

Discussion #3: Opposite Paths to Success: New Guinea, Tikopia, and Japan

Ross Salawitch

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Class Web Site: <http://www.atmos.umd.edu/~rjs/class/honr229L>

ELMS Page: <https://myelms.umd.edu/courses/1269254>



<https://www.worldatlas.com/webimage/countrys/oceania/pg.htm>

<https://atomvoyages.com/articles/cruising-destinations/232-tikopia-island-a-little-known-outpost-of-traditional-culture-in-the-south-pacific.html>

10 September 2019

Learning Enrichment, Event 1

Event: [How to Talk About Carbon Removal: Critical Questions About Climate Change Futures](#)

Date: Thurs, September 12 Time: 8:30 AM to 10:30 am (talk begins promptly at 9 am)

Location: ASU Barrett & O'Connor Washington Center, 1800 I St NW, 8th floor

Speaker: Matthew Nisbet, Northeastern University:

<https://camd.northeastern.edu/faculty/matthew-c-nisbet>

Website: <https://www.eventbrite.com/e/how-to-talk-about-carbon-removal-critical-questions-about-climate-change-futures-tickets-69346018809>

What if there was an efficient, cost-effective, and globally scaled technology that pulled carbon dioxide out of the atmosphere – or smokestack, or exhaust pipe – and safely stored it underground forever? What a game-changer! The politics around climate change would shift dramatically. Rancorous fights over emissions and temperature targets would become moot; the urgency for transitioning to a low-carbon energy system would diminish; and fears of impending global catastrophe would be allayed.

Unfortunately, this carbon removal and storage technology remains almost entirely speculative. Small-scale pilots are only beginning to illuminate the technology's technical feasibility, cost, and associated impacts.

So why do plans for keeping global temperatures below 1.5°C depend on the deployment of this hypothetical technology? Large-scale carbon capture has become an implicit, but critical, component of many climate proposals. No less an authority than the Intergovernmental Panel on Climate Change relies on unproven, uncertain carbon dioxide removal technologies to meet its ambitious targets.

Join Northeastern University professor **Matthew Nisbet** and the **Institute for Carbon Removal Law & Policy** for a discussion on a report in preparation, *[The Carbon Removal Debate: Asking Critical Questions about Climate Change Futures](#)*. The report works towards a common climate justice framework that can inform how various stakeholders think about, talk about, and act on this potentially transformative – but as yet still unproven – technology.

Sponsor: CSPO: <https://cspo.org/>

The Consortium for Science, Policy, and Outcomes (CSPO) at Arizona State University is an intellectual network aimed at enhancing the contribution of science and technology to society's pursuit of equality, justice, freedom, and overall quality of life.

Learning Enrichment, Event 2

Event: [Killer Heat in the United States: Climate Choices and the Future of Dangerously Hot Day](#)

Date: Wed, September 25 Time: 10:30 am to tbd

Location: 1111 19th Street NW, 3rd Floor, Washington, DC.

Speakers: Astrid Caldas, Senior Climate Scientist and Shana Udvardy, Climate Resilience Analyst

Website: <https://www.eventbrite.com/e/killer-heat-in-the-united-states-climate-choices-and-the-future-of-dangerously-hot-days-tickets-70177295179>

The Union of Concerned Scientists recently released a new report *Killer Heat in the United States: Climate Choices and the Future of Dangerously Hot Days*. This analysis shows the rapid, widespread increases in extreme heat that are projected to occur across the country due to climate change, including conditions so extreme that a heat index cannot be measured. The analysis also finds that the intensity of the coming heat depends heavily on how quickly we act now to reduce heat-trapping emissions.

The implications of this analysis are profound: in many places, extreme heat will lead to an increase in deaths or illnesses, disrupt long-standing ways of life, force people to stay indoors to keep cool, and perhaps even drive large numbers of people away from areas that become too unpleasant or impractical to live.

The results highlight a stark choice: We can continue on our current path, where we fail to reduce emissions and extreme heat soars. Or we can take bold action now to dramatically reduce emissions and prevent the worst from becoming reality. Join Astrid Caldas and Shana Udvardy to discuss the analysis, findings, solutions, and interactive maps.

Sponsor: **FEMA's Resilient Nation Partnership Network**

The Resilient Nation Partnership Network is a unique coalition of approximately 150 organizations that are committed to building stronger, more resilient communities and represent a variety of industries and expertise. Our Network is purely built on the pursuit of fostering thought leadership, knowledge sharing, and collaboration among diverse organizations that share a commitment to building a more resilient future.

Learning Enrichment, Event 3

Event: [Carbontech on the Hill](#)

Date: Thurs, September 26 Time: 4:30 to 7:30 pm

Location: U.S. Capitol Visitor Center, First St NE, HVC 201, Washington, DC 20515

Speakers: Dr. Marcius Extavour, Carbon XPRIZE, Roxanne Brown, United Steelworkers, and John Litynski, U.S. Department of Energy

Website: <https://www.eventbrite.com/e/carbontech-on-the-hill-registration-70805843183?aff=ebdssbdestsearch>

All non-congressional attendees must be registered.

Third Way, Carbon180, and XPRIZE are excited to host the second annual “Carbontech on the Hill” event, which brings together carbontech innovators from across the country to share their work and progress toward building a new carbon economy.

From jet fuel to plastics and building materials, the carbontech sector is turning the carbon equation on its head; helping to create a world where we remove more carbon than we emit. Not only is the carbontech sector good for climate, it can create and preserve high-paying jobs and secure U.S. leadership in lucrative new industries.

Please join us for a briefing where we’ll explore the tremendous opportunity for carbontech in the United States, and what it could mean for American businesses, workers, and climate efforts.

Sponsors: [Third Way](#), [Carbon180](#), and [XPRIZE](#)

<https://www.thirdway.org/about>

<https://carbon180.org>

<https://www.xprize.org/prizes/carbon>

HONR 229L: Climate Change: Science, Economics, and Governance

AT 2, Q 1:

In your own words (i.e., summarize in a series of short phrases rather than typing verbatim that Diamond wrote), what was his rationale for devoting an entire chapter to the Maya?

Diamond focuses on the Maya because they were ultimately a society unlike the other collapsed societies that he examines in other chapters. Their environment was not particularly fragile, nor were they mere "savages," but rather they had impressive advancements for the time. Rather than just external factors impacting the collapse of the society, **many of the factors of their collapse were also internal: ecocide and conflict** being the main two that the chapter discusses. Additionally, we can also study the Maya in a more in-depth manner because of the preservation of written texts.

I also took from the story that frequent warfare extracted a toll on the Mayan civilization.

Sad that the Maya engaged in so many frequent conflicts.

Had the Maya been able to not engage in warfare, perhaps their majestic civilization would have persisted into modern times.

HONR 229L: Climate Change: Science, Economics, and Governance

AT 2, Q 2:

In 2 to 3 sentences, describe the main point Diamond is trying to convey about the fall of the Maya in this chapter?

The *Mayan society*, although advanced, *collapsed due to population growth depleting resources as deforestation, erosion, and drought decreased the amount of available farmland*. As the population grew, food and land became scarce causing wars between kingdoms, which (combined with poor leadership) also contributed to the collapse. The Mayans are a warning that advanced societies can create environmental issues that lead to their own downfall.

Indeed, population is a key factor governing sustainability.

Scholars currently debate Earth's carrying capacity.

The Earth certainly does have a carrying capacity, and once breached, consequences could be severe.

More on Earth's carrying capacity in "The Last Word".

HONR 229L: Climate Change: Science, Economics, and Governance

AT 2, Q 2:

In 2 to 3 sentences, describe the main point Diamond is trying to convey about the fall of the Maya in this chapter?

In this chapter about the collapse of the Maya, Diamond conveys the main point that even large, complex civilizations can suffer a collapse due to many of the same reasons that smaller civilizations in more fragile ecosystems collapse. Diamond describes how the Maya, who are known for how advanced they were, still fell into the same problems of deforestation and resource deprivation, which then lead to increased fighting, which all compounded into the collapse of the civilization. **There was also an underlying theme of how the kings and nobles did not take action to stop the obvious issues that were arising.**

It is important that Democratic societies elect wise politicians who can govern with a view on long-term sustainability.

HONR 229L: Climate Change: Science, Economics, and Governance

AT 2, Q 3:

Describe in a sentence or 2 something new you learned upon reading this chapter: please state something specific.

It was interesting to learn about how the Maya did not only suffer from the one main Classic collapse, but they suffered numerous other collapses both before and after the Classic collapse. Diamond also talked about how the *Maya cycled through phases of wet years and dry years*, often times where each phase would "recur at intervals of about 208 years," (pg. 174), and this was interesting as Diamond discusses because it the *cyclical pattern of droughts* makes the theory of droughts being a key contributor to the collapse of the Maya weaker.

This seems odd. I wonder if this is true?

I learned that reservoirs in Tikal could contain enough drinking water for 10,000 people over 18 months.

Must have been terrifying as the water level in the reservoirs dropped.

I certainly can imagine this being a factor causing one group to attack another group.

Solar Induced Drought ?

Science 18 May 2001:
Vol. 292 no. 5520 p. 1293
DOI: 10.1126/science.292.5520.1293

PALEOCLIMATE

A Variable Sun and the Maya Collapse

Richard A. Kerr

A record of drought from the bottom of Yucatán lakes suggests that an inconstant sun may have helped drag down the mighty Maya

Tackling a touchy question outside the mainstream of opinion usually gives a scientist pause. But on page [1367](#) of this issue paleoclimatologist David Hodell and his colleagues take on two touchy subjects at once. They argue that subtle variations in the sun's brightness helped trigger a drastic climate change, and that, in turn, played a role in the downfall of a whole civilization. Drawing on a mucky lake-bottom core from the Yucatán Peninsula, home to ancient Mayas, they confirm that the area's worst drought in many millennia struck just as Maya civilization began its accelerating decline. That drought was only one of many that tended to return every 200 years, in step with and presumably driven by 200-year oscillations in solar activity.



Sun-struck·The astronomically inclined Maya—this structure marks a solar alignment—may have succumbed to a sun-induced drought

CREDIT: MARK BRENNER

<http://www.sciencemag.org/content/292/5520/1293.full>

Solar Induced Drought ?

Science 18 May 2001:

Vol. 292 no. 5520 p. 1293

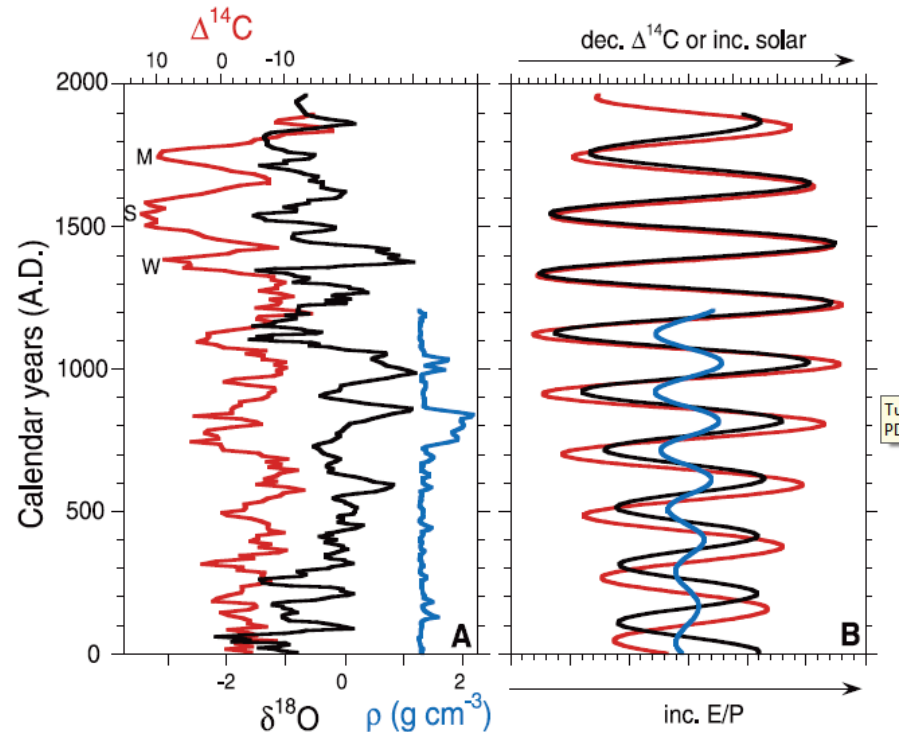
DOI: 10.1126/science.292.5520.1293

Comparison of the Punta Laguna $\delta^{18}\text{O}$ and the $\Delta^{14}\text{C}$ production records shows an antiphase relation for the past 2000 years. Higher $\delta^{18}\text{O}$ coincides with lower $\Delta^{14}\text{C}$ production, implying that drought occurred during times of increased solar activity.

The mechanism by which changes in solar activity cause evaporation/precipitation shifts in Yucatan is not certain.

One hypothesized mechanism is variations in cosmic ray intensity affect cloud formation and precipitation.

Calculations conducted using climate models imply that changes in solar output may affect global mean temperature, humidity, convection, and intensity of Hadley circulation in the tropics.



<http://www.sciencemag.org/content/292/5520/1293.full>

HONR 229L: Climate Change: Science, Economics, and Governance

AT 2, Q 4:

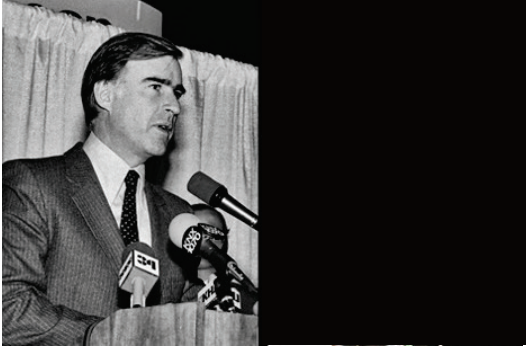
In 2 to 3 sentences, describe how the history of the Maya may be applicable to the situation faced today by the world's population, with respect to global warming?

Diamond references that one of the reasons for the Mayan collapse was that *kings were too entrenched in their desire for short term goals that they completely neglected the long term.* This is applicable to nowadays because we have heard concerns of climate change for decades now and not much has really been done, i.e. those in power either didn't acknowledge it or did acknowledge it and instead chose to ignore it. Hence, **we are at a point now in which we recognize the problem and we have very little time to turn it around before it is too late, but if we take a page out of the Mayan's playbook and push the problem to the side, then we will collapse just as they did.**

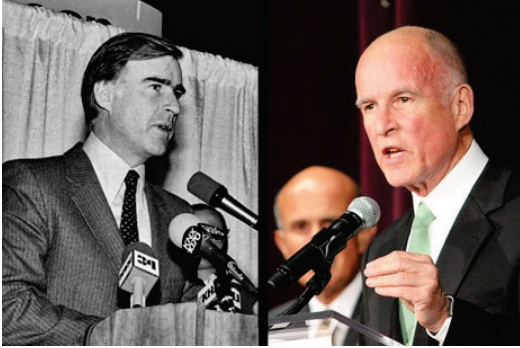
... Collaboration and cooperation are the only hope at slowing climate change.

It may seem trite, but a key aspect of averting climate catastrophe is the election of politicians who govern with a view on long term sustainability.

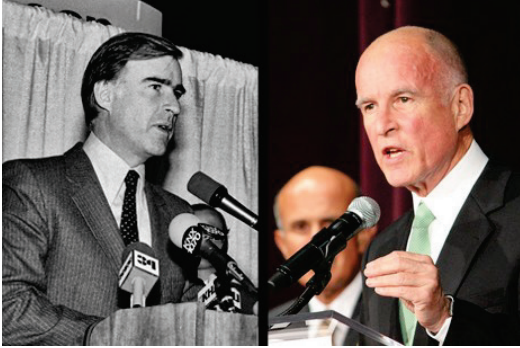
Name That Politician



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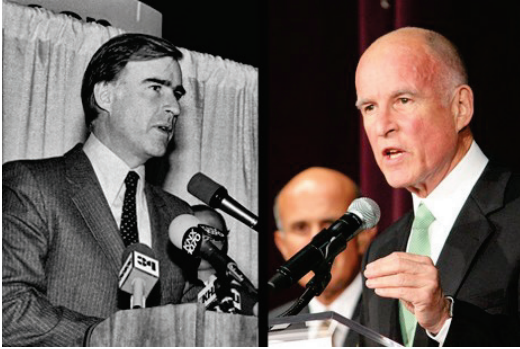


Which state approved the country's first energy-efficiency standards for appliances? The first green building codes? The first big wind farms? And who was governor when all those fine things happened?

The answer is **California** under **Jerry Brown** – aka Governor Moonbeam – who just happens to be running for the office again, some 30 years later. Last week, Brown unveiled a clean-energy plan to put far more solar panels on California's rooftops, in addition to appointing a renewable energy czar and strengthening appliance standards.

<https://grist.org/article/2010-06-24-jerry-brown-clean-energy-revolution-in-california-once-and-again/>

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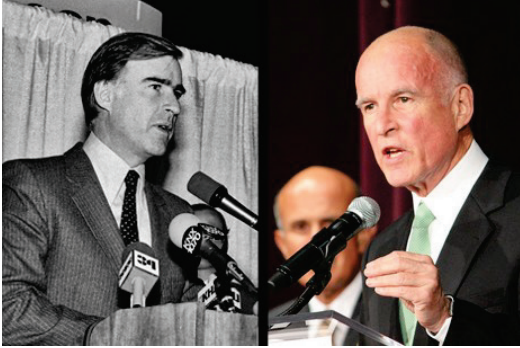
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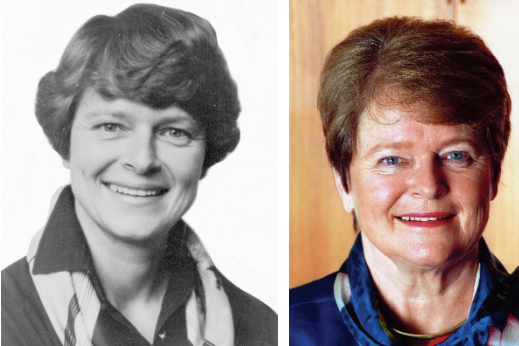
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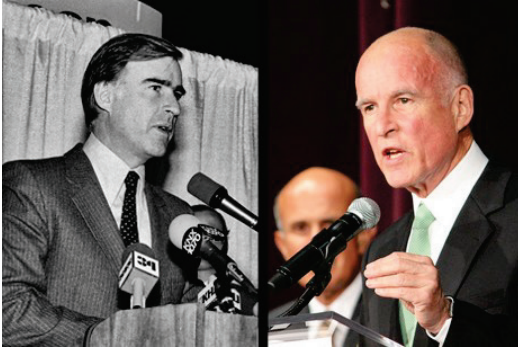
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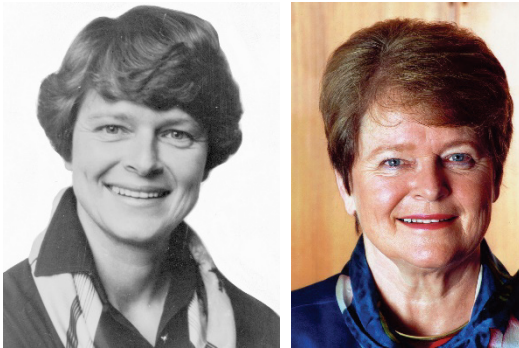
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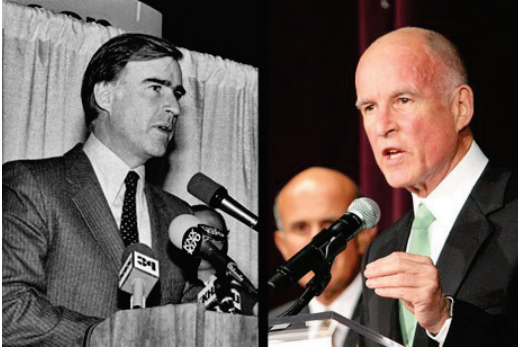


Gro Brundtland served five years as Minister of the Environment before becoming the first woman prime minister of Norway. In the mid-1980s, she chaired the World Commission on Environment and Development that published "Our Common Future", which popularized the concept of sustainable development.

Brundtland Report mantra: ***sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs.***

<https://www.iwu.edu/news/2017/events/stevenson-lecture-gro-brundtland.html>

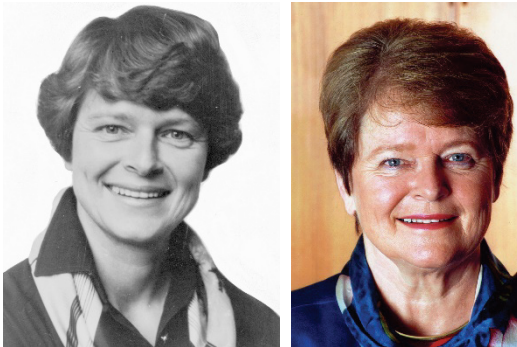
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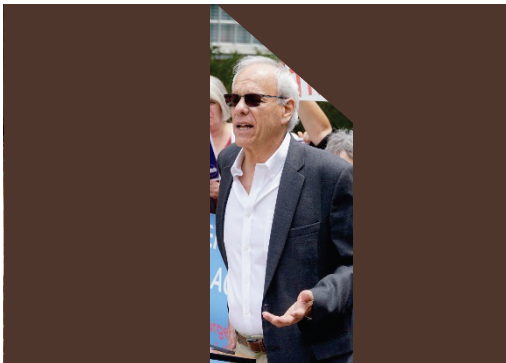
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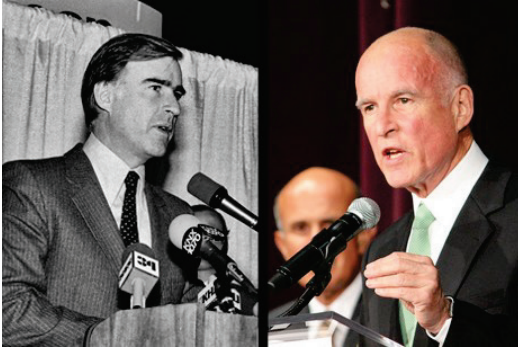
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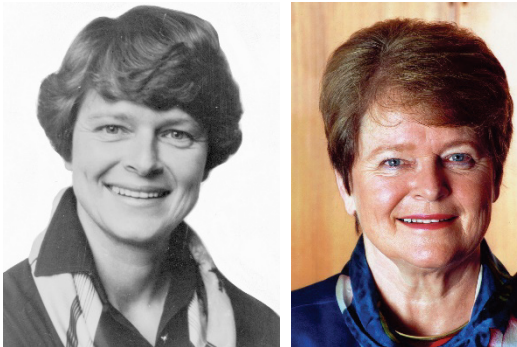
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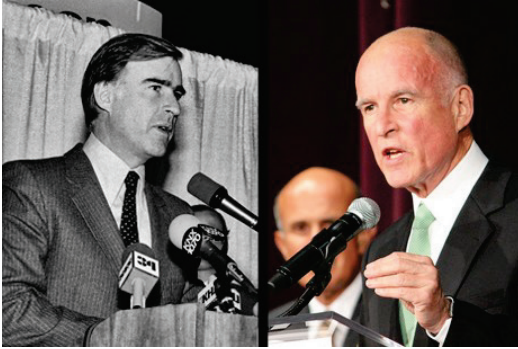
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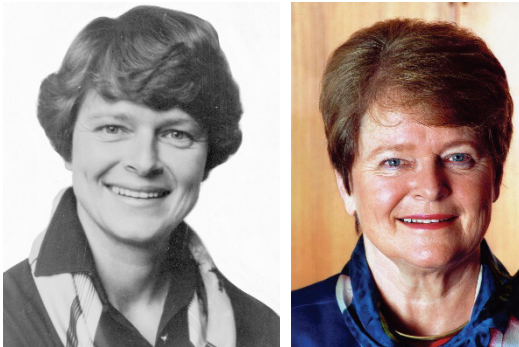
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A bill to accelerate **Maryland's efforts to reduce greenhouse gas emissions** sailed through the state Senate on Tuesday and was hailed by environmentalists as one of the nation's strongest state requirements for tackling carbon pollution. The Senate voted 38 to 8 to **cut greenhouse gas emissions to 40 percent below 2006 levels by 2030.**

This vote sends a resounding message that climate action is an economic and health imperative in the state of Maryland," said Mike Tidwell, director of the Chesapeake Climate Action Network. He credited **Sen. Paul G. Pinsky (D-Prince George's)**, a member of a state climate-change panel, and Ben Grumbles, secretary of the state Department of the Environment, with building bipartisan support for the legislation.

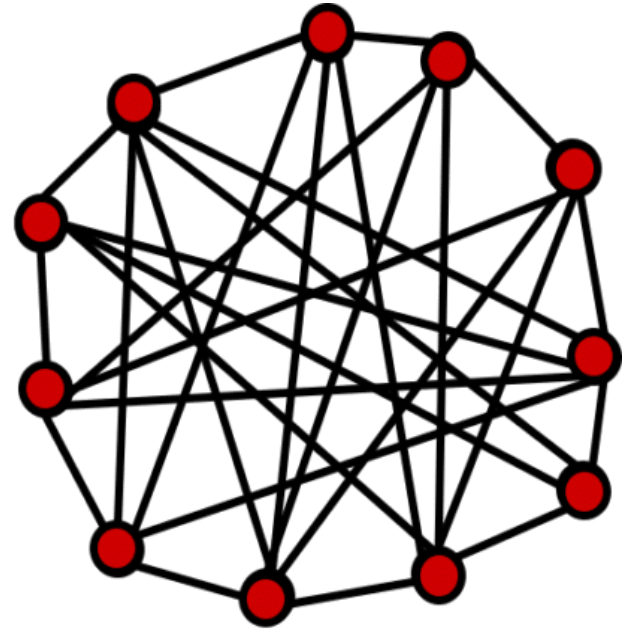
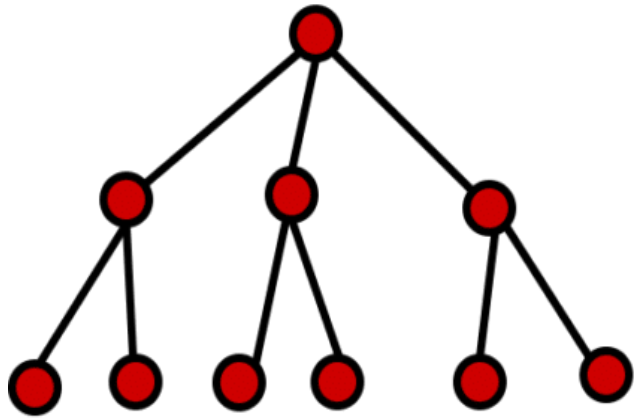
https://www.washingtonpost.com/local/md-politics/maryland-sets-new-target-for-reducing-greenhouse-gas-emissions/2016/02/23/f56fe196-da47-11e5-891a-4ed04f4213e8_story.html

HONR 229L: Climate Change: Science, Economics, and Governance

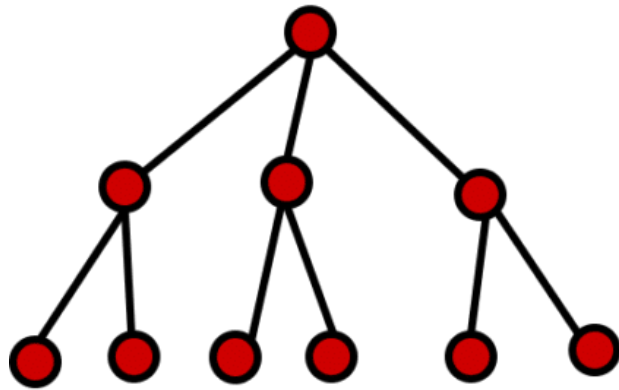
Opposite Paths to Success:
New Guinea, Tikopia, and Japan

Emma Eklund

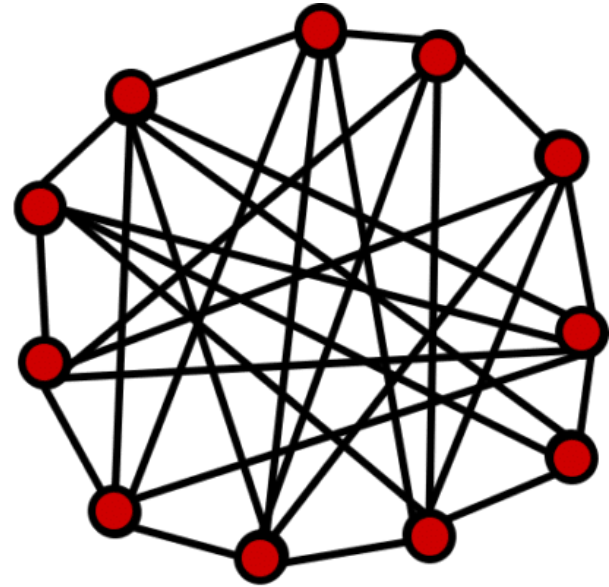
September 10 2019



Two different approaches to solving governmental problems



“Top-down”



“Bottom-up”





What approach did Japan use and why? (278)

- **Top down approach** since people aren't familiar with the whole island
- Large enough to have a **centralized government** with a king who is looking out for the interests for all people and thinking of long term so that they can stay in power

Why did Japan go into isolation? (296)



<https://letterhole.com/2017/02/03/closed-ports-and-Christians-japans-era-of-isolation/>

Why did Japan go into isolation? (296)

- Some catholic missionaries came and converted daimyo to Christianity who then tried to bribe / assassinate government officials
- So the shogun decided that Christianity posed a threat and forbid Japanese from traveling overseas



What was driving deforestation? (297)

What was driving deforestation? (297)

- No imports
- Esthetic preference for wood
- Urban construction- daimyo wanted to impress each other with big castles
- Fuel- heating houses, cooking
- Agriculture

What are the consequences?

Increased:

- Wildfires
- Soil erosion
- Earthquakes
- Flooding



<https://www.brinknews.com/why-investors-are-backing-zero-deforestation/>

What was the turning point?





The 1657 Meireki fire and demand for timber



What did the Japanese do to stop deforestation?

What did the Japanese do to stop deforestation?

- Increased reliance on seafood
- Zero population growth
- Switch to coal
- Woodland management
 - Very detailed reports (301)
 - Inspecting wood shipments
 - Amount of timber you could use varied with social status (302)

What approach did the small islands use and why? (pg. 277)



<https://en.unifrance.org/movie/44844/nous-tikopia>

They used **bottom up** since all of the people are familiar with the whole island and know how affected they are by the degradation so they have a **common interest** to fix it in order to improve quality of life and they can benefit from it





New Guinea Highlands



Broad open valleys with few clumps of trees
separated by ditches for irrigation

What is being grown in this picture?



<https://www.flickr.com/photos/bioversity/15028728556>

What is being grown in this picture?



Taro

What is being grown in this picture?



They grew taro, bananas, yams, sugarcane, sweet potatoes, pigs, and chickens



Sweet potato garden had vertical ditches running down the slope, European convinced them to make it horizontal and during the next heavy rains the landslide carried the entire garden down





What are they growing?



What is silviculture?

Growing trees instead of field crops

- Casuarina was grown at a massive scale by transplanting seedlings along stream banks
- Why is it good?
 1. Hard wood and fast growing
 2. Root nodules fix nitrogen
 3. Leaf fall increases nitrogen and carbon that go into the soil
 4. Reduces erosion
 5. Reduce infestation with a taro beetle

Why was bottom up successful in this case?(284)

- No chiefs, only people called **big men** who were just a little bit more influential, decisions were made by everyone
- They saw the degradation that deforestation was causing, meaning lower crop growth rates and more erosion and decided to change their practices



Tikopia; 1.8 square miles, 1,200 people



What are two problems that they had to overcome?

What did they import and how frequently did they import? (287)



What did they import and how frequently did they import? (287)

Imported stone for making tools , they had small canoes, so **trips were infrequent**, they also brought in unmarried young people



Infrequent trips meant it's necessary to **store surplus food** since cyclones average about 20 per decade



What sustainable food practices did they use?

- Grass for mulch
- Antiaris toxicaria- bark was used for cloth
- Garden for growing yams, bananas, taro (grown on swamp)
- For protein they depended on fish and ducks and in order to catch or eat fish they needed to get permission from the chief



First, some perspective.

Tikopia is **1.8 square miles**.

How big is campus?

University of Maryland—College Park is a public institution that was founded in 1856. It has a total undergraduate enrollment of 29,868, its setting is suburban, and the campus size is 1,335 acres. It utilizes a semester-based academic calendar. University of

$1335 \text{ acres} \times 0.0015625 \text{ sq mile / acre} = \mathbf{2.1 \text{ square miles}}$





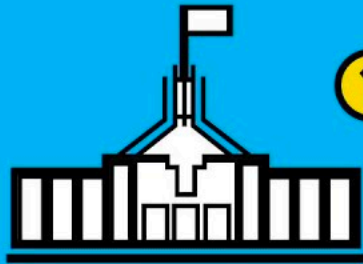
Recap: Why are these two islands examples of bottom up?



<https://www.hrw.org/news/2016/01/27/papua-new-guinea-failing-protect-women-and-girls>

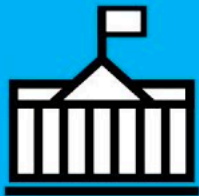
What do you think of this approach?
Any other examples?





1

FEDERAL



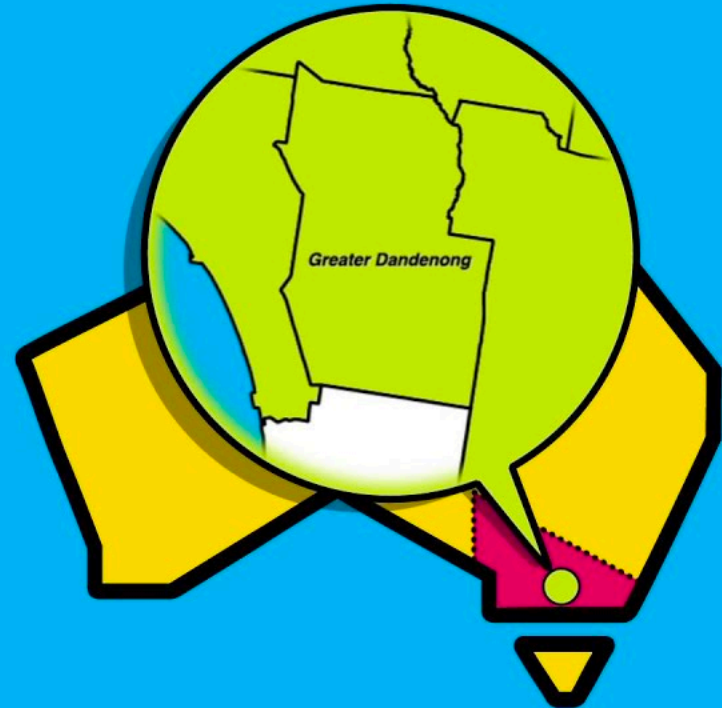
2

STATE



3

LOCAL



<https://www.youtube.com/watch?v=UeEh9ChyVQ4>

Could middle sized islands use these approaches? (279)



<https://www.lonelyplanet.com/articles/how-to-choose-caribbean-island>

Methods to keeping a stable, non-increasing population



<https://www.thelocal.fr/20170626/what-you-need-to-know-about-frances-rising-population>

Methods to keeping a stable, non-increasing population

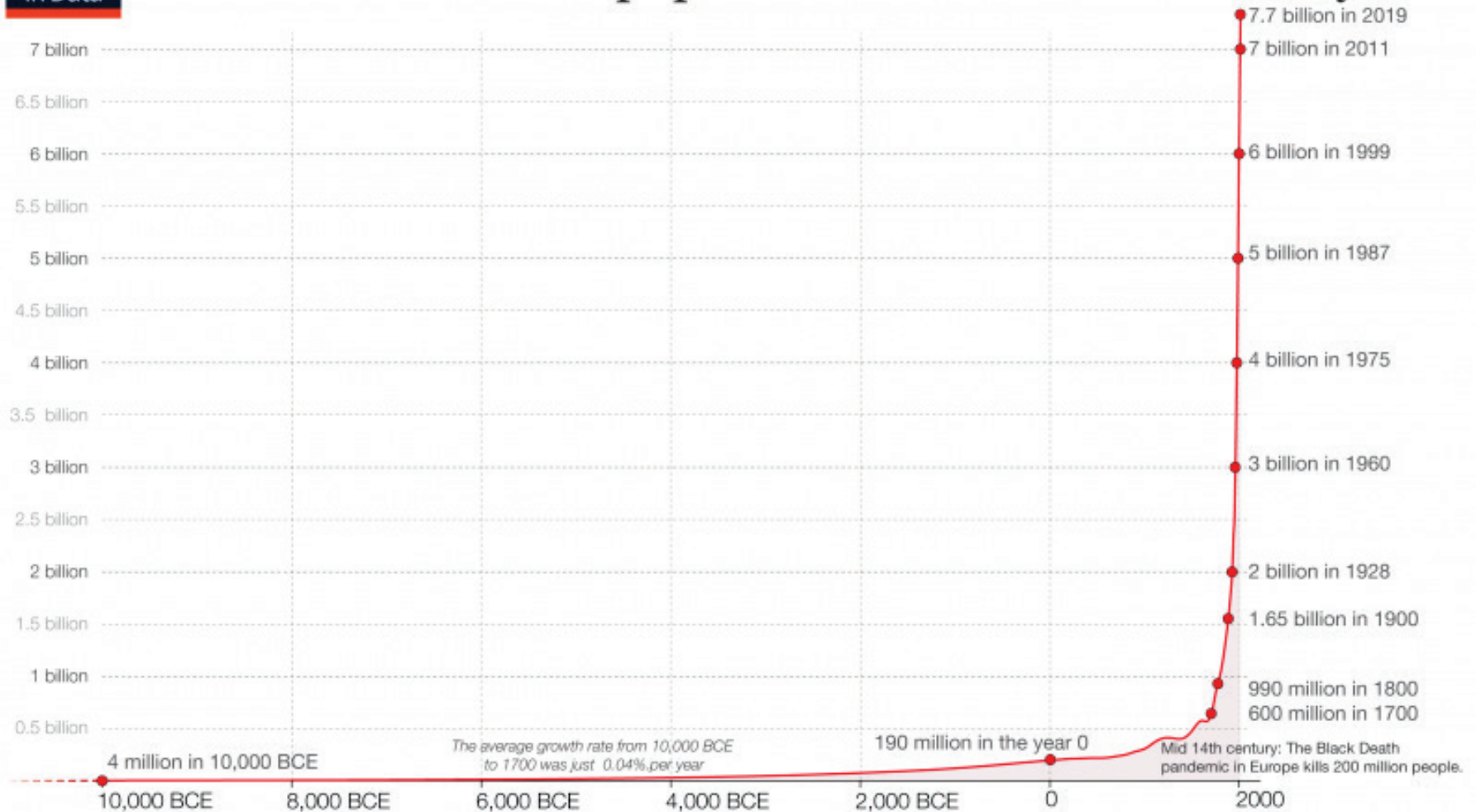
1. Ritual for zero growth
2. Parents feel it is wrong for them to have children once their son has reached
3. Contraception
4. Abortion
5. Marriable age or have more children than a number variously given
6. Infanticide
7. Celibacy
8. Suicide
9. War

HONR 229L: Climate Change: Science, Economics, and Governance

Last Word: Opposite Paths to Success: New Guinea, Tikopia, and Japan

Ross Salawitch

The size of the world population over the last 12,000 years



Based on estimates by the *History Database of the Global Environment (HYDE)* and the United Nations. On [OurWorldinData.org](https://ourworldindata.org) you can download the annual data.

This is a visualization from [OurWorldinData.org](https://ourworldindata.org), where you find data and research on how the world is changing.

Licensed under [CC-BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) by the author Max Roser.

<https://ourworldindata.org/world-population-growth>

World Population

Sep 10, 2019 14:46 UTC (+4)



<https://www.census.gov/popclock/>

World Population

Sep 10, 2019 14:46 UTC (+4)



Sep 11, 2018 15:38 UTC (+4)



98.8 million more persons, just this past year

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Sep 10, 2019 14:46 UTC (+4)



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98.8 million more persons, just this past year

That's nearly 100 million more mouths to feed!

$100 \times 10^6 / 365 = 2.7 \times 10^5 = 270,000$ persons per day

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**5 × capacity of Capital One Field at Maryland Stadium, per day
(assuming for the sake of argument fill capacity of 54,000)**

<https://www.census.gov/popclock/>

World Population

Sep 10, 2019 14:46 UTC (+4)



TOP 10 MOST POPULOUS COUNTRIES (July 1, 2019)

1. China	1,389,618,778
2. India	1,311,559,204
3. United States	331,883,986

<https://www.census.gov/popclock/>

World Population

Sep 10, 2019 14:46 UTC (+4)



TOP 10 MOST POPULOUS COUNTRIES (July 1, 2019)

1. China	1,389,618,778
2. India	1,311,559,204
3. United States	331,883,986
4. Indonesia	264,935,824

<https://www.census.gov/popclock/>

World Population

Sep 10, 2019 14:46 UTC (+4)



TOP 10 MOST POPULOUS COUNTRIES (July 1, 2019)

1. China	1,389,618,778	6. Brazil	210,301,591
2. India	1,311,559,204		
3. United States	331,883,986		
4. Indonesia	264,935,824		
5. Pakistan	210,797,836		

<https://www.census.gov/popclock/>

World Population

Sep 10, 2019 14:46 UTC (+4)



TOP 10 MOST POPULOUS COUNTRIES (July 1, 2019)

1. China	1,389,618,778	6. Brazil	210,301,591
2. India	1,311,559,204	7. Nigeria	208,679,114
3. United States	331,883,986	8. Bangladesh	161,062,905
4. Indonesia	264,935,824	9. Russia	141,944,641
5. Pakistan	210,797,836	10. Mexico	127,318,112

<https://www.census.gov/popclock/>

World Population

Sep 10, 2019 14:46 UTC (+4)



TOP 10 MOST POPULOUS COUNTRIES

		Last Year	Difference
1. China	1,389,618,778	1,384,688,986	4.9 million
2. India	1,311,559,204	1,296,834,042	14.7 million
3. United States	331,883,986	329,256,465	2.6 million
4. Indonesia	264,935,824	262,787,403	2.1 million
5. Pakistan	210,797,836	206,460,804	4.3 million
			27.9 million out of the 98.8 million new folks in the top 5

<https://www.census.gov/popclock/>

Earth's Carrying Capacity

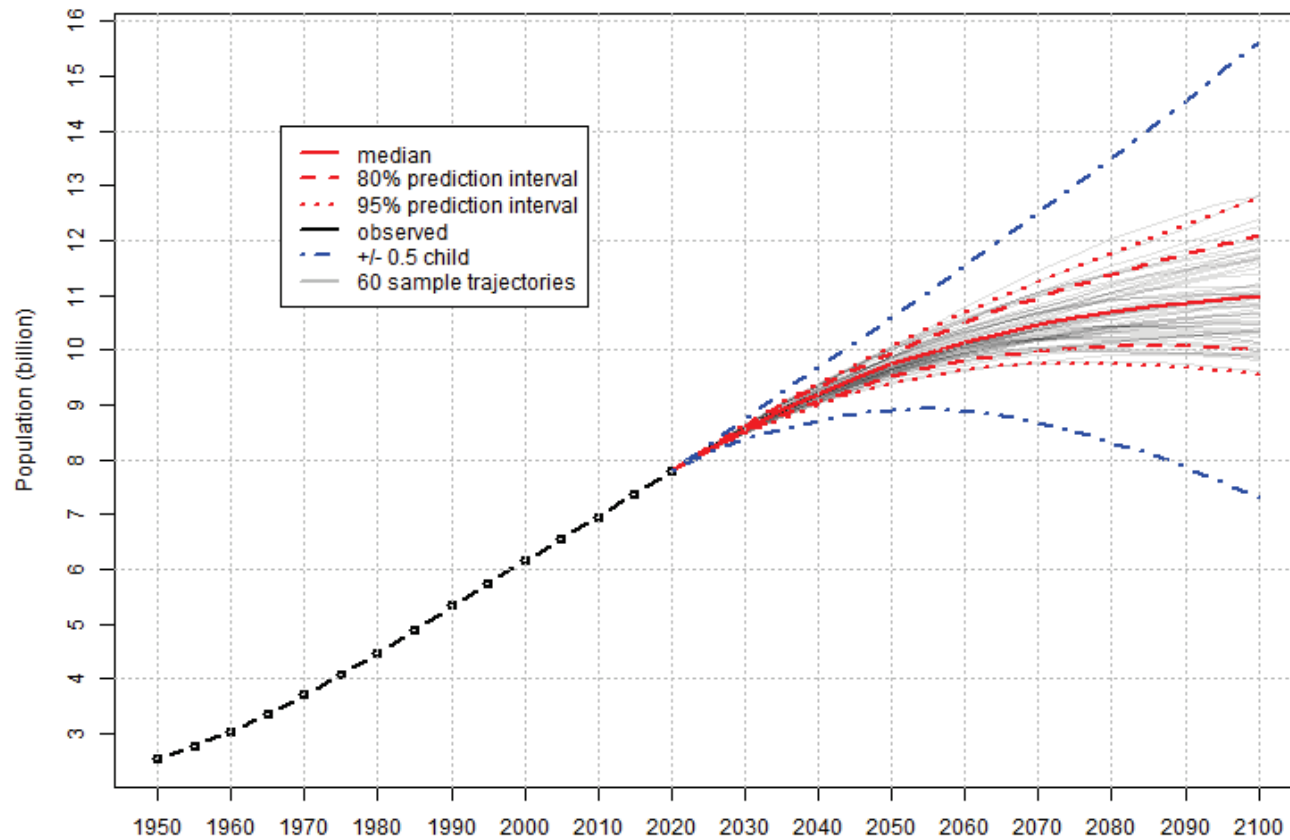
Much has been written about Earth's carrying capacity.

E. O. Wilson writes:

If everyone agreed to become vegetarian, leaving little or nothing for livestock, the present 1.4 billion hectares of arable land (3.5 billion acres) would support about **10 billion people**. If humans utilised as food all of the energy captured by plant photosynthesis on land and sea – some 40 trillion watts – **the planet could support about 17 billion people**. But long before that ultimate limit was approached, the planet would surely have become a hellish place to exist.

<https://www.independent.co.uk/arts-entertainment/books/features/the-world-is-not-enough-655035.html>

World Population Projection

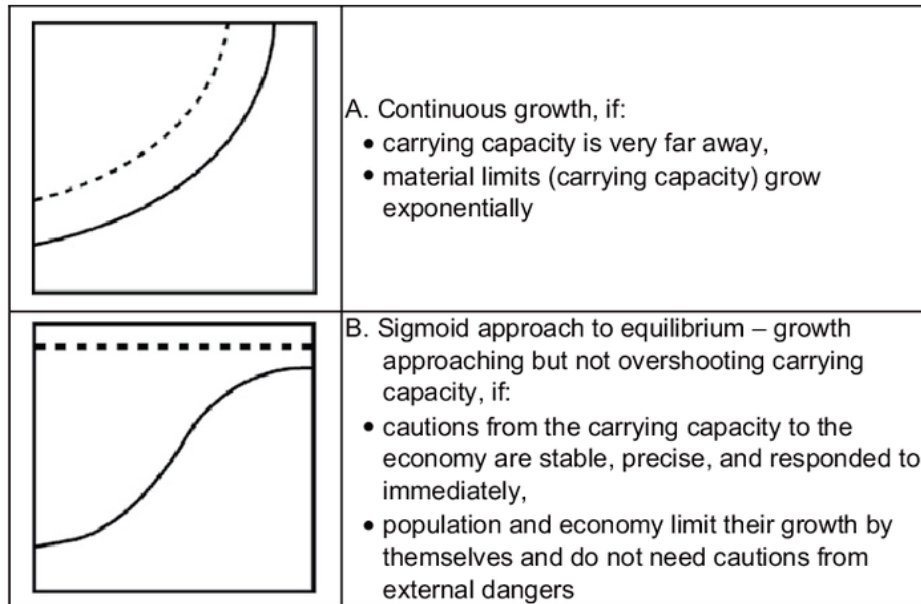


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United Nations, DESA, Population Division. *World Population Prospects 2019*. <http://population.un.org/wpp/>

This chart shows probabilistic projections of the total world population are based on estimates of total fertility and life expectancy at birth, from the 2019 Revision of the World Population Prospects. These projections were carried out with a Bayesian Hierarchical Model. The figure display the probabilistic median, and the 80 and 95 per cent prediction intervals of the probabilistic population projections, as well as the (deterministic) high and low variant (± 0.5 child) of the 2019 Revision of the World Population Prospects.

<https://esa.un.org/unpd/wpp/Graphs/Probabilistic/POP/TOT/>

Four Possible Outcomes

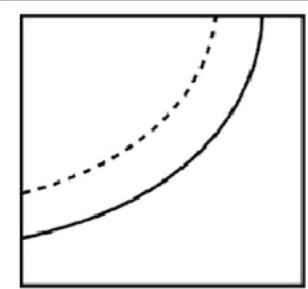
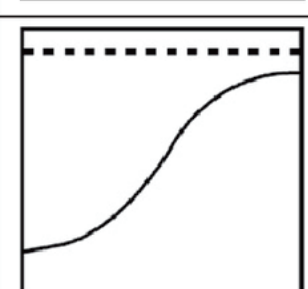
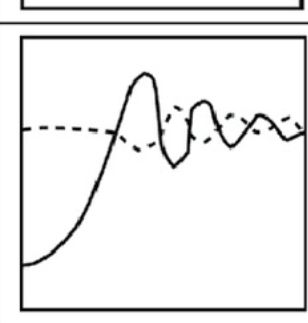


DASHED lines: Carrying Capacity
SOLID lines: Population

Horizontal axis: time

https://www.researchgate.net/figure/Schematic-alternatives-of-population-development-dotted-line-14carrying-capacity-solid_fig4_257967228

Four Possible Outcomes

	<p>A. Continuous growth, if:</p> <ul style="list-style-type: none"> • carrying capacity is very far away, • material limits (carrying capacity) grow exponentially
	<p>B. Sigmoid approach to equilibrium – growth approaching but not overshooting carrying capacity, if:</p> <ul style="list-style-type: none"> • cautions from the carrying capacity to the economy are stable, precise, and responded to immediately, • population and economy limit their growth by themselves and do not need cautions from external dangers
	<p>C. Overshoot and oscillation, if:</p> <ul style="list-style-type: none"> • cautions and responses are delayed, • the carrying capacity does not deteriorate and can quickly recover from eroding

DASHED lines: Carrying Capacity
SOLID lines: Population

Horizontal axis: time

https://www.researchgate.net/figure/Schematic-alternatives-of-population-development-dotted-line-14carrying-capacity-solid_fig4_257967228

Four Possible Outcomes

DASHED lines: Carrying Capacity
SOLID lines: Population

Horizontal axis: time

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	<p>C. Overshoot and oscillation, if:</p> <ul style="list-style-type: none"> • cautions and responses are delayed, • the carrying capacity does not deteriorate and can quickly recover from eroding
	<p>D. Overshoot and collapse, if:</p> <ul style="list-style-type: none"> • cautions and responses are delayed, • the carrying capacity deteriorates and cannot recover once been exceeded

https://www.researchgate.net/figure/Schematic-alternatives-of-population-development-dotted-line-14carrying-capacity-solid_fig4_257967228