areas and cities, workforce of largest multinational entities
10^7	Ten Million	P7	***National***: megacities, states, nations, bioregions (e.g. Puget Sound)
10^8	One hundred million	P8	***Regional****:* transnational and sub-continental jurisdictions, entities or areas
10^9	One billion	P9	***Continental*****:** continental and multinational entities or areas
10^{10}	Ten Billion	P10	***Global*****:** global treaties, agreements and organizations

Individual

10^0

One

You are here!

CC: Avsar Aras

Close Family & Friends

Sauk family photographed - Frank Rinehart in 1899

10^1

Ten

>1

≤10

Extended Family & Coworkers

CC: Anna Frodesiak

10^2

One Hundred

Neighborhood & School

CC: Tomas Vinar

10^3

One Thousand

Village

Google Earth – Paszto, Hungary

10^4

Ten Thousand

10^5

Community

CC: Wikicommons – Las Cruces, NM USA

One Hundred Thousand

Where People/Planet, Local/Global Converge

10^5

CC: Wikicommons – Neyland Stadium

One Hundred Thousand

10^6

Urban

Boston, Massachusetts CC: Werner Kunz

One Million

State/Metropolis

CC: Mexico City

10^7

Ten Million

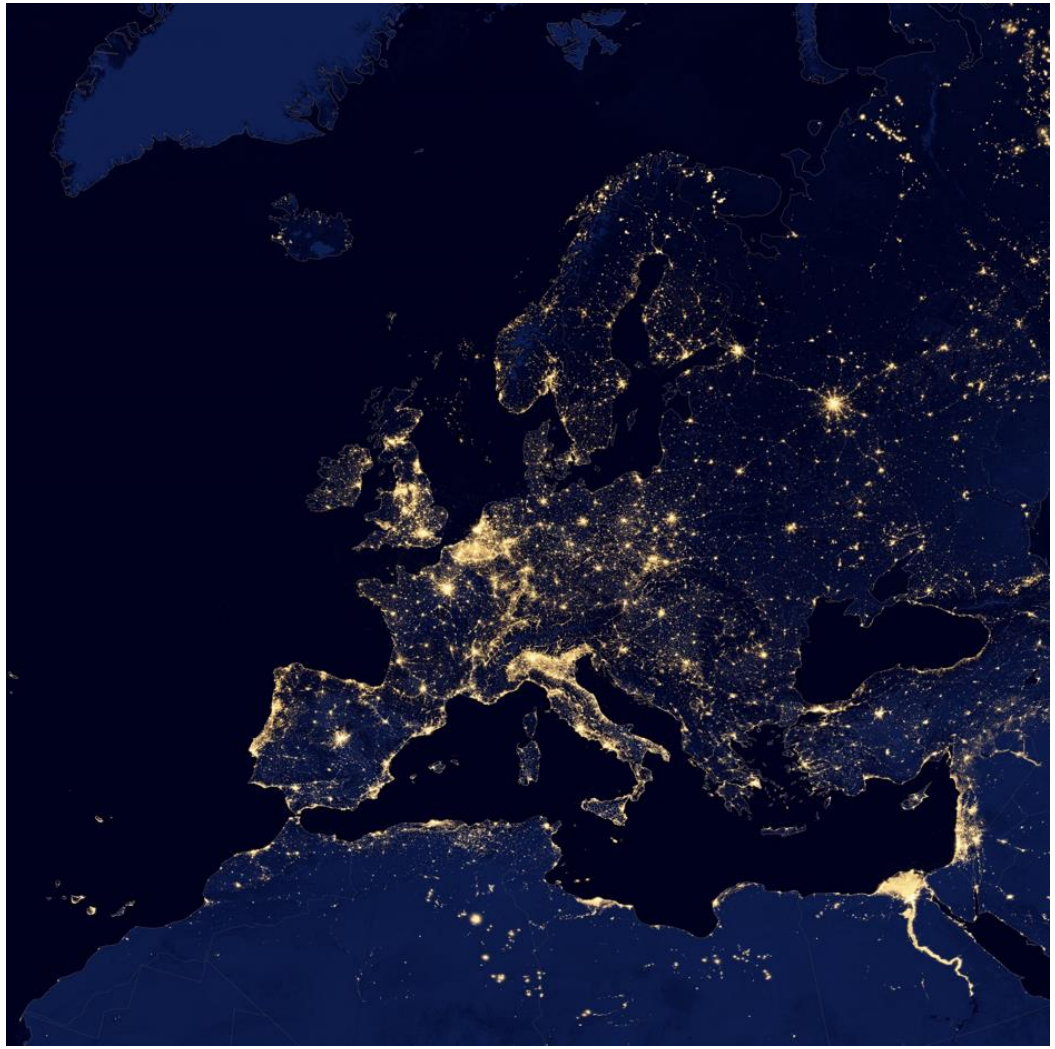
10^8

One Hundred Million

Transnational

NASA: Lights at Night of Egypt

Continental



NASA: Lights at Night of Europe

10^9

One Billion

Global

10^{10}

Ten Billion

What do we know about transformation?

- Every individual can transform the world (Waldrop, 2016)
- And some more than others...

Image courtesy of Euronews

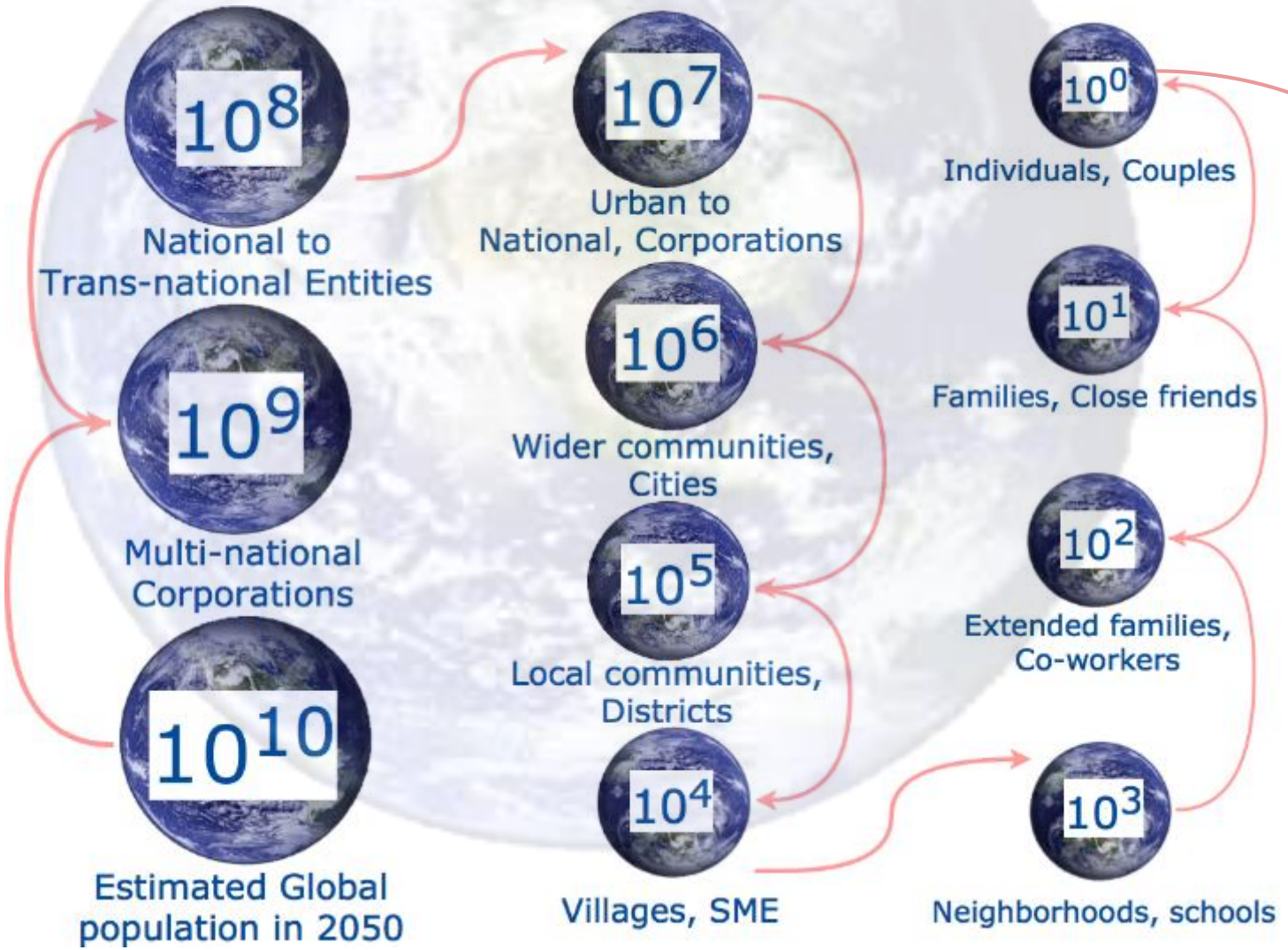
Eight men own the same wealth as the 3.6 billion people who make up the poorest half of humanity.

2017 Oxfam Report

- Global transformation requires transformation in **beliefs, behaviors and lifestyles** as well as infrastructures (O´Brien and Sygna, 2013)

“powers of 10” framework for society

with common but differentiated responsibilities

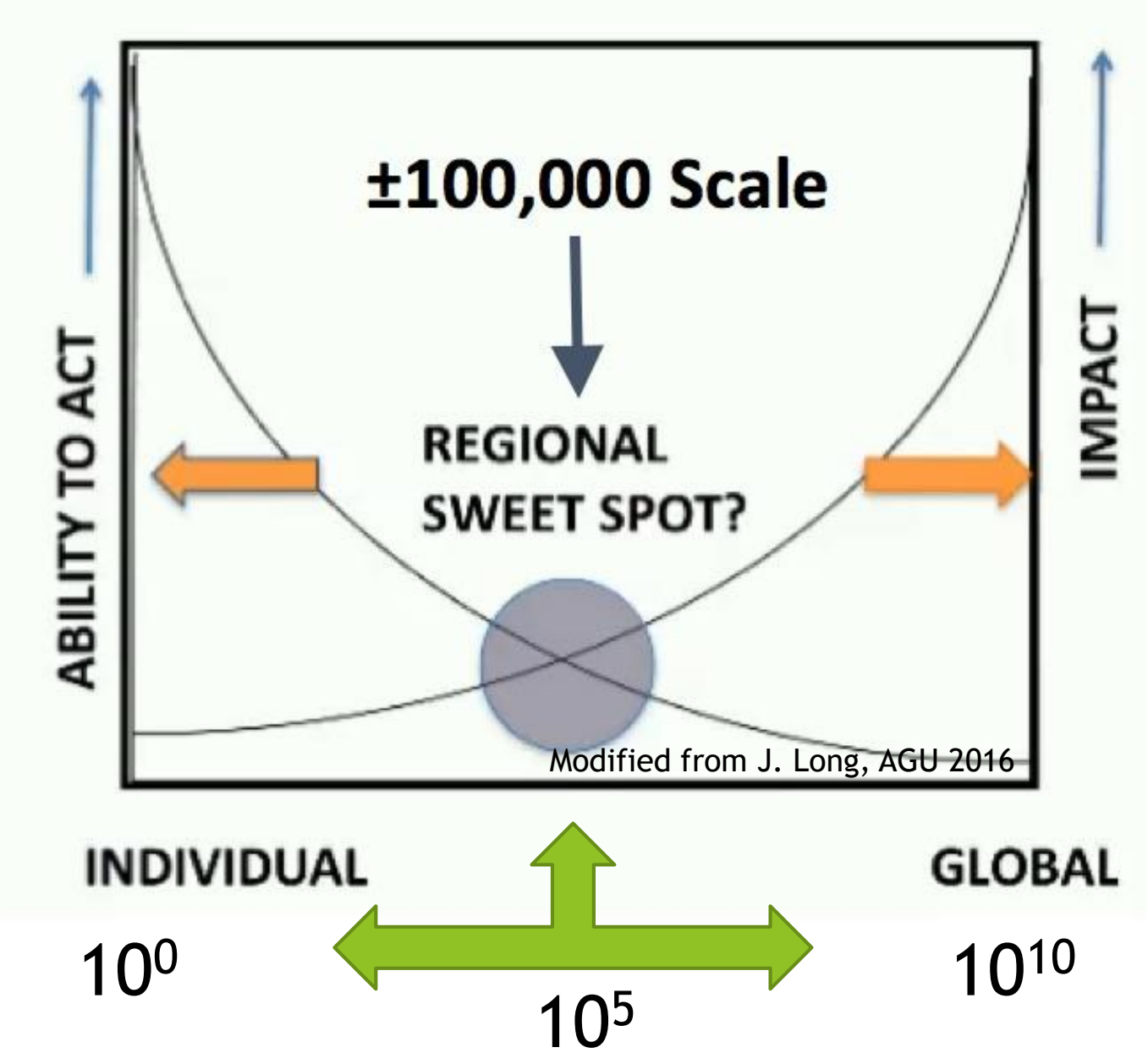


10X “degrees of separation” between individual and global cohort

Is there a “Sweet Spot” in the Middle?

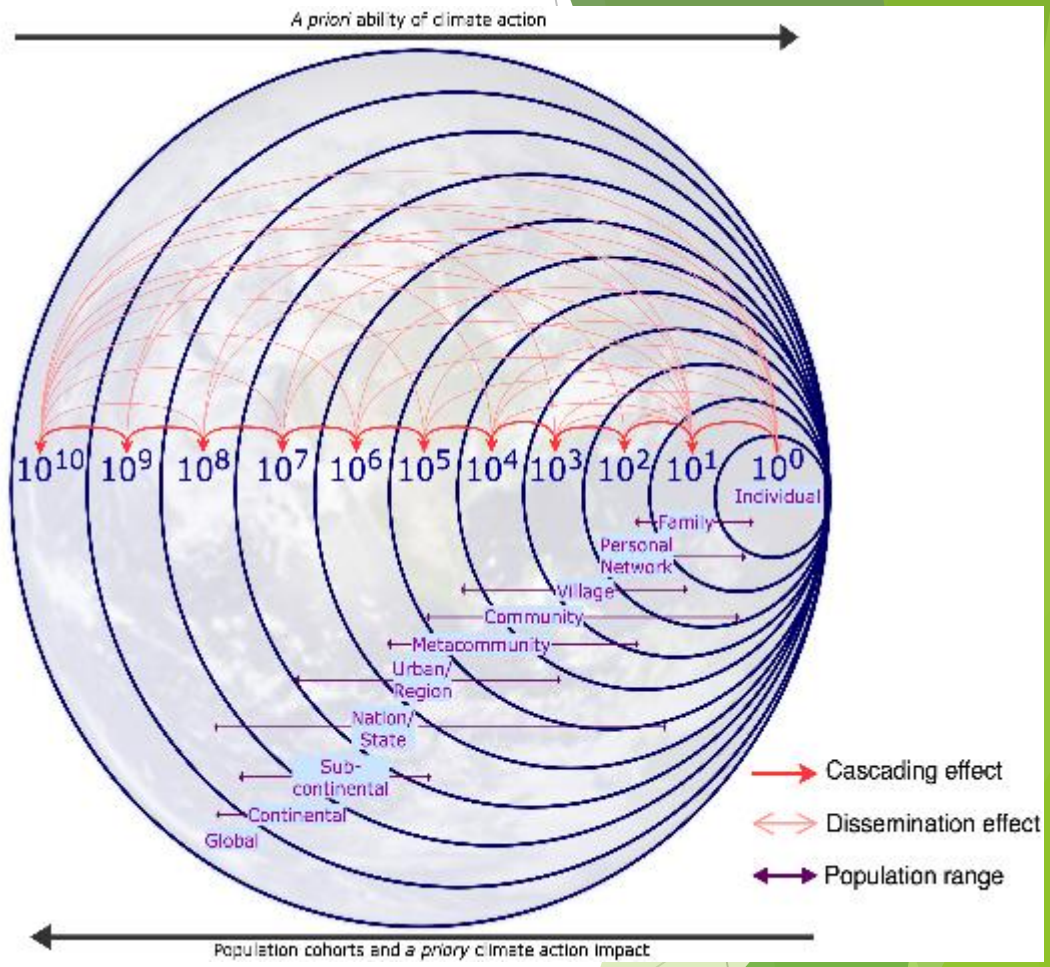
Think Global/Local

Act Local/Global



Powers of 10: a cross-scale optimization framework for rapid sustainability transformation

- **Avit K. Bhowmik,** Future Earth and Stockholm Resilience Centre
- **Mark S. McCaffrey,** Institute for Sustainable Development Studies, National University for Public Service, Budapest
- **Chad Frischmann**, Project Drawdown
- **Owen Gaffney,** Future Earth and Stockholm Resilience Centre
- **Abigail M. Ruskey,** U.S. Partnership for Education for Sustainable Development



Submitted Manuscript 2018
EarthARXIV Preprint Available

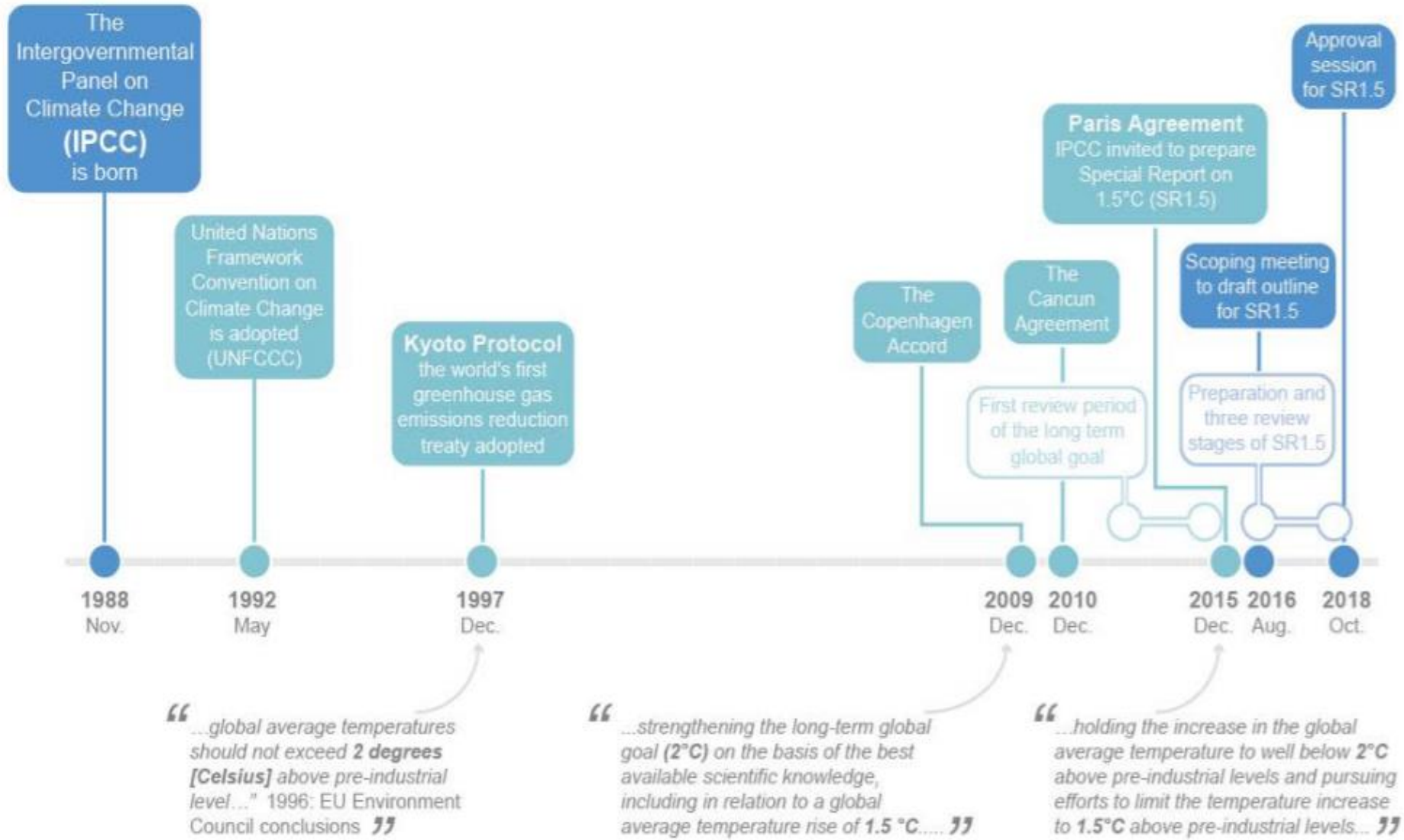
United Nations
Framework Convention on
Climate Change

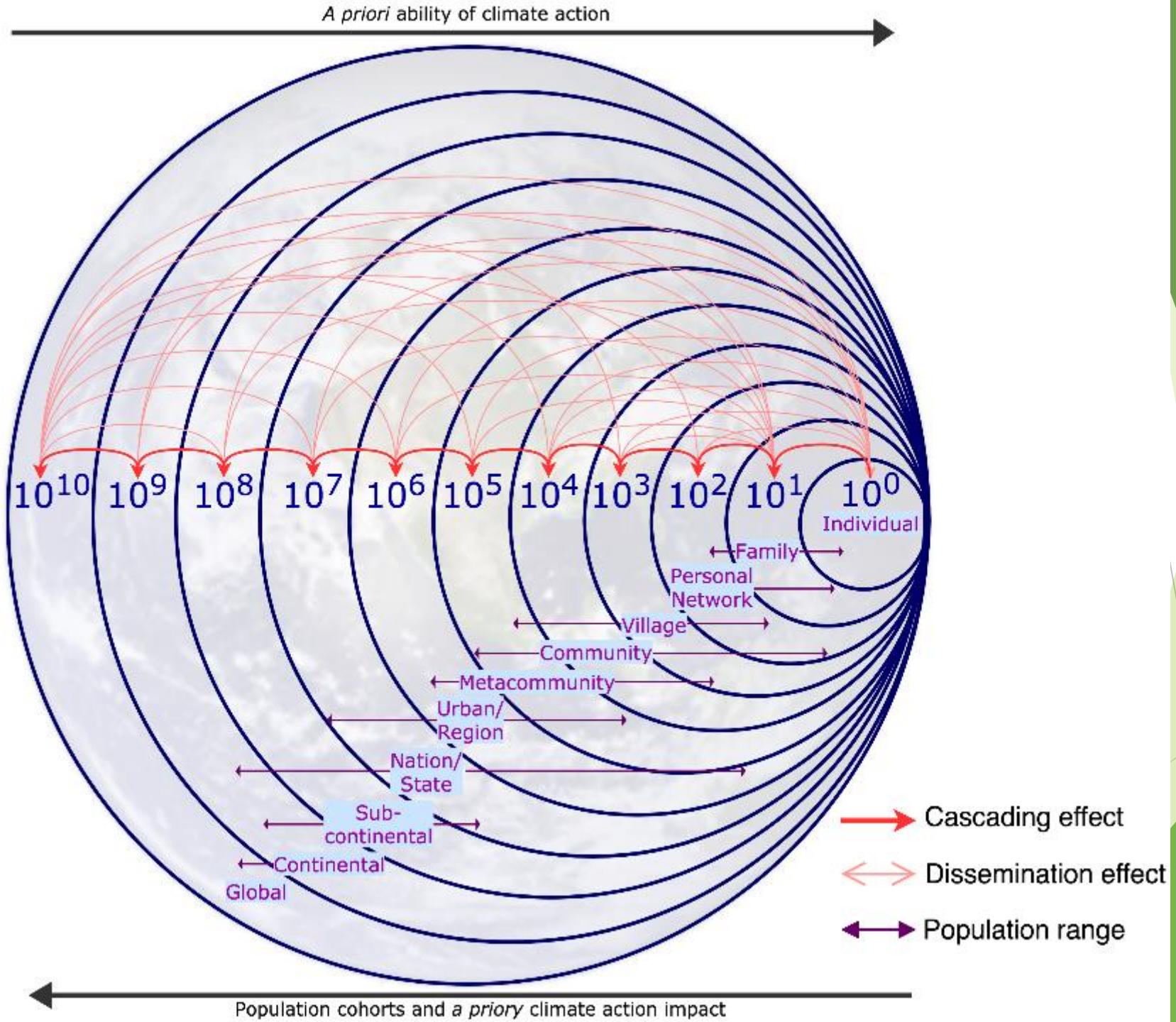
- Public participation in addressing climate change and its effects and developing adequate responses

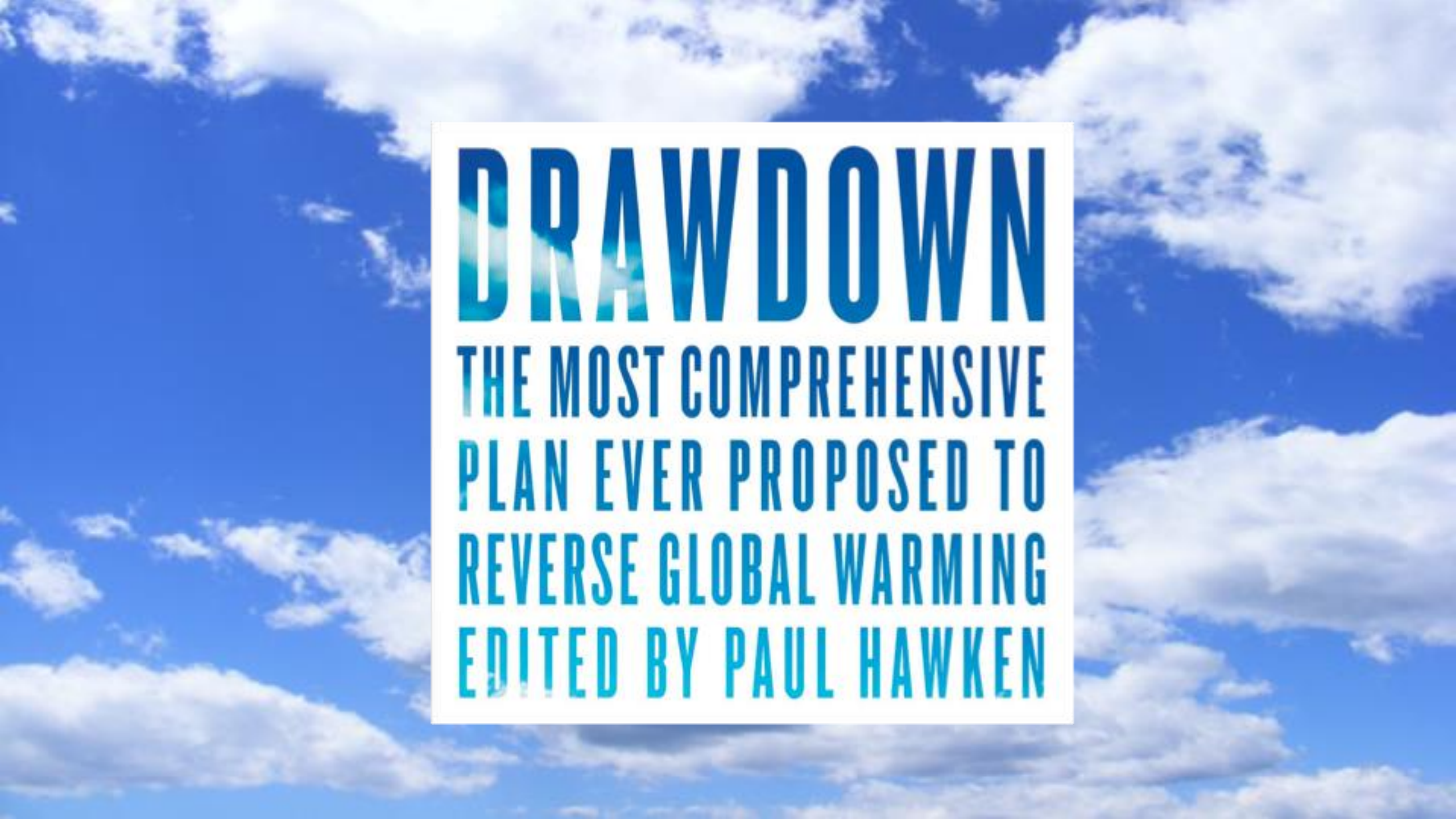
ARTICLE 6: EDUCATION, TRAINING AND PUBLIC AWARENESS

FAQ1.1: **Timeline of 1.5°C**

Milestones in the IPCC's preparation of the Special Report on Global Warming of 1.5°C and some relevant events in the history of international climate negotiations

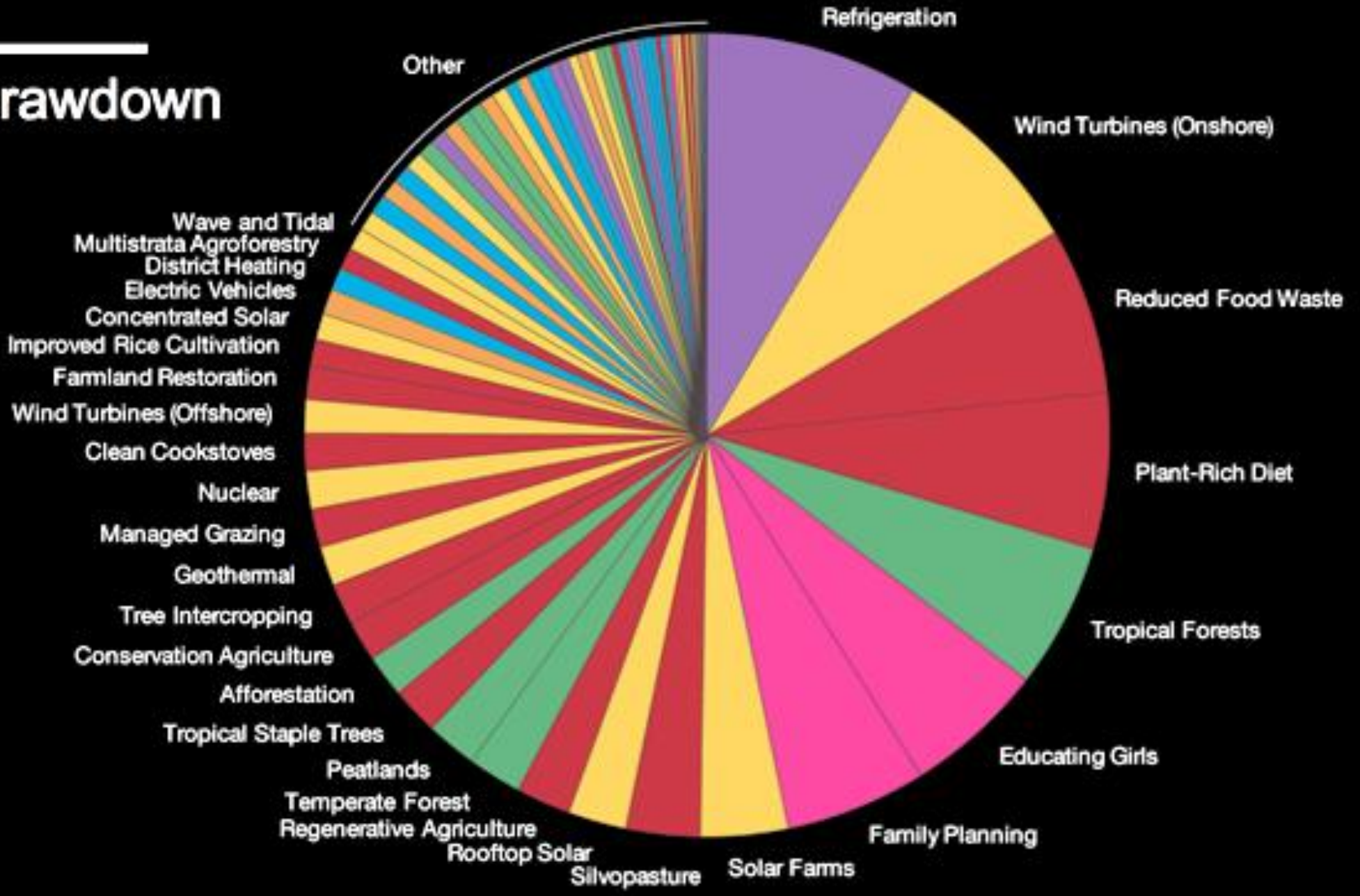



A priori ability of climate action
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
10^{5}
10^{4}
10^{3}
10^{2}
10^{1}
10^{0}
Individual
Family
Personal Network
Village
Community
Metacommunity
Urban/ Region
Nation/ State
Sub-continental
Continental
Global
Cascading effect
Dissemination effect
Population range
Population cohorts and *a priory* climate action impact


DRAWDOWN
THE MOST COMPREHENSIVE
PLAN EVER PROPOSED TO
REVERSE GLOBAL WARMING
EDITED BY PAUL HAWKEN

Drawdown is that point in time when the
of greenhouse gases peak and begin to decline on a year-to-year basis.

Drawdown


Refrigeration
Wind Turbines (Onshore)
Reduced Food Waste
Plant-Rich Diet
Tropical Forests
Educating Girls
Family Planning
Solar Farms
Silvopasture
Rooftop Solar
Regenerative Agriculture
Temperate Forest
Peatlands
Tropical Staple Trees
Afforestation
Conservation Agriculture
Tree Intercropping
Geothermal
Managed Grazing
Nuclear
Clean Cookstoves
Wind Turbines (Offshore)
Farmland Restoration
Improved Rice Cultivation
Concentrated Solar
Electric Vehicles
District Heating
Multistrata Agroforestry
Wave and Tidal
Other

TOP 20

RANK	SOLUTION	SECTOR	REDUCED CO2
1	**Refrigeration**	Materials	89.74 GT
2	**Wind Turbines (Onshore)**	Energy	84.60 GT
3	**Reduced Food Waste**	Food	70.53 GT
4	**Plant-Rich Diet**	Food	66.11 GT
5	**Tropical Forests**	Land Use	61.23 GT
6	**Educating Girls**	Women and Girls	59.60 GT
7	**Family Planning**	Women and Girls	59.60 GT
8	**Solar Farms**	Energy	36.90 GT
9	**Silvopasture**	Food	31.19 GT
10	**Rooftop Solar**	Energy	24.60 GT
11	**Regenerative Agriculture**	Food	23.15 GT
12	**Temperate Forest**	Land Use	22.61 GT
13	**Peatlands**	Land Use	21.57 GT
14	**Tropical Staple Tree Crops**	Food	20.19 GT
15	**Afforestation**	Land Use	18.06 GT
16	**Conservation Agriculture**	Food	17.35 GT
17	**Tree Intercropping**	Food	17.20 GT
18	**Geothermal**	Energy	16.60 GT
19	**Managed Grazing**	Food	16.34 GT
20	**Nuclear**	Energy	16.09 GT

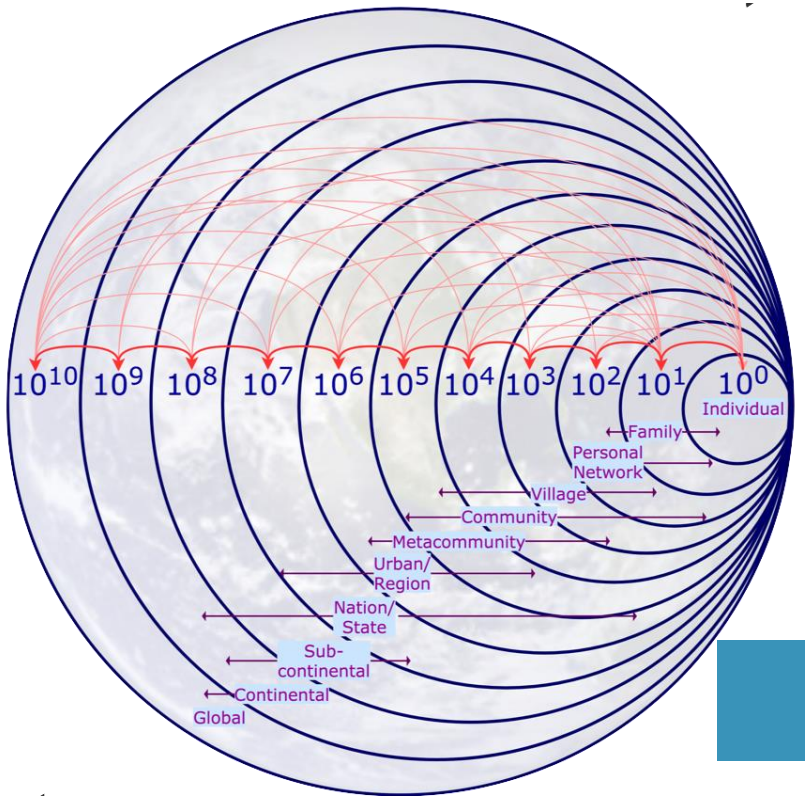
CONCEPT OF AGENCY

Critical mass for decision making and implementation,
who benefit and lose first hand (Bandura, 2006; Archer, 1996)

Individual **Proxy** **Collective**

AGENCIES FOR IMPLEMENTING DRAWDOWN SOLUTIONS

AGENCY



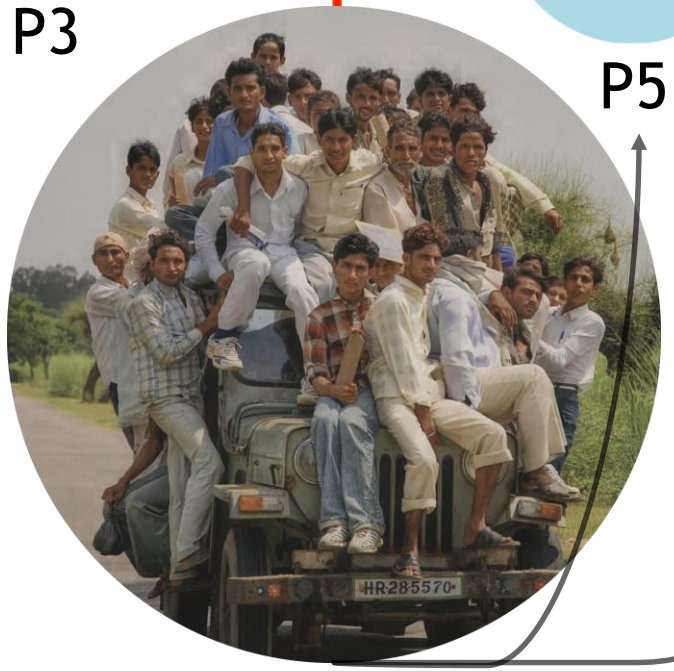
DRAWDOWN

Educating Girls
Total CO_{2e} reduced: 59.60 Gt

Optimal Agency Cohorts: Individual – Community
CO_{2e} reduced at individual (P0): 3.78 Gt

SWEET SPOT

P4: Community



40.05
P0

104.9
P1

96.87
P2

130.51
P3

179.05

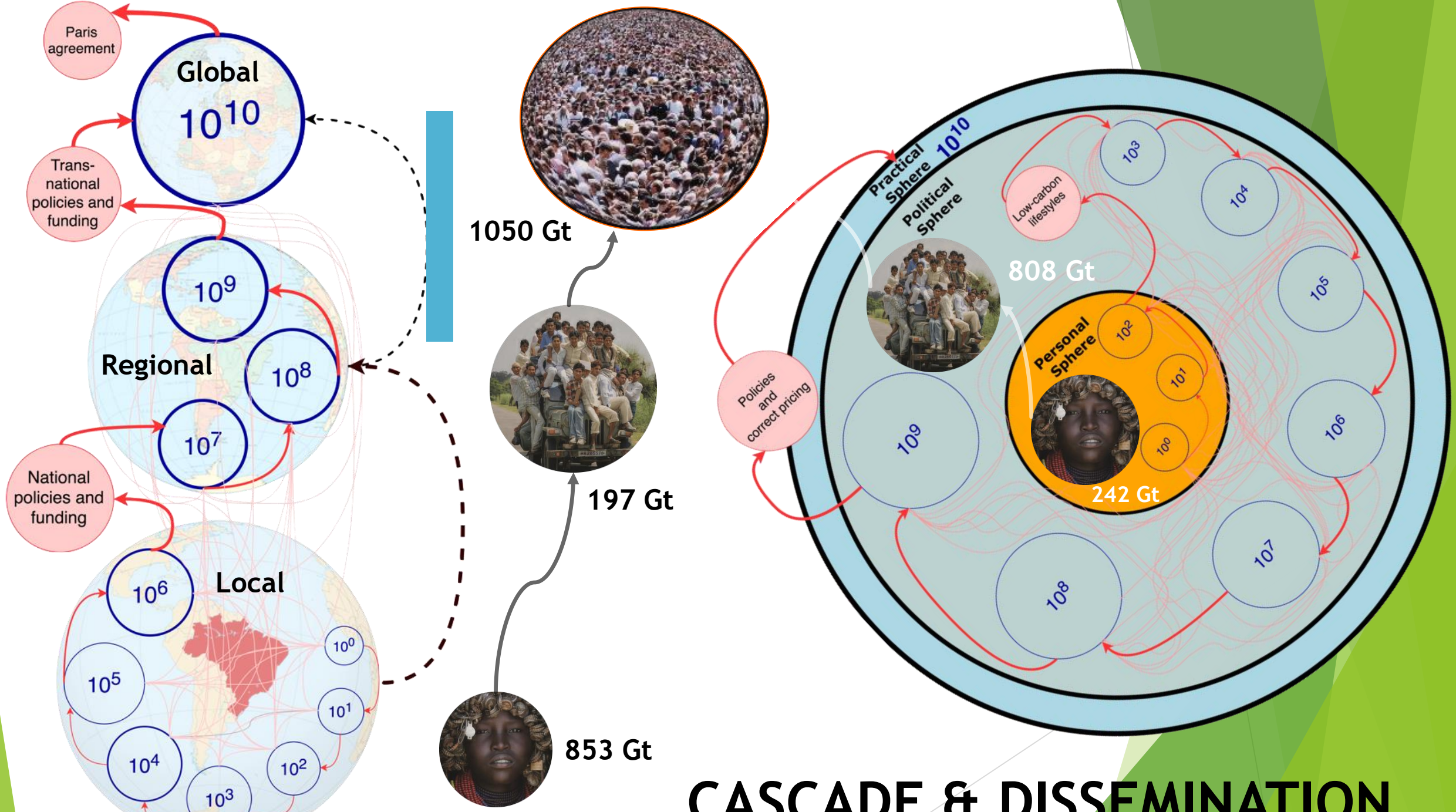
149.39
P5

152.46
P6

128.59
P7

68.23
P8

179 Gt CO_{2e} reduced with 56 climate action strategies USD 8 trillion benefit



CASCADE & DISSEMINATION

CLIMATE ACTION AT SCALE THAT MATTERS

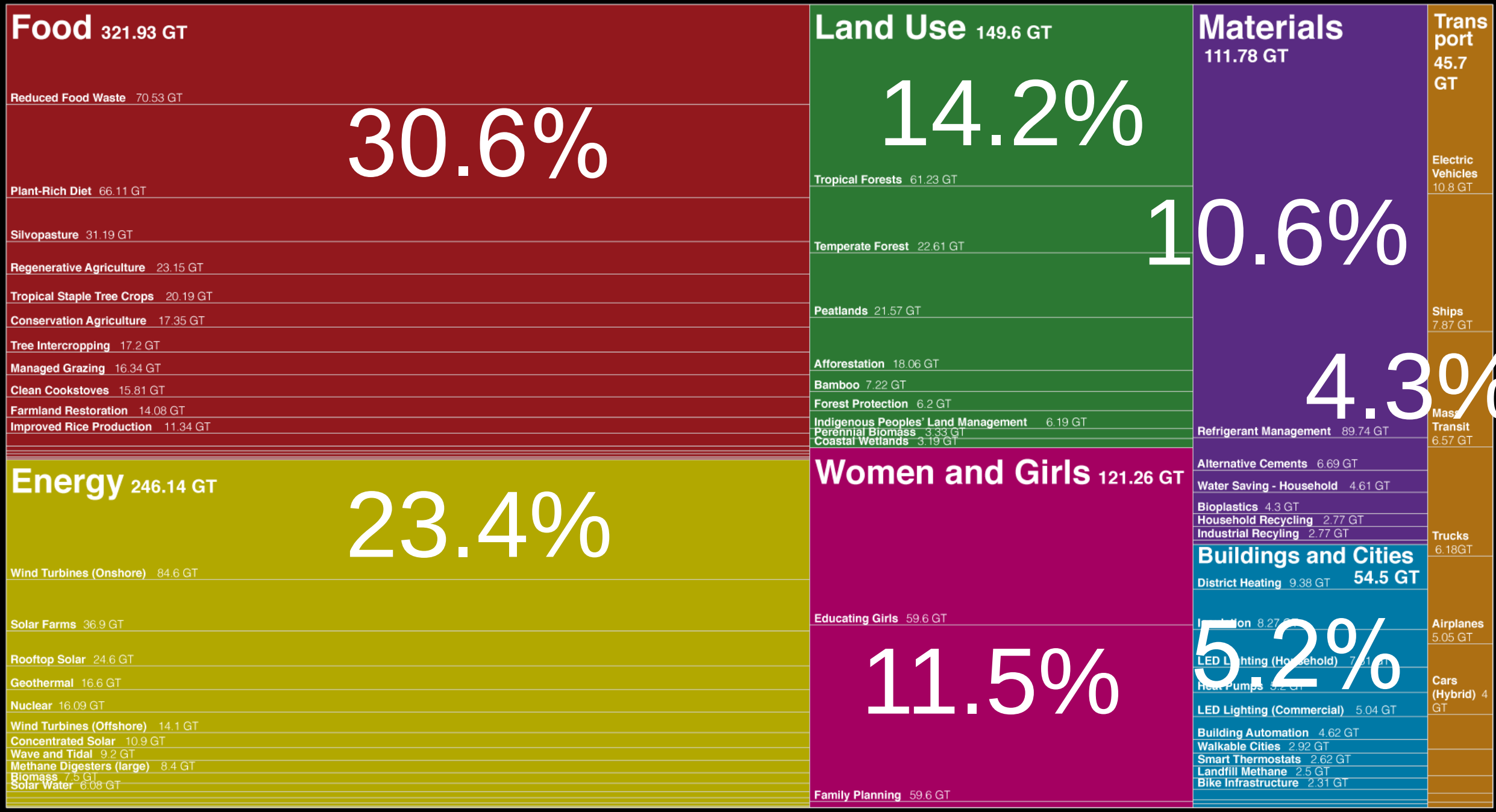
WE NEED TO GET AWAY FROM THE NATIONAL SCALE FOCUS AND PRIORITIZE COMMUNITY TO URBAN SCALE EFFORTS

Alesina, 2003; Wilson, 2012

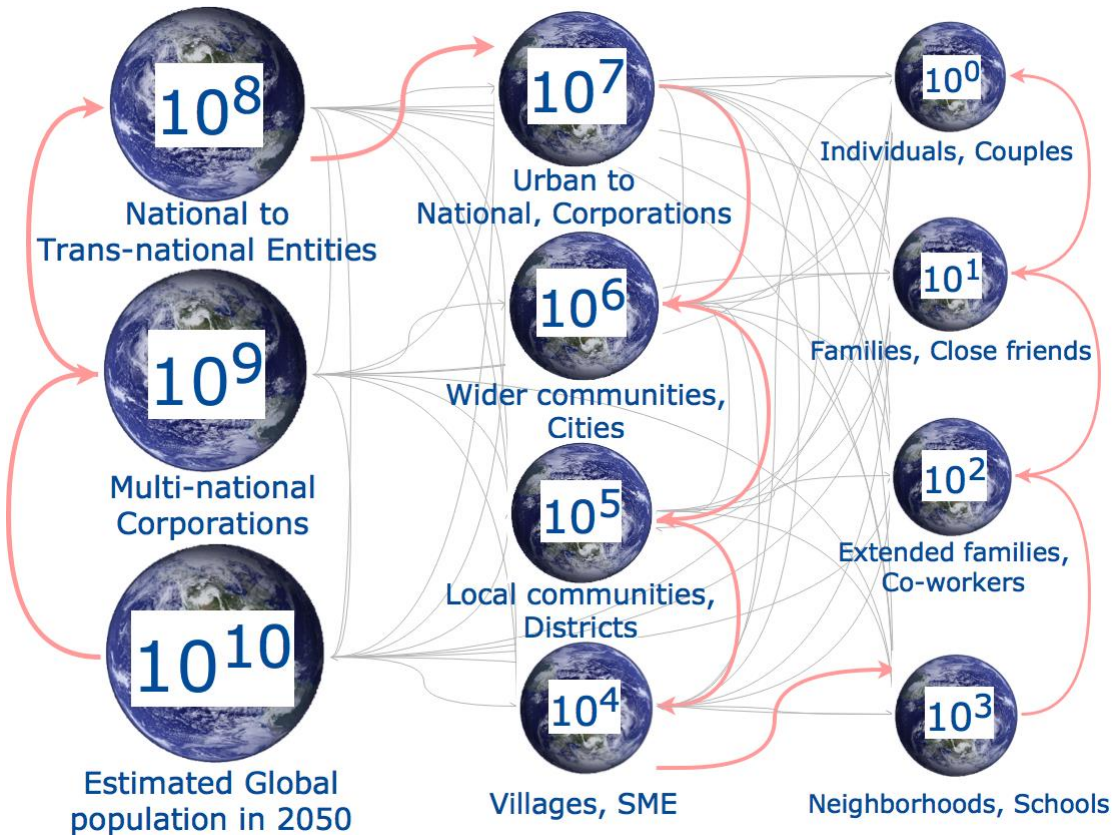
Major Finding:

The "sweet spot" to scale Drawdown strategies—and rapidly curb and sequester greenhouse gases—is at the community to metacommunity P4-P5 or 10,000 to 100,000 population scale…

providing there is also alignment with larger scale solutions and policies (P6-10) and strong amplification of individual, household and neighborhood efforts (P0-3).


Food 321.93 GT
30.6%
Reduced Food Waste 70.53 GT
Plant-Rich Diet 66.11 GT
Silvopasture 31.19 GT
Regenerative Agriculture 23.15 GT
Tropical Staple Tree Crops 20.19 GT
Conservation Agriculture 17.35 GT
Tree Intercropping 17.2 GT
Managed Grazing 16.34 GT
Clean Cookstoves 15.81 GT
Farmland Restoration 14.08 GT
Improved Rice Production 11.34 GT
Land Use 149.6 GT
14.2%
Tropical Forests 61.23 GT
Temperate Forest 22.61 GT
Peatlands 21.57 GT
Afforestation 18.06 GT
Bamboo 7.22 GT
Forest Protection 6.2 GT
Indigenous Peoples' Land Management 6.19 GT
Perennial Biomass 3.33 GT
Coastal Wetlands 3.19 GT
Materials
111.78 GT
10.6%
4.3%
Refrigerant Management 89.74 GT
Alternative Cements 6.69 GT
Water Saving - Household 4.61 GT
Bioplastics 4.3 GT
Household Recycling 2.77 GT
Industrial Recyling 2.77 GT
Trans port 45.7 GT
Electric Vehicles 10.8 GT
Ships 7.87 GT
Mas Transit 6.57 GT
Trucks 6.18GT
Airplanes 5.05 GT
Cars (Hybrid) 4 GT
Energy 246.14 GT
23.4%
Wind Turbines (Onshore) 84.6 GT
Solar Farms 36.9 GT
Rooftop Solar 24.6 GT
Geothermal 16.6 GT
Nuclear 16.09 GT
Wind Turbines (Offshore) 14.1 GT
Concentrated Solar 10.9 GT
Wave and Tidal 9.2 GT
Methane Digesters (large) 8.4 GT
Biomass 7.5 GT
Solar Water 6.08 GT
Women and Girls 121.26 GT
Educating Girls 59.6 GT
11.5%
Family Planning 59.6 GT
Buildings and Cities
54.5 GT
District Heating 9.38 GT
5.2%
LED Lighting (Commercial) 5.04 GT
Building Automation 4.62 GT
Walkable Cities 2.92 GT
Smart Thermostats 2.62 GT
Landfill Methane 2.5 GT
Bike Infrastructure 2.31 GT

Determine common but differentiated responsibilities



Range of implementation

BUILDINGS AND CITIES

DISTRICT HEATING

With district systems, a central plant channels hot and/or cool water via a network of pipes to many buildings—heating and cooling them more

WOMEN AND GIRLS

EDUCATING GIRLS

Education lays a foundation for vibrant lives for girls and women, their families, and their communities. It also avoids emissions by curbing population growth.

TRANSPORT

ELECTRIC BIKES

Electric bikes get a boost from a small battery-powered motor. They are the most environmentally sound means of motorized transport in the world today.

FOOD

FARMLAND RESTORATION

The world's abandoned farmland is an opportunity for drawdown. Restoring it sequesters carbon and can improve food security, farmers' livelihoods, and ecosystem health.

LAND USE

FOREST PROTECTION

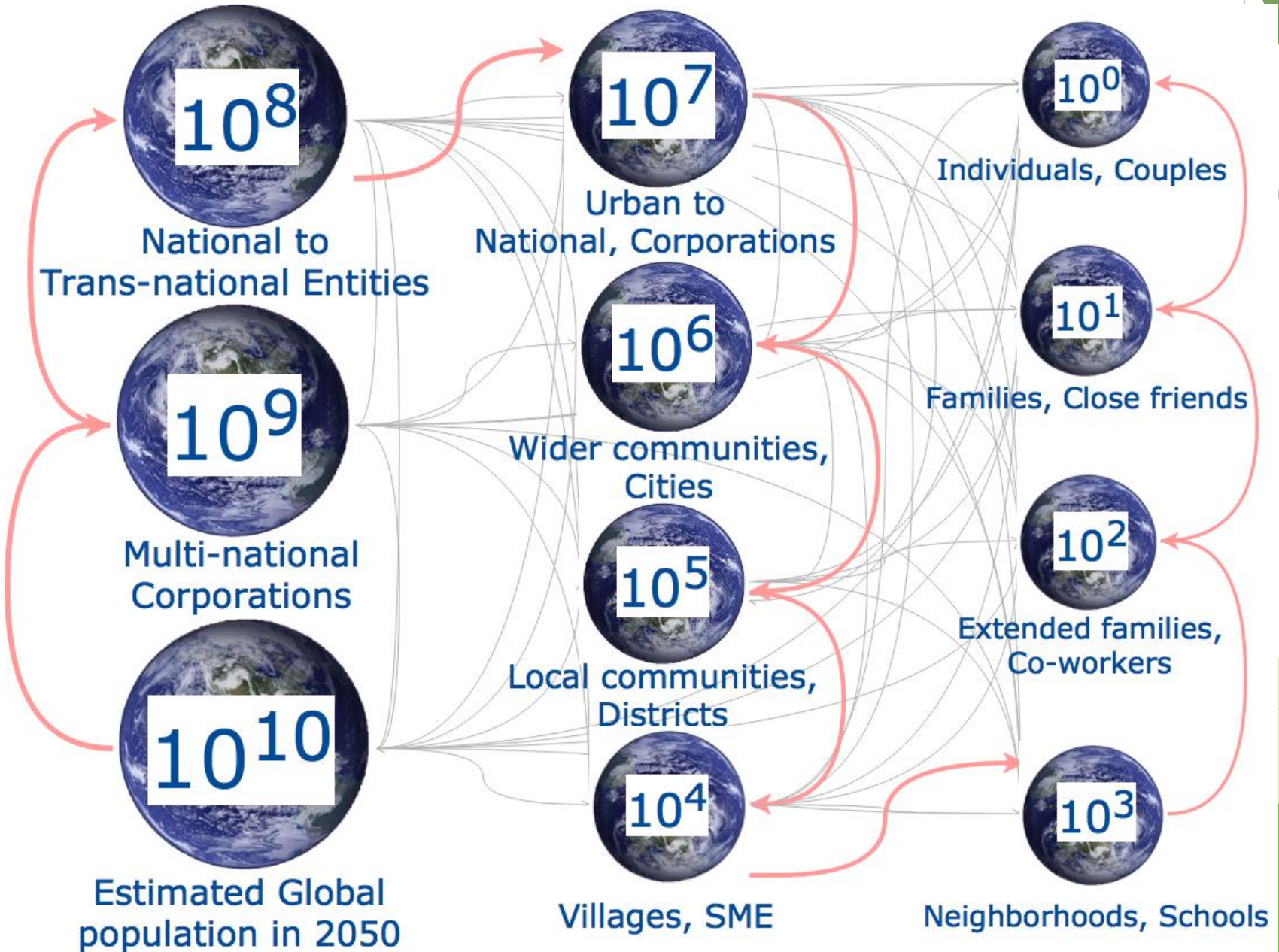
With mature canopy trees and complex understories, primary forests contain 300 billion tons of carbon and are the greatest repositories of biodiversity on the planet.

ENERGY

GEOTHERMAL

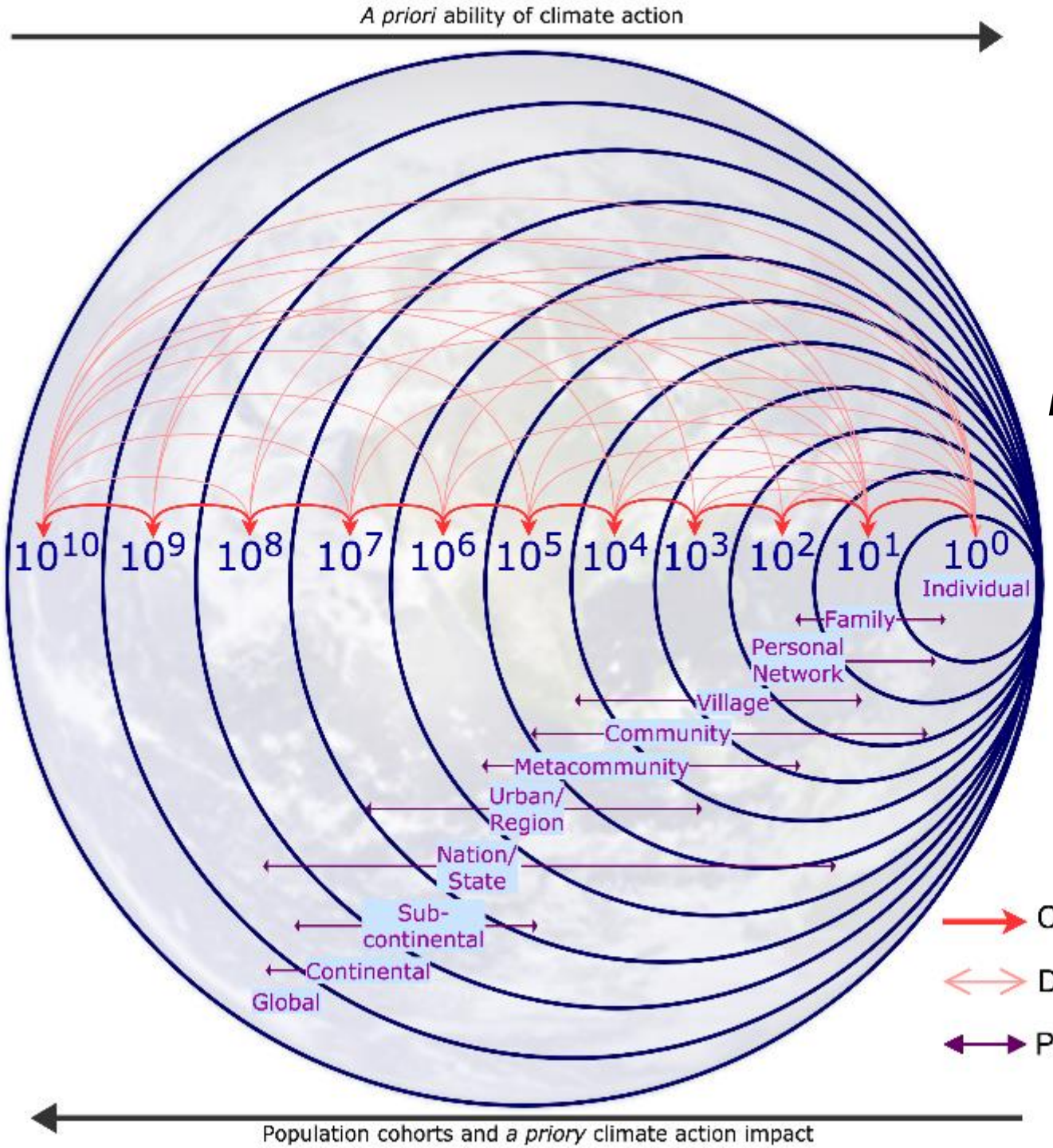
Geothermal power—literally "earth heat"—taps into underground reservoirs of steamy hot water, which can be piped to the surface to drive turbines that produce electricity.

We live in a hyperconnected world



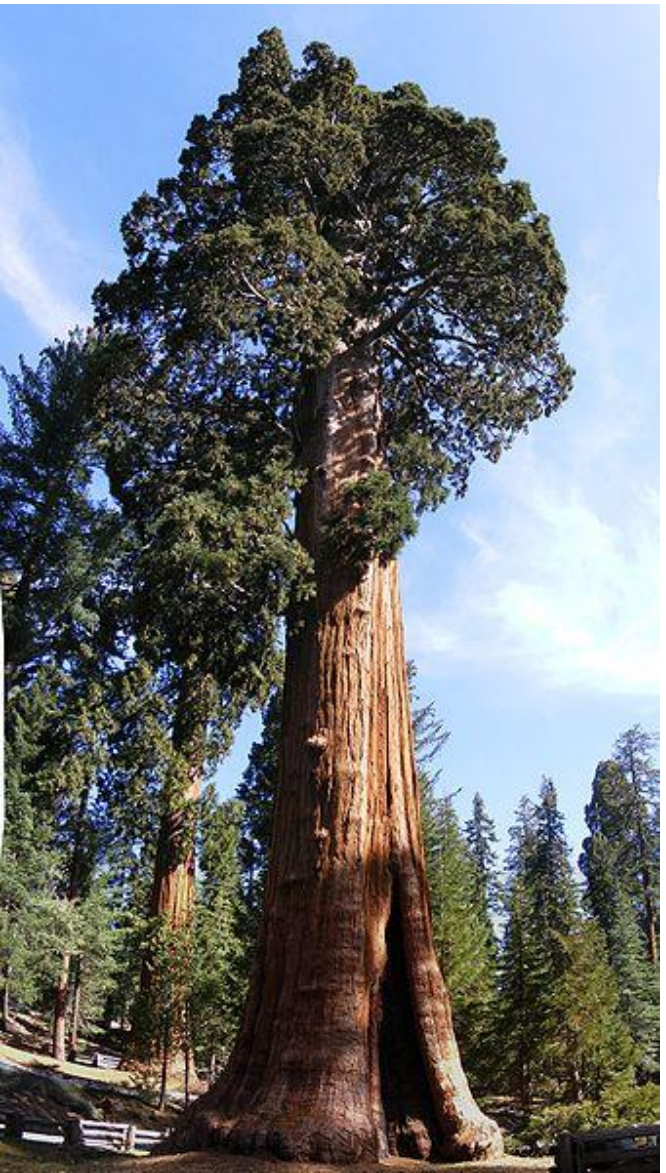
(Waldrop, 2016)


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIE AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS



Powers of 10 as Mental Model for seeing how I am nested within and connected to the global village.

PLAN FOR THE FUTURE



- Planning for 1 year: plant rice
- Planning for 10 years: plant a tree
- Planning for 100 years: educate children
- Planning for 1000 years: inform, inspire & engage society