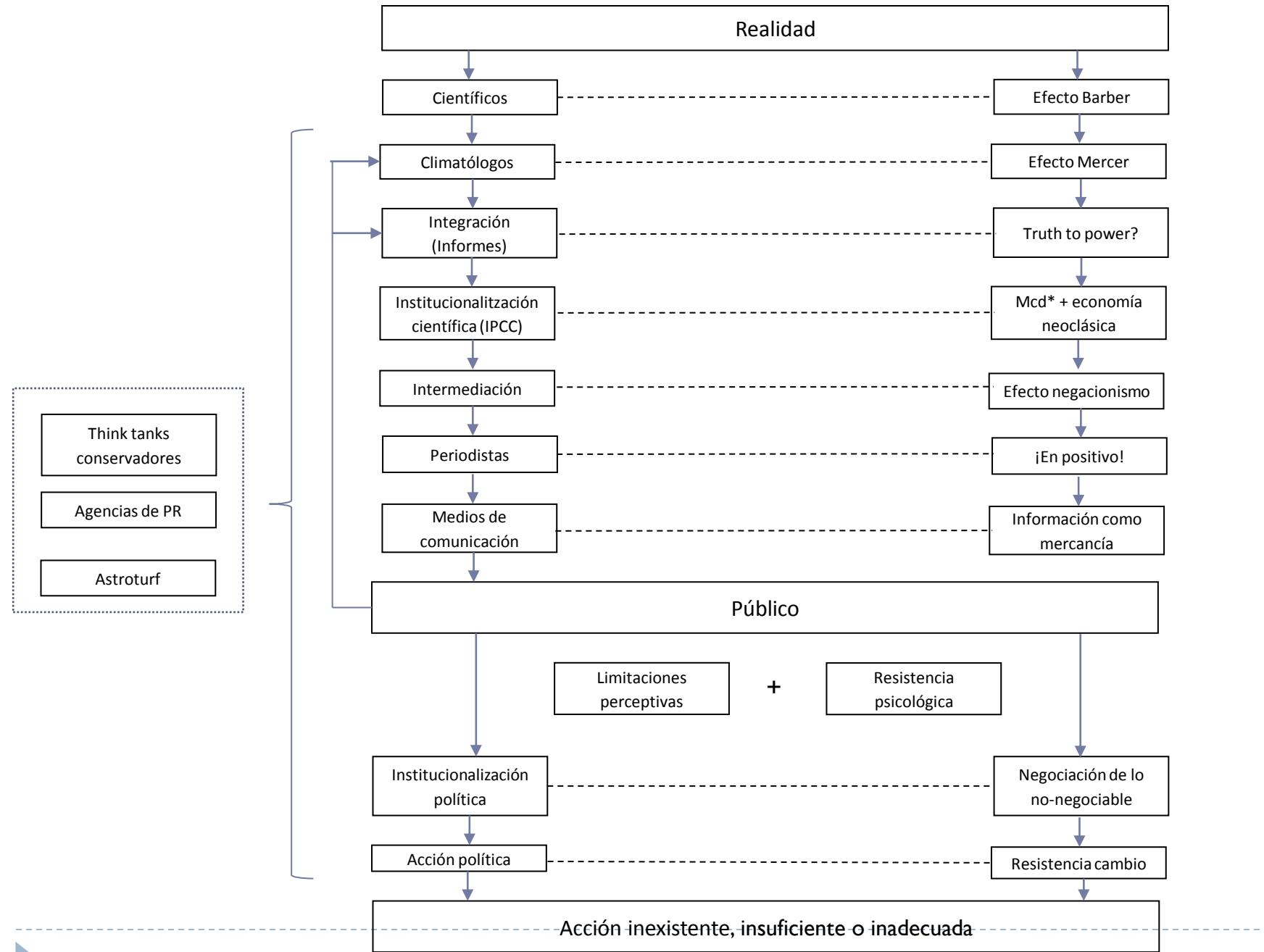


¿Hemos alcanzado los límites del crecimiento?

Ferran Puig Vilar
ATTAC Palencia, 13/04/2016

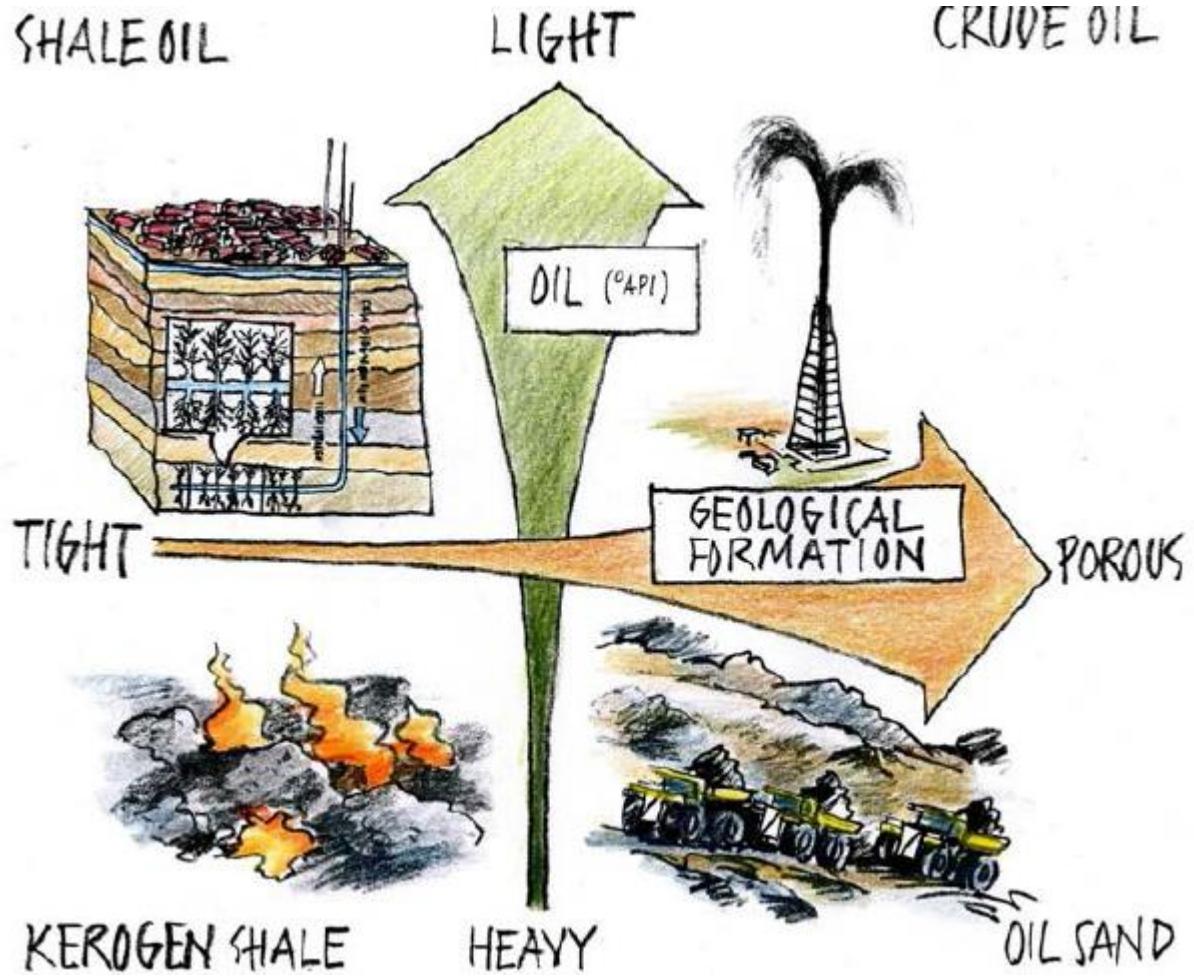


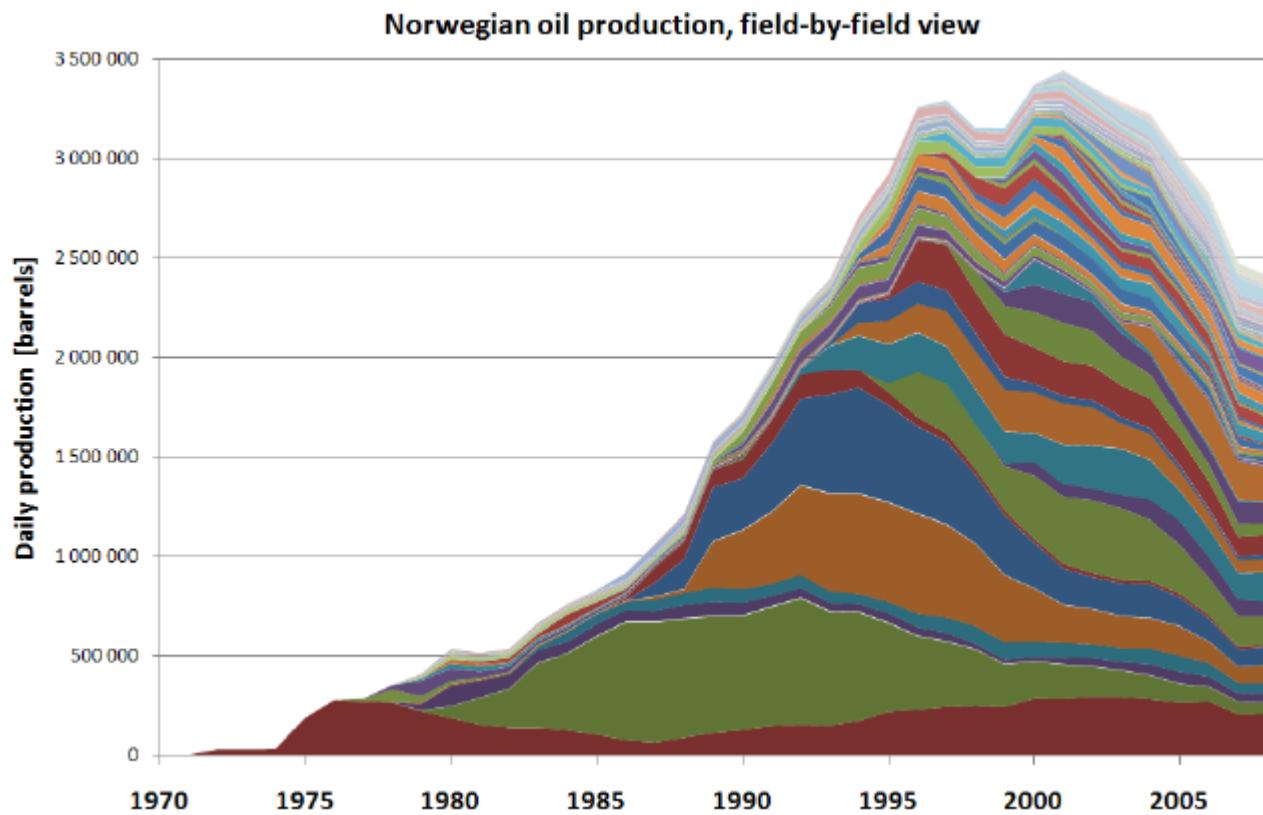
* Mínimo común denominador

Conceptos previos – 1: Energía

- ▶ Primaria vs. vectores
- ▶ Zenit de producción de un recurso energético-mineral: importancia
- ▶ Tasa de retorno energética TRE / EROEI (!) de una fuente de energía primaria
 - ▶ Símil business
- ▶ Combustibles fósiles
 - ▶ Convencionales
 - ▶ No convencionales
- ▶ La paradoja de Jevons
 - ▶ Directa
 - ▶ Indirecta
- ▶ Energías alternativas
 - ▶ Capacidad de concentración
 - ▶ Materiales
 - ▶ Interacción
 - ▶ Rendimientos decrecientes en escalabilidad
 - ▶ Densidad energética

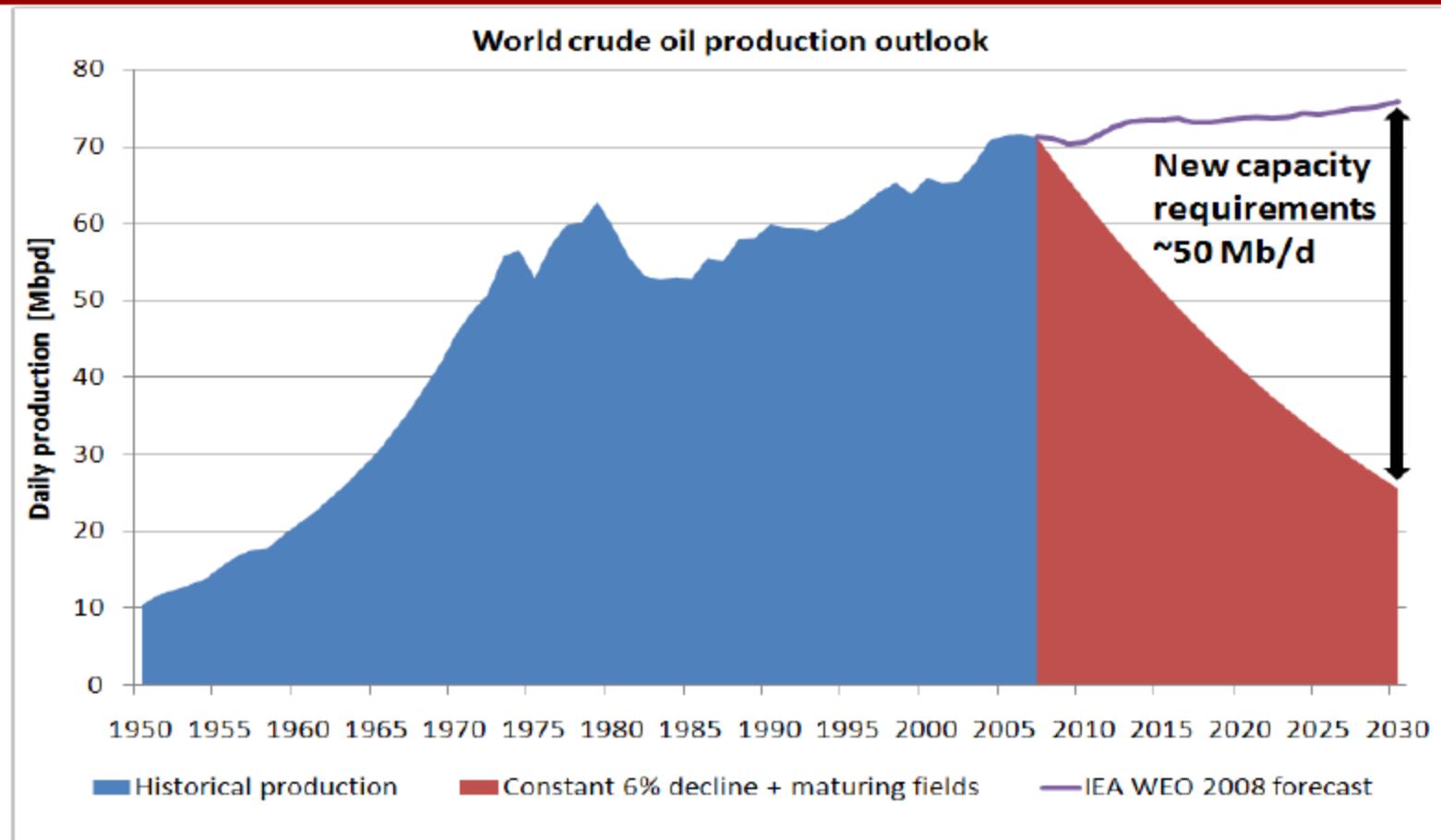








Future production needs?

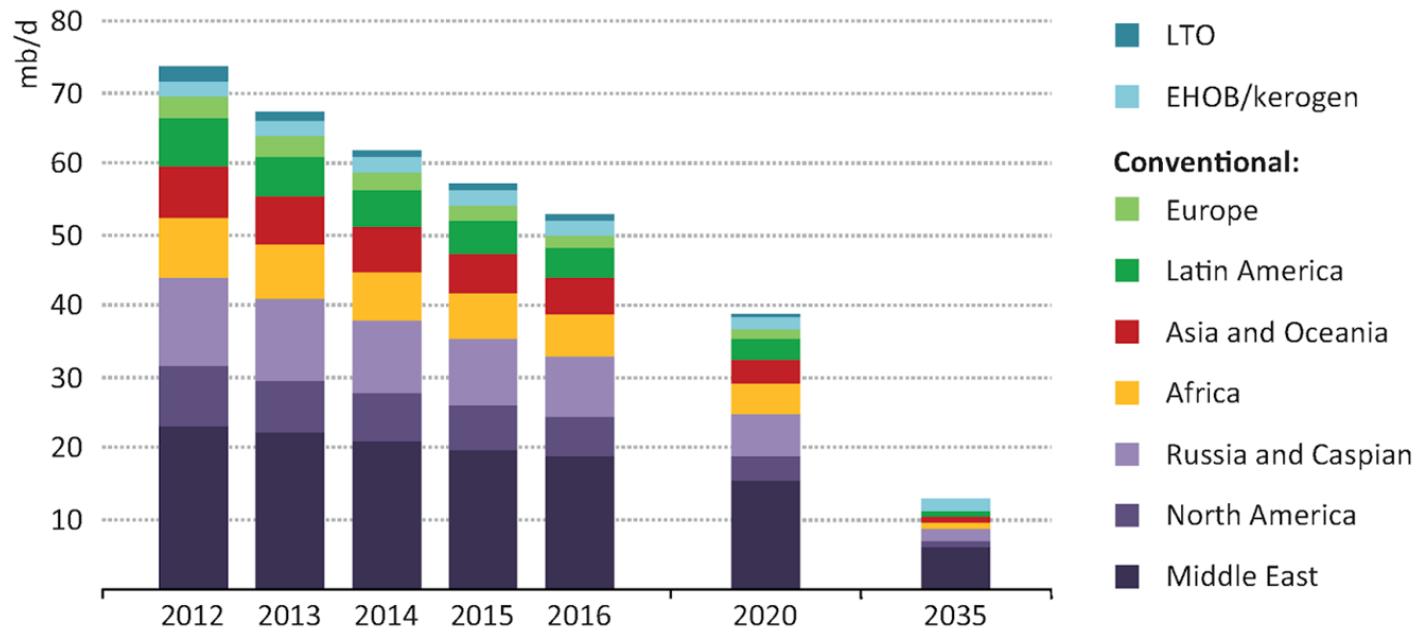


Source: Höök, Hirsch & Aleklett (2009) Giant oil field decline rates and their influence on world oil production, *Energy Policy*, Volume 37, Issue 6, Pages 2262-2272



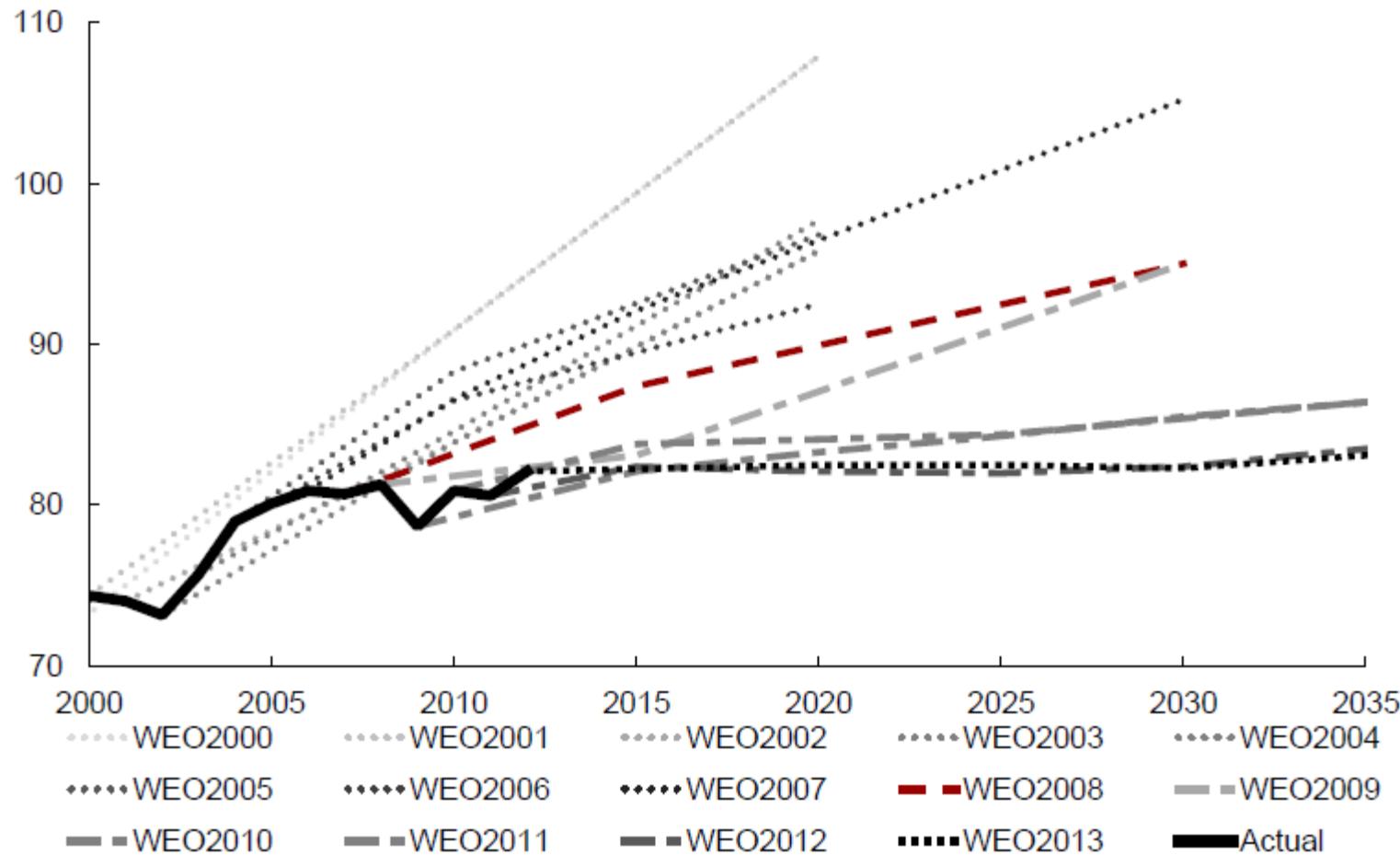
Evolución producción estimada yacimientos en producción

Figure 14.6 ▷ Production that would be observed from all currently producing fields in the absence of further investment (excluding NGLs)



Note: EHOB = extra-heavy oil and bitumen.

Conventional outlook

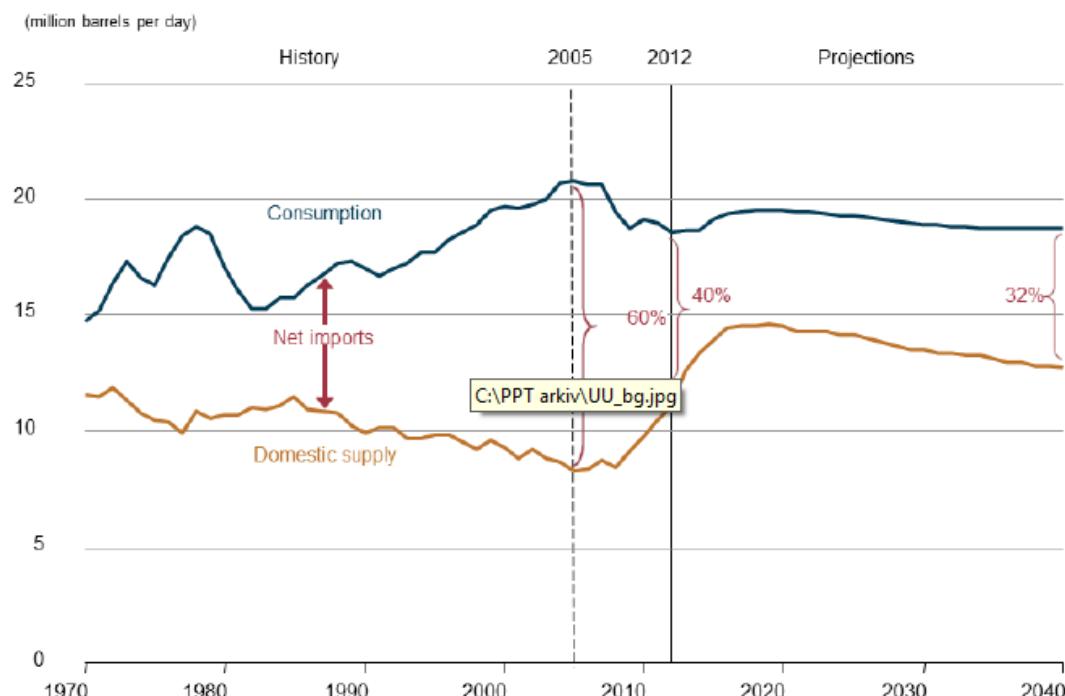


Sources: IEA World Energy Outlook 2000-2013



USA will need to import oil in the future

Figure 12. U.S. petroleum and other liquid fuels supply, 1970-2040



UPPSALA
UNIVERSITET



Kiell Aleklett

La energía que cuesta tener energía



Sociedad industrial
y tecnológica TRE 12-25



Sociedad industrial
desarrollada TRE 8-15



Sociedad industrial
incipiente TRE 6-13



Sociedad agropecuaria
avanzada TRE 5-6

Franja de TRE
mínima requerida
para la civilización

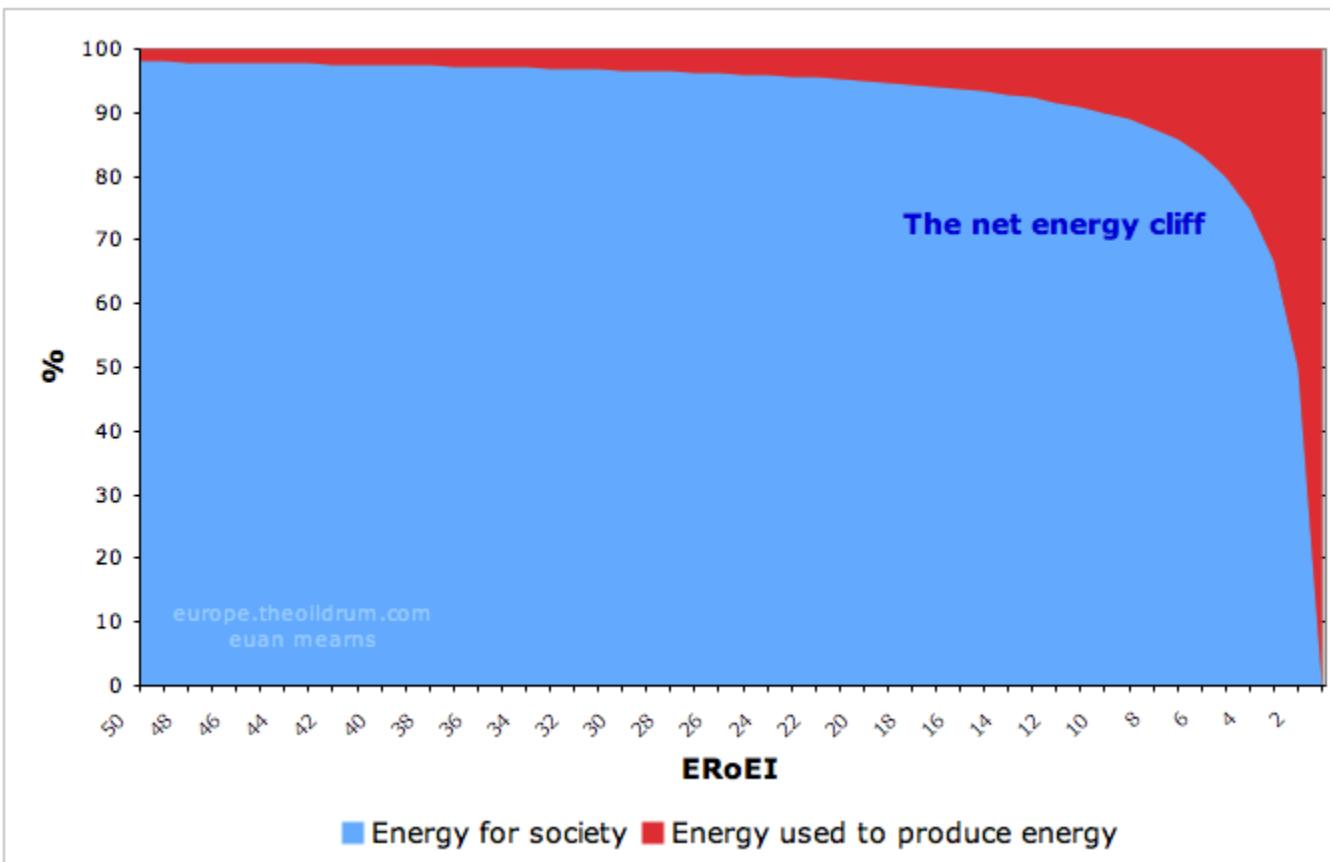


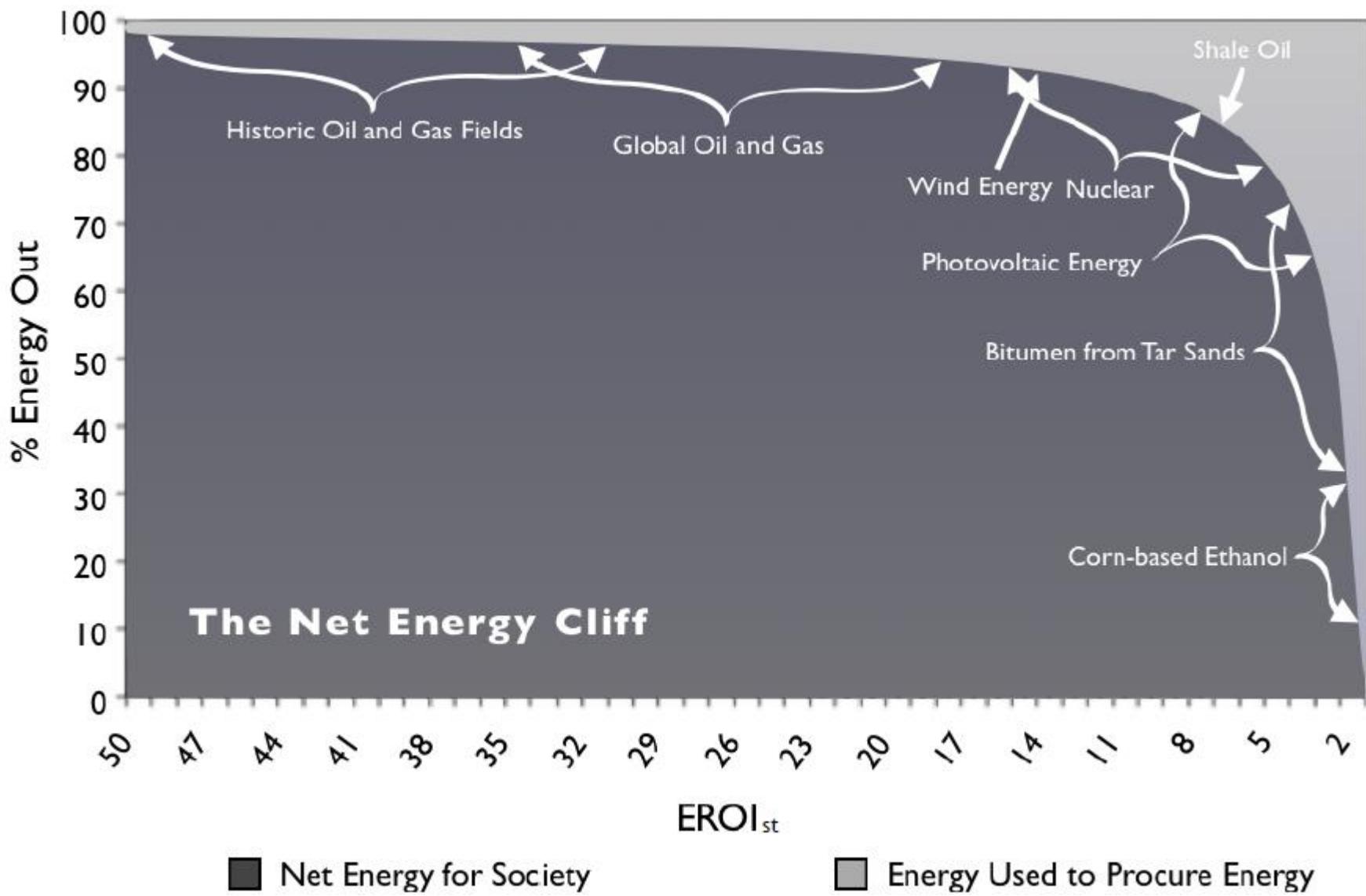
Agricultura-ganadería
primitiva TRE 4-5



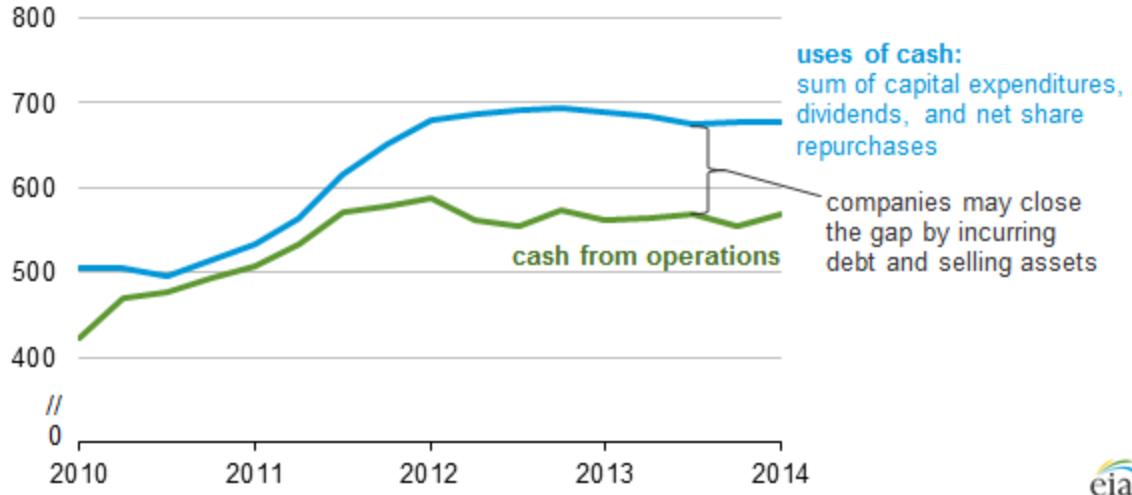
Cazadores recolectores
Nivel metabólico TRE 2-3





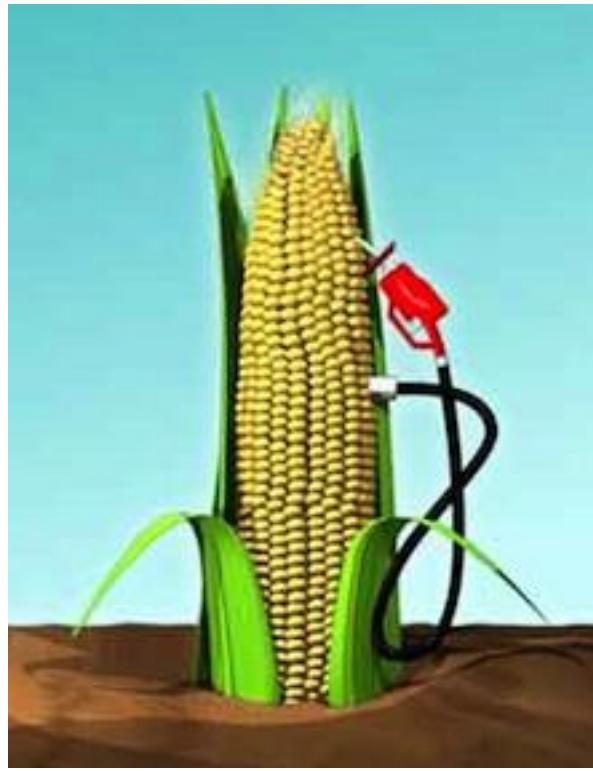


Major energy companies' cash from operations and uses of cash
billion 2014 dollars, annualized values from quarterly reports

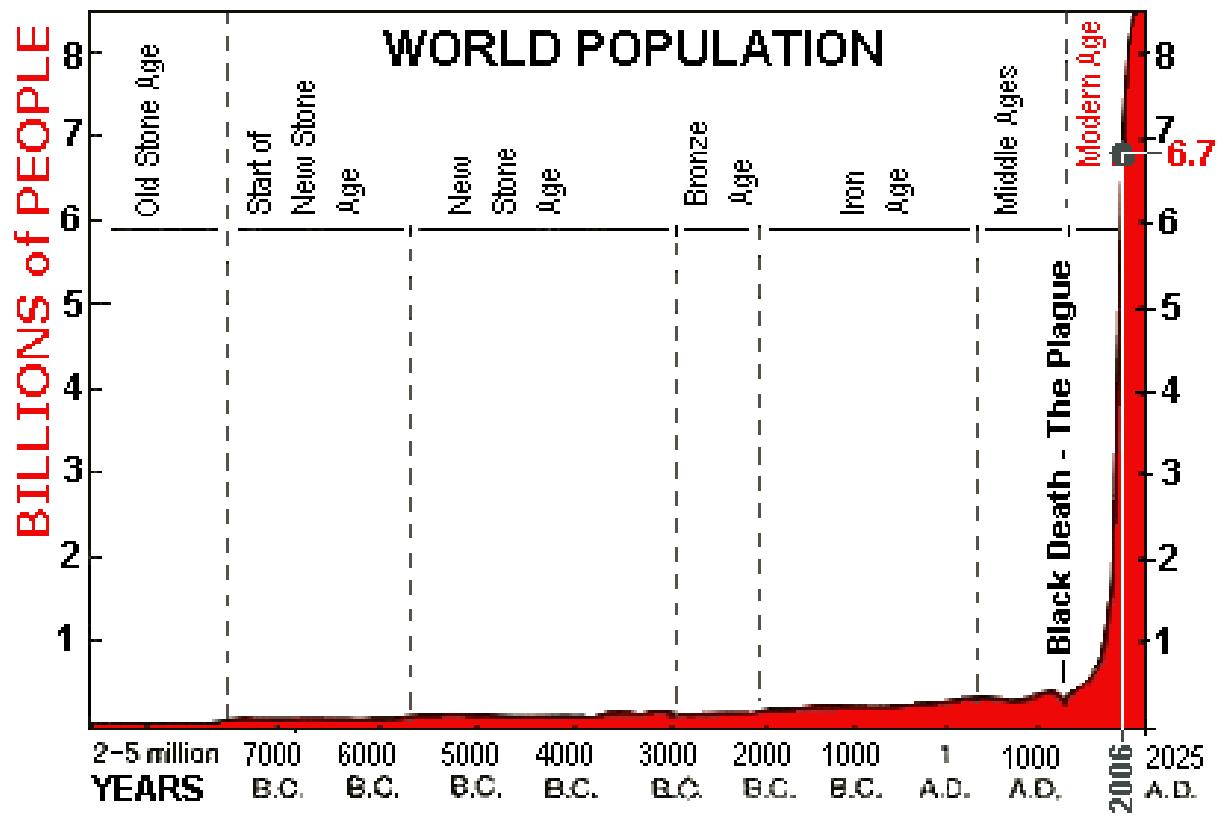


uses of cash:
sum of capital expenditures,
dividends, and net share
repurchases

companies may close
the gap by incurring
debt and selling assets



¿Somos demasiados?



Conceptos previos – 2: Economía

- ▶ Economía medioambiental vs. economía ecológica
 - ▶ Totalitarismo neoclásico
 - ▶ Los tres pisos de Martínez Alier
- ▶ Función de producción de Cobb Douglass
 - ▶ Límites evaporados
 - ▶ Residuo de Solow
- ▶ Relación economía–energía:
¡termodinámica!
 - ▶ Ayres + Warr
 - ▶ Esclavos
 - ▶ Timothy Garrett
 - $9,7 \pm 0,3 \text{ mW}/\$_{1990}$
 - ▶ Megamáquina
- ▶ La ley de los rendimientos decrecientes
- ▶ Crecimiento ineconómico de Daly
- ▶ ¿Economía sin crecimiento?
 - ▶ Sistema financiero



“Para muchos economistas, la tecnología es un único exponente en alguna variante de la función de producción de Cobb-Douglas: funciona automáticamente, sin desfases, sin coste, carente de límites y sólo produce resultados deseables.

¡No es de extrañar que los economistas estén tan extasiados con su potencial para resolver los problemas humanos!”





Joan Martínez-Alier (2010) - Hacia una economía sostenible: dilemas del ecologismo actual - Club de Roma Barcelona - 14/12/2010 -
Departament d'Economia i d'Història Econòmica, Universitat Autònoma de Barcelona: "La economía tiene tres pisos: arriba está el ático y sobre-ático, una lujosa penthouse bien amueblada y con abrigadas alfombras, con salones de ruleta y bacará, donde se anotan y negocian las deudas que durante un tiempo pueden crecer exponencialmente; en medio, está un piso muy atareado con mucha gente y mucho ruido, que parece ser el principal ya que contiene la economía productiva donde se producen y consumen bienes y servicios, una mezcla de fábrica de automóviles y grandes almacenes en época de rebajas; y por abajo está el sótano con la sala de máquinas, el depósito del carbón y la sucia habitación de las basuras, que proporciona energía a todo el edificio y también sirve de sumidero."

¿Cuántos somos?

- ▶ Emisiones amo
(2.500 Kcal/dia/persona)
- ▶ 90 kgC/persona/año
- ▶ Emisiones esclavos:
1.260 kC/persona/año

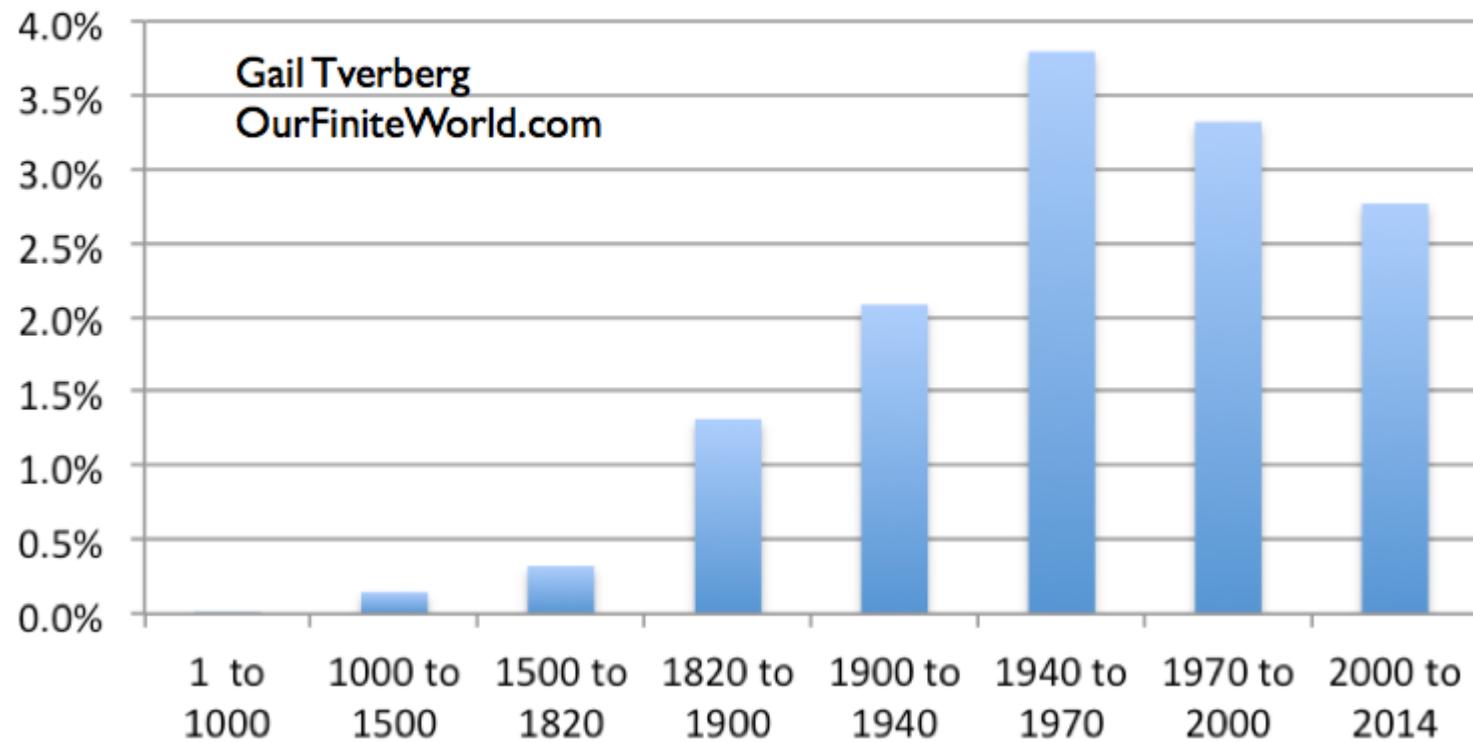
Esclavos: $1,26/0,09 = 14$ por amo

Población amos: 7.000.000.000 persones

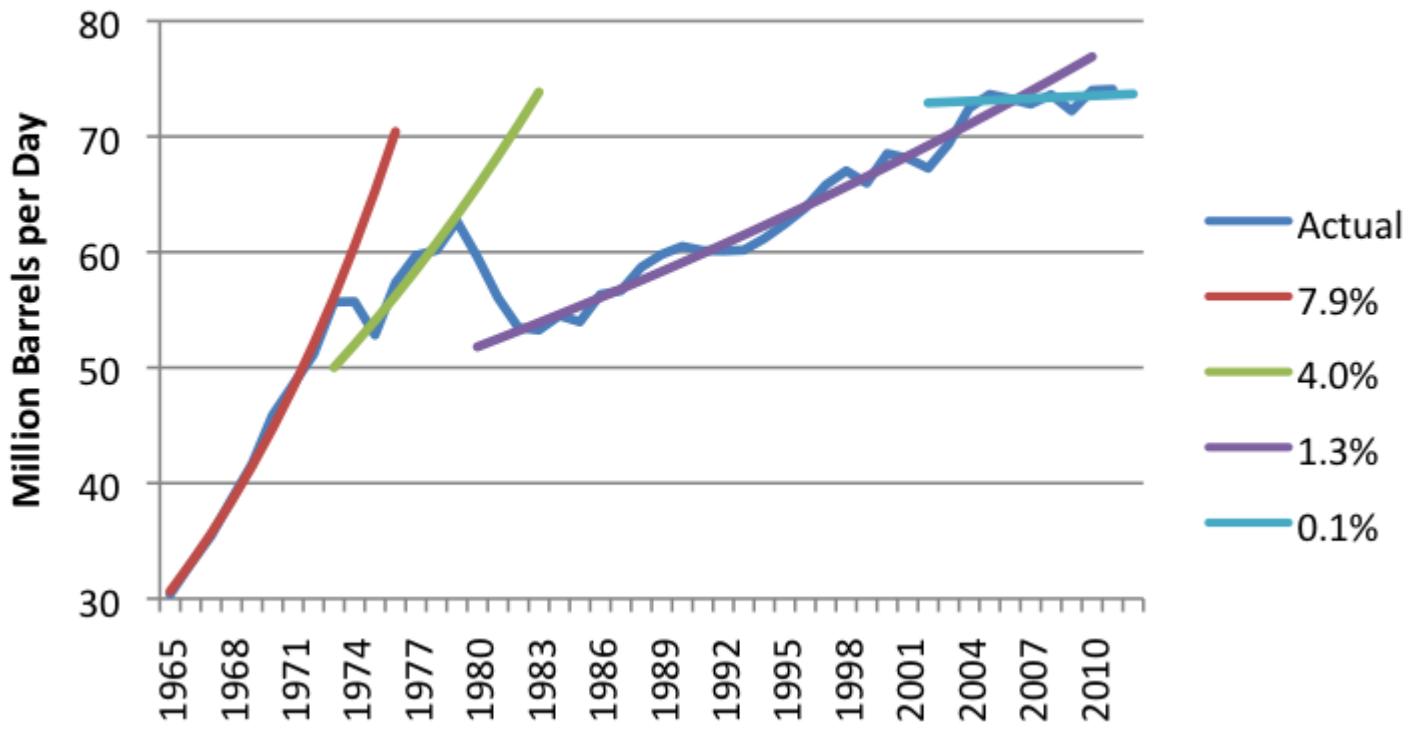
Población total equivalente: $\approx 100.000.000.000$ personas



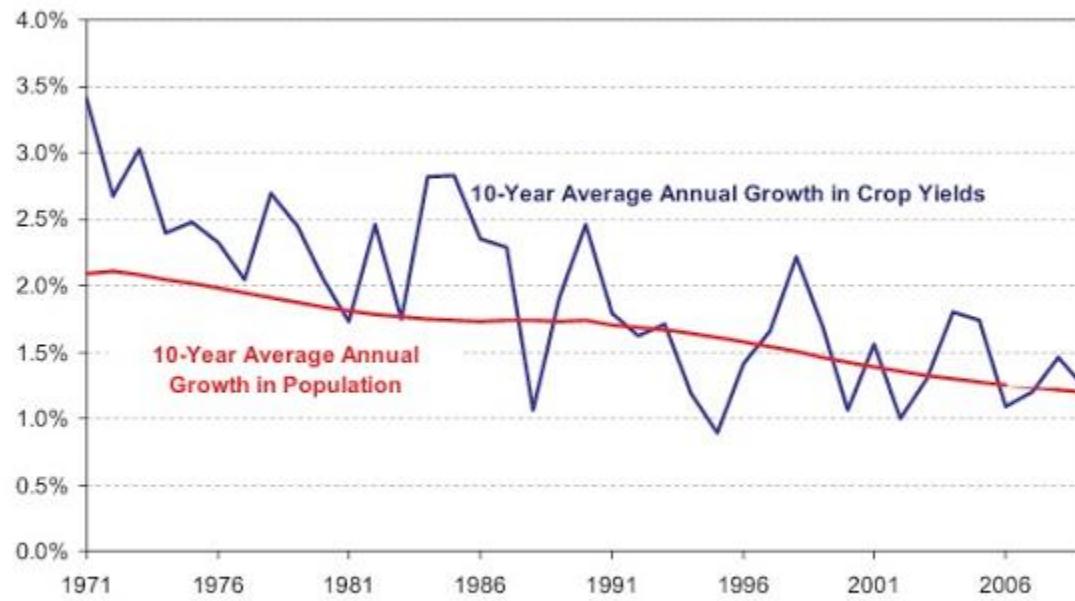
Average Annual % Growth in GDP



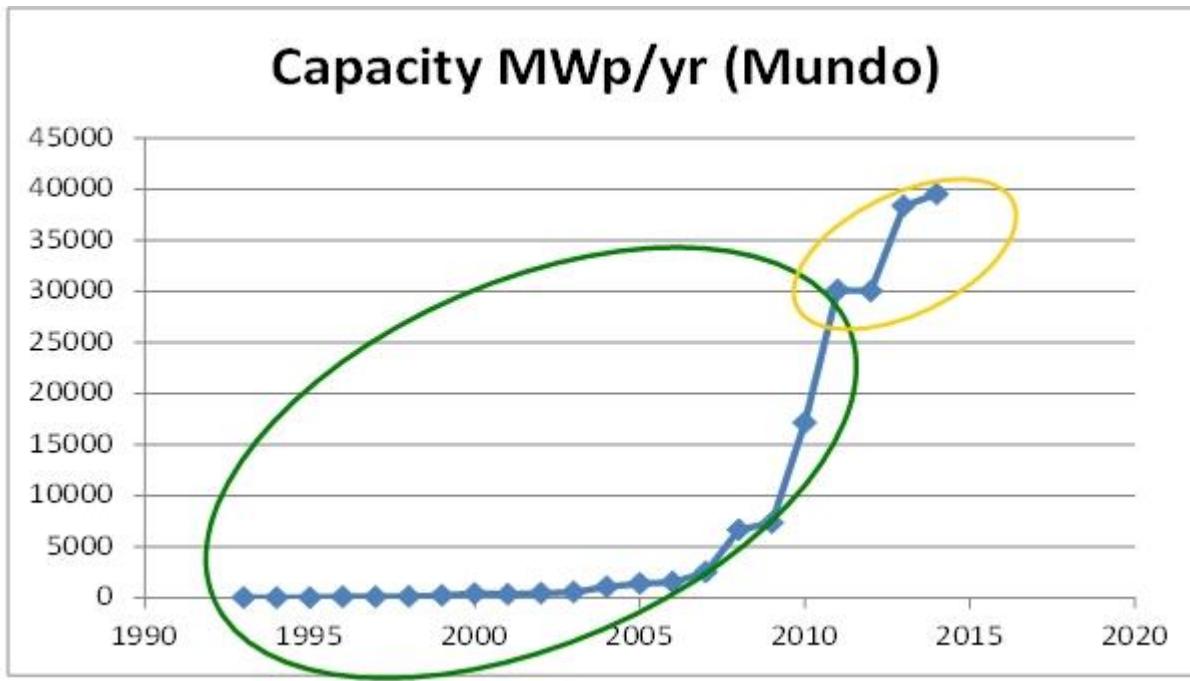
World Crude Oil Production & Fitted Growth %



10-Year Average Annual Growth in Crop Yields



Source: Food and Agriculture Organization of the United Nations As of 12/31/09



Carlos de Castro Carranza - ¿Es el fin del crecimiento exponencial de la solar fotovoltaica (y de la eólica)? - Grupo de Energía, Economía y Dinámica de Sistemas, Universidad de Valladolid - 15/07/2015 -
<http://www.eis.uva.es/energiasostenible/?p=2933>

Conceptos previos – 3: Dinámica de sistemas

- ▶ Qué es un modelo
- ▶ Modelización bottom-up / top-down
 - ▶ Propiedades emergentes
- ▶ Contorno de un sistema
 - ▶ Bosque y árboles; mapa
 - ▶ Ciclo de vida

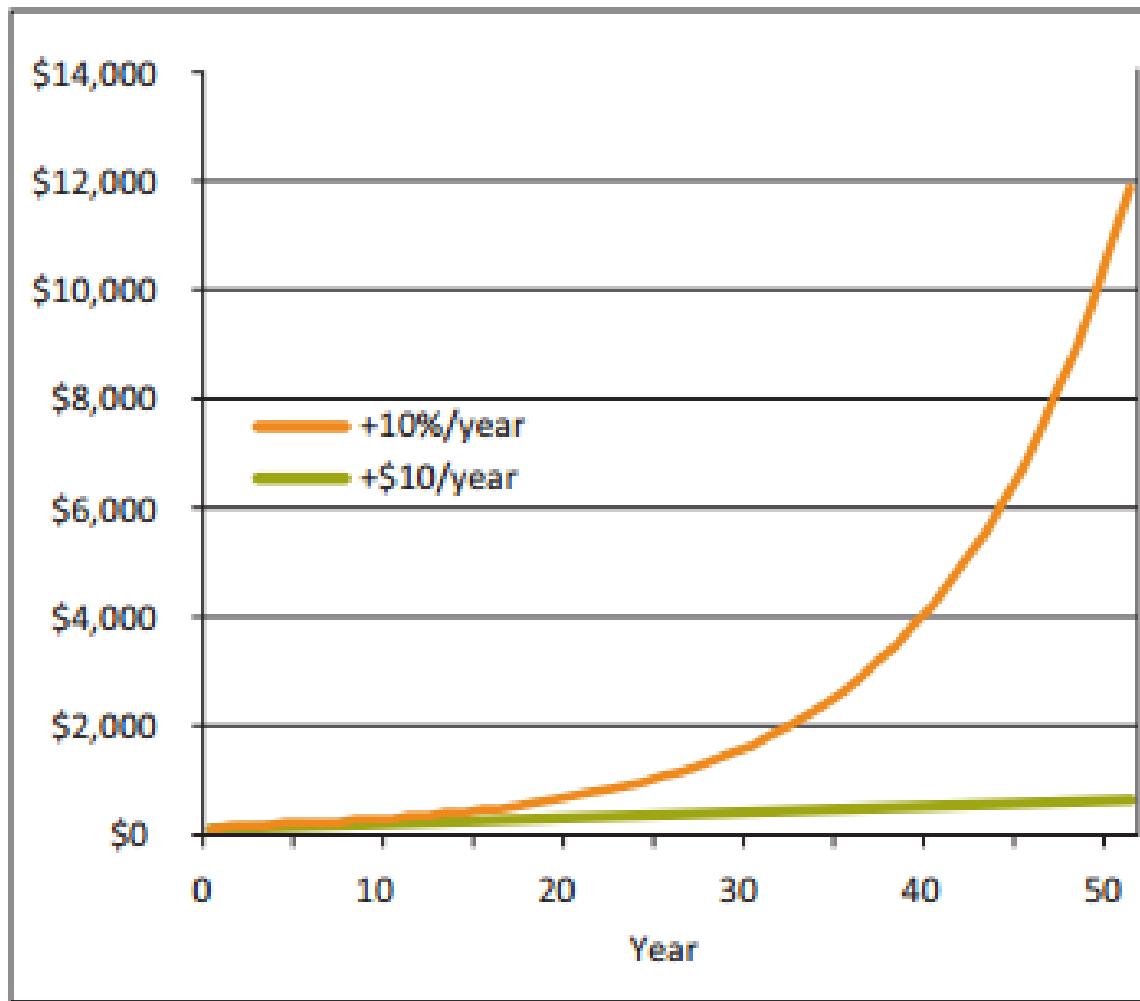
Dinámica

- Rápida, lenta
- Comportamiento exponencial
- Ciclos, retardos
- Limitaciones perceptivas
- Realimentación, interacción y causalidad mutua
- Estados de equilibrio y margen de estabilidad
- Controladores: geoingeniería...
- Sistemas lineales y no lineales





Exponential Growth Versus Arithmetic Growth



Aplicaciones de la dinámica de sistemas

- ▶ Ingeniería
 - ▶ Regulador de James Watt
 - ▶ *On governors* – James Clerck Maxwell
 - ▶ Ubicuo
- ▶ Biología
 - ▶ Lynn Margulis, James Lovelock
 - ▶ Maturana & Varela
- ▶ Sistema Tierra
 - ▶ Cambio climático
- ▶ Sociología – Historia - Economía



New Studies in Archaeology

The Collapse of Complex Societies

JOSEPH A. TAINTER

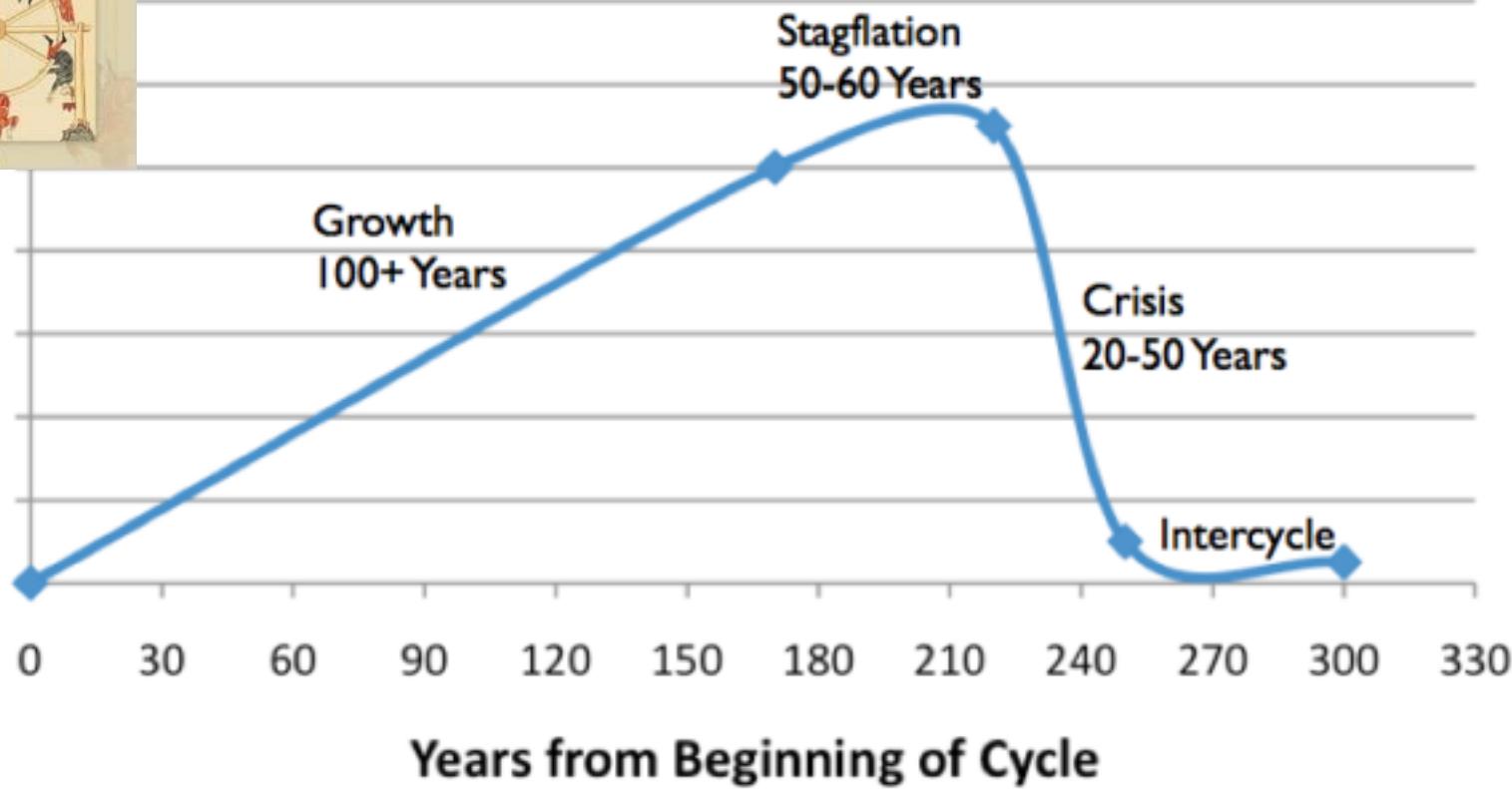


SECULAR CYCLES

Peter Turchin and Sergey A. Nefedov

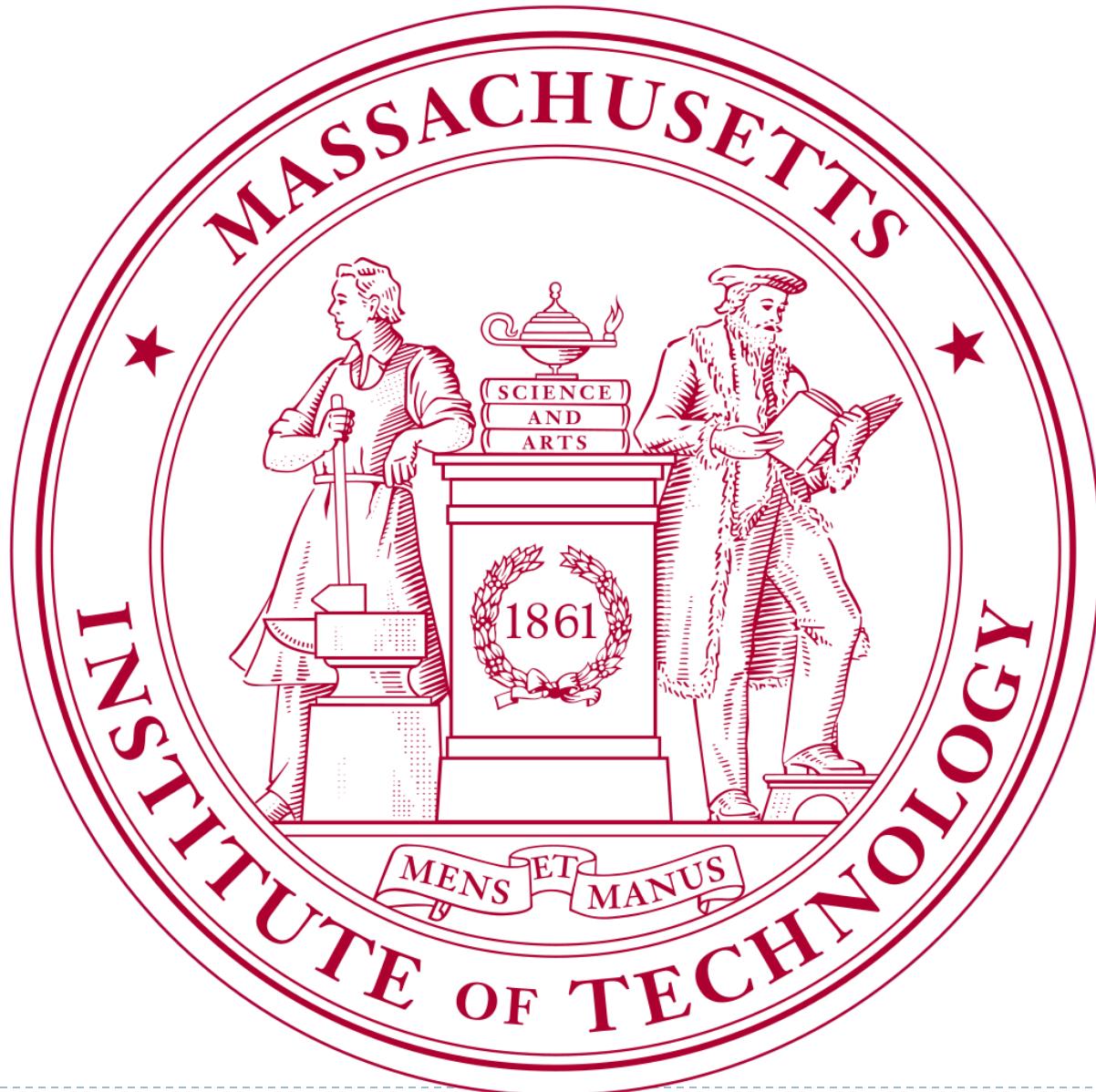


Shape of Typical "Secular Cycle"



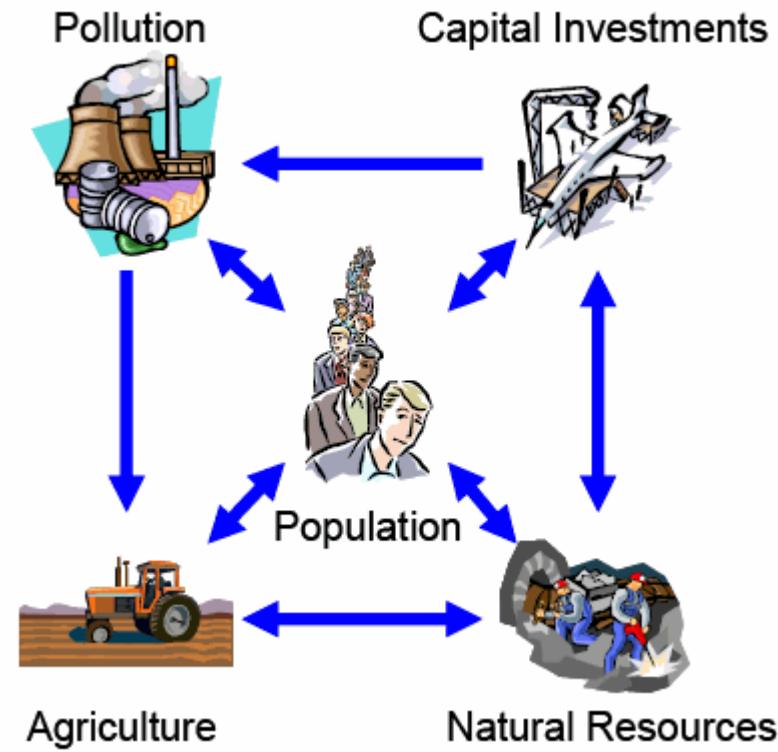
Ciclos seculares de Peter Turchin y Sergey Nefedov (Interpretación de Gail Tverberg, 2013)



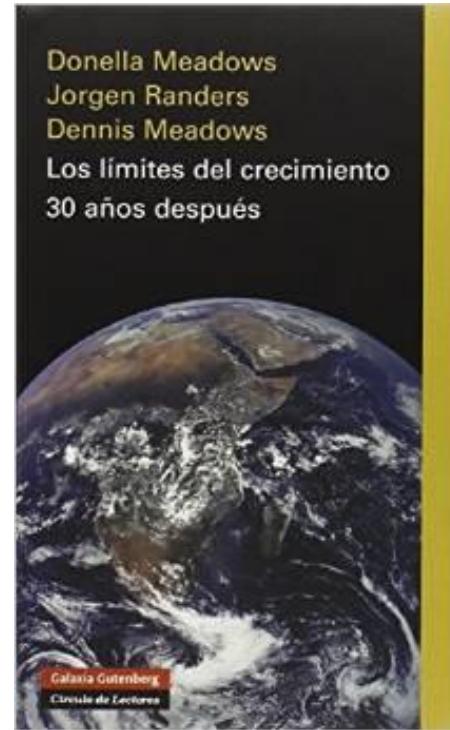
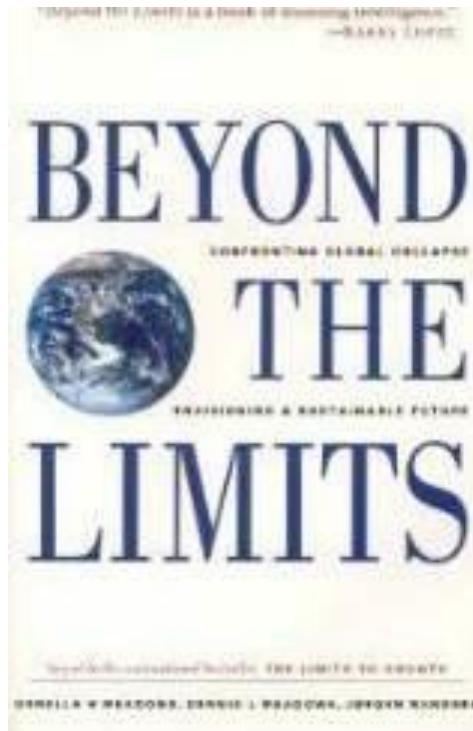
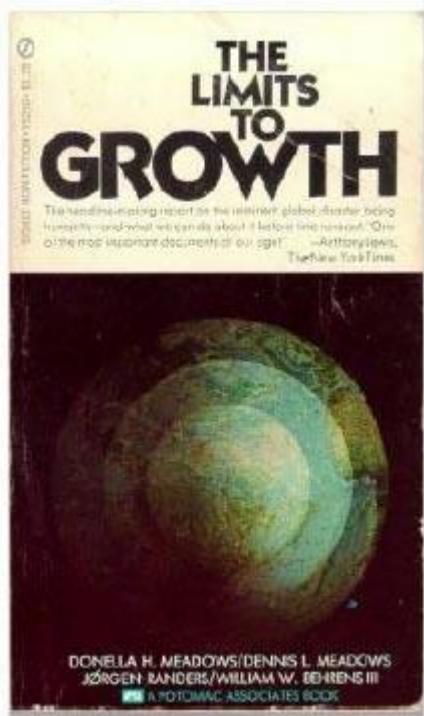


Informe: Los límites del crecimiento

Modelo World3



Original y revisiones propias



Los mensajes clave de LLDC

- I. En un sistema no lineal no es posible extralimitarse sin descender despu s bruscamente tarde o temprano
 - ▶ Salvo si fuera posible un declive gestionado
- II. 6 escenarios
 - ▶ En el caso standard run (que advert an que conduce indefectiblemente al overshoot and collapse), dicho derrumbe se producir a antes de 100 a os
 - ▶ Entre 2010 y 2030 algunos recursos comenzar n a escasear o ser n demasiado caros, y el da o f sico (l ease dificultad de acceso a la energ a y cambio clim tico) ser a crecientemente visible
- III. La importancia clave de los retardos del sistema



-
- ▶ “Una entidad física que crece sólo se desacelerará y después se detendrá acomodándose suavemente a sus límites (crecimiento en forma de S) si recibe señales precisas y oportunas que le indiquen dónde se halla con respecto a sus límites, siempre y cuando responda con rapidez y precisión a tales señales... (p. 260) **Si una sociedad obtiene sus señales de la mera disponibilidad de existencias más que de su tasa de reposición, sin duda se extralimitará.”**
 - ▶ “El problema se agrava si la base del recurso es erosionable y se destruye durante la extralimitación.”
-

-
- ▶ “El resultado de la extralimitación y el colapso es un medio ambiente deteriorado para siempre y un nivel de vida material mucho más bajo del que habría sido posible si nunca hubiera sometido al medio ambiente a tensiones excesivas
 - ▶ A escala mundial, la extralimitación y el colapso podrían comportar la quiebra de los grandes ciclos de sostenimiento de la naturaleza que regulan el clima, purifican el aire, regeneran la biomasa, preservan la biodiversidad y convierten los residuos en nutrientes.”
-

Carga del planeta superada en 1980

Tracking the ecological overshoot of the human economy

Mathis Wackernagel^{*†}, Niels B. Schulz[‡], Diana Deumling^{*}, Alejandro Callejas Linares[§], Martin Jenkins[¶], Valerie Kapos[¶], Chad Monfreda^{*}, Jonathan Loh^{||}, Norman Myers^{**}, Richard Norgaard^{††}, and Jørgen Randers^{††}

^{*}Redefining Progress, 1904 Franklin Street, 6th Floor, Oakland, CA 94612; [†]Institute for Interdisciplinary Studies of Austrian Universities, Department of Social Ecology, Schottenfeldgasse 29, 1070 Vienna, Austria; [‡]Centro de Estudios para la Sustentabilidad, Obreros Textiles 57 Departamento 6, Colonia Marco Antonio Muñoz, 91060 Xalapa, Veracruz, Mexico; [§]World Conservation Monitoring Centre, 219 Huntingdon Road, Cambridge CB3 0DL, United Kingdom; [¶]World-Wide Fund for Nature International, Avenue Mont-Blanc, 1196 Gland, Switzerland; ^{**}Green College, Oxford University, Oxford OX2 6HG, United Kingdom; ^{||}Energy and Resources Group, 310 Barrows Hall, University of California, Berkeley, CA 94720-3050; and ^{††}Norwegian School of Management BI, Elias Smiths vei 15, Box 580, N-1302 Sandvika, Norway

Edited by Edward O. Wilson, Harvard University, Cambridge, MA, and approved May 16, 2002 (received for review January 17, 2002)

Sustainability requires living within the regenerative capacity of the biosphere. In an attempt to measure the extent to which humanity satisfies this requirement, we use existing data to translate human demand on the environment into the area required for the production of food and other goods, together with the absorption of wastes. Our accounts indicate that human demand may well have exceeded the biosphere's regenerative capacity since the 1980s. According to this preliminary and exploratory assessment, humanity's load corresponded to 70% of the capacity of the global biosphere in 1961, and grew to 120% in 1999.

Accounting for Humanity's Use of the Global Biosphere

The human economy depends on the planet's natural capital, which provides all ecological services and natural resources. Drawing on natural capital beyond its regenerative capacity results in depletion of the capital stock. Through comprehensive resource accounting that compares human demand to the biological capacity of the globe, it should be possible to detect this depletion to help prepare a path toward sustainability.

The purpose of this study is to develop such an accounting framework, and to measure the extent of humanity's current demand on the planet's biopродuctive capacity. We build on many earlier attempts to create comprehensive measures of human impact on the biosphere. For example, Vitousek *et al.* (1) used consumption estimates to calculate humanity's appropri-

Our global accounts build on assessments of the "ecological footprint" of humanity (12, 13). Such assessments are based on six assumptions:

1. It is possible to keep track of most of the resources humanity consumes and the wastes humanity generates.
2. Most of these resource and waste flows can be measured in terms of the biologically productive area necessary to maintain these flows (those resource and waste flows that cannot be excluded from the assessment).
3. By weighting each area in proportion to its usable biomass productivity (that is, its potential production of biomass that is of economic interest to people), the different areas can be expressed in standardized hectares. These standardized hectares, which we call "global hectares," represent hectares with biomass productivity equal to the world average productivity that year.
4. Because these areas stand for mutually exclusive uses, and each global hectare represents the same amount of usable biomass production for a given year, they can be added up to a total representing the aggregate human demand.
5. Nature's supply of ecological services can also be expressed in global hectares of biologically productive space.
6. Area demand can exceed area supply. For example, a forest harvested at twice its regeneration rate appears in our accounts at twice its area. This phenomenon is called "ecological overshoot" (14, 15).



The World's Ecological Footprint

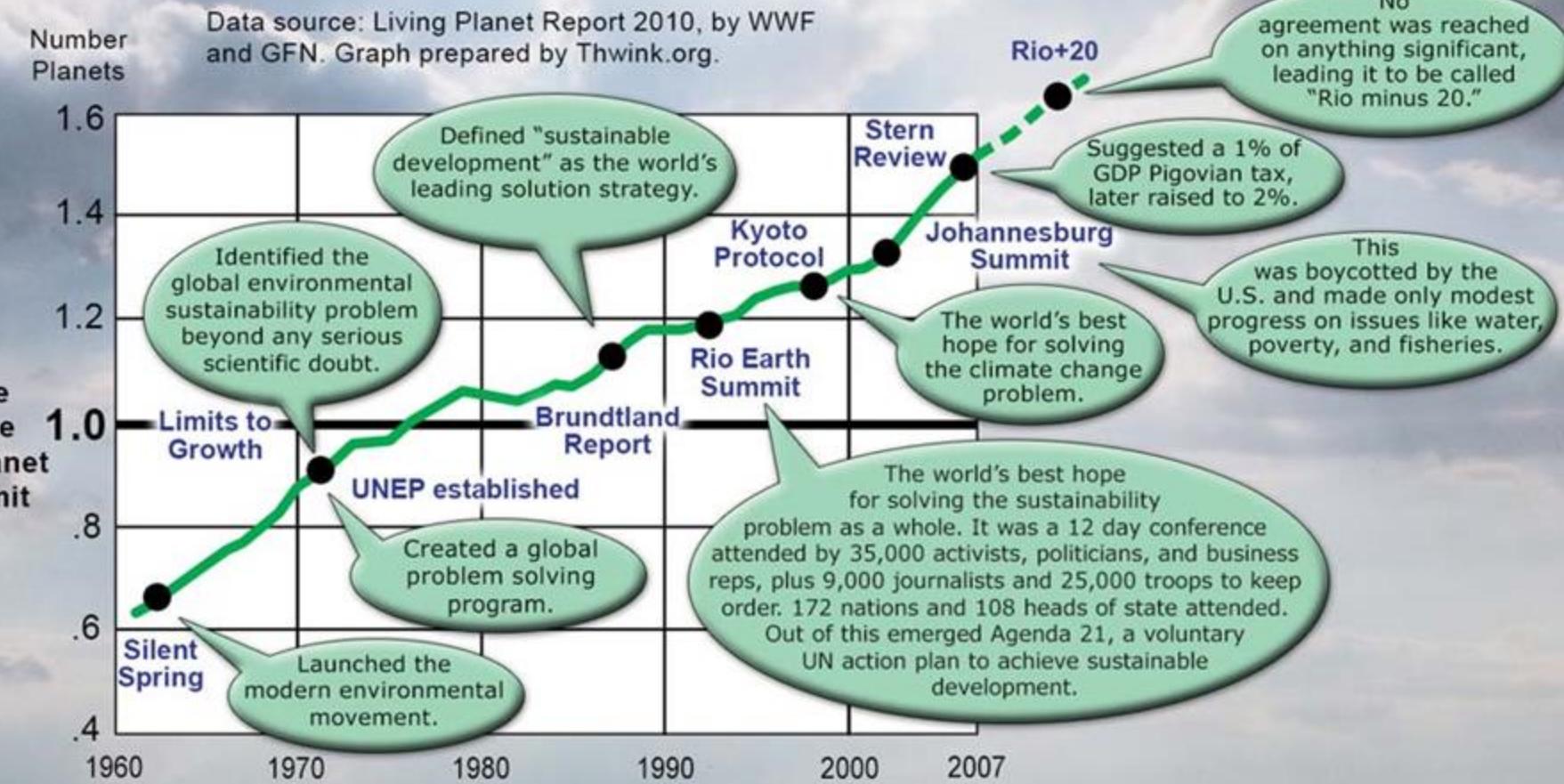
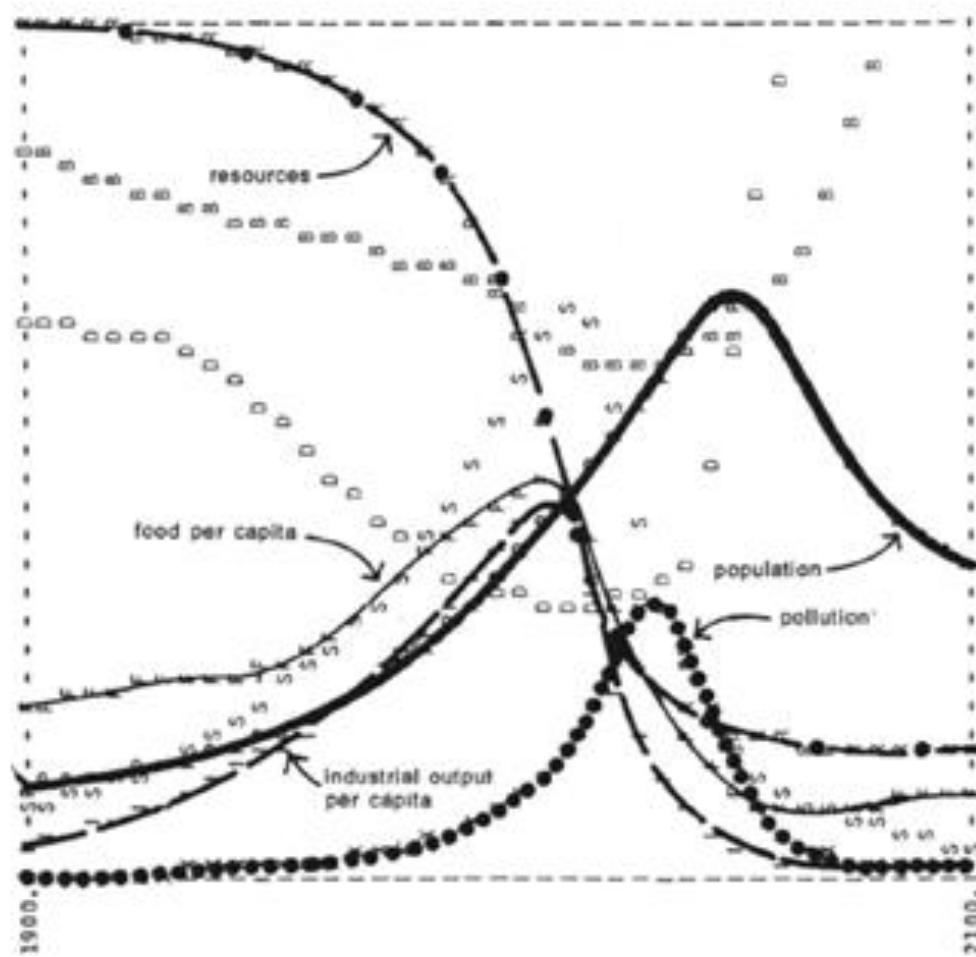


Figure 35 WORLD MODEL STANDARD RUN



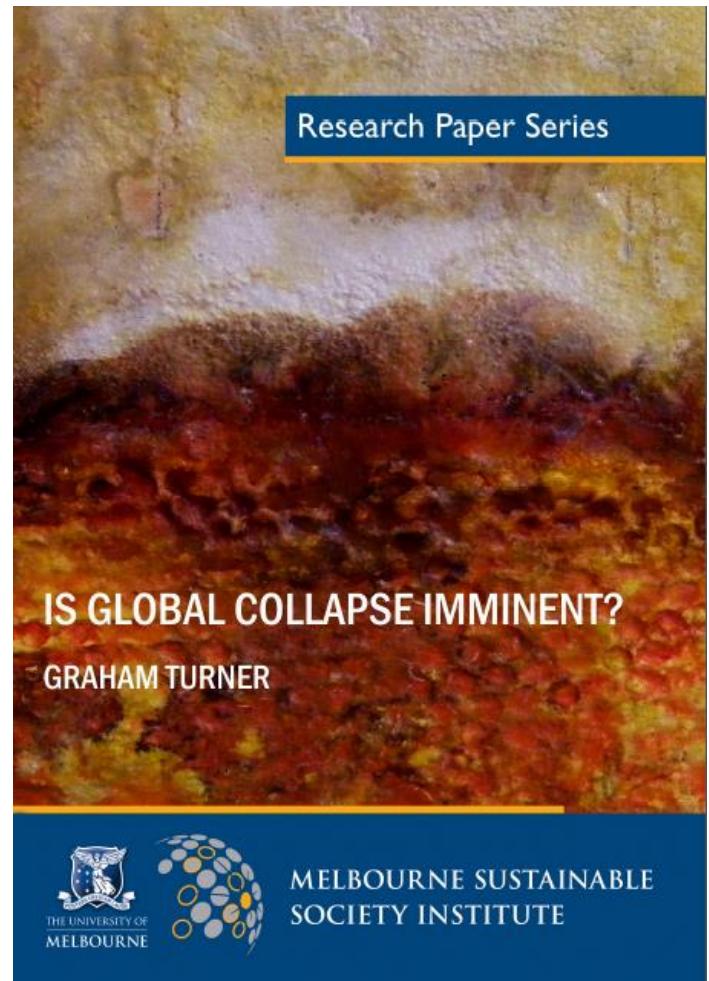
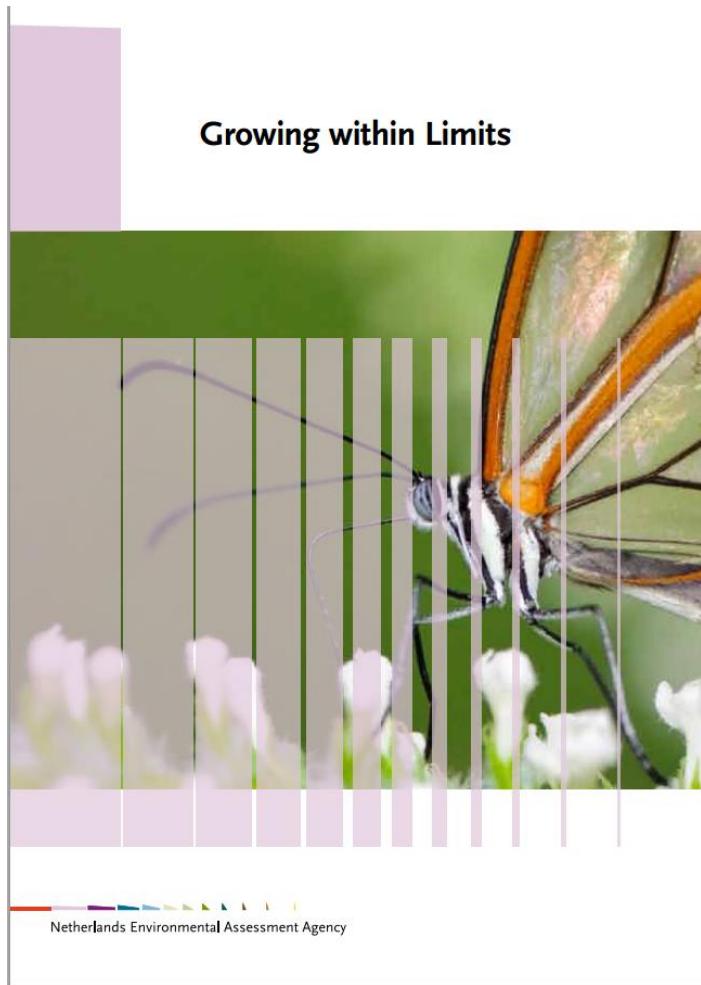
UGO BARDI

LOS LÍMITES DEL CRECIMIENTO RETOMADOS

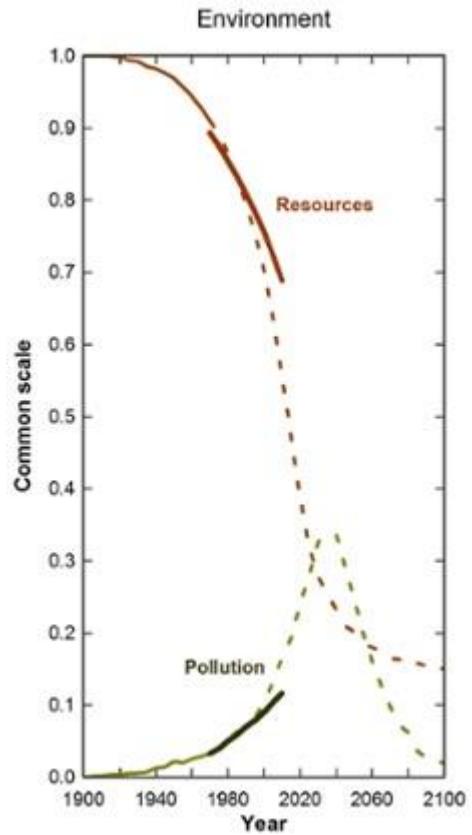
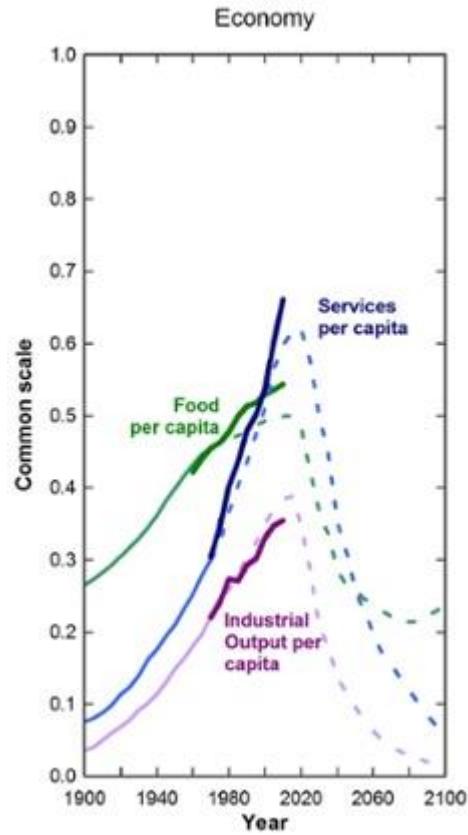
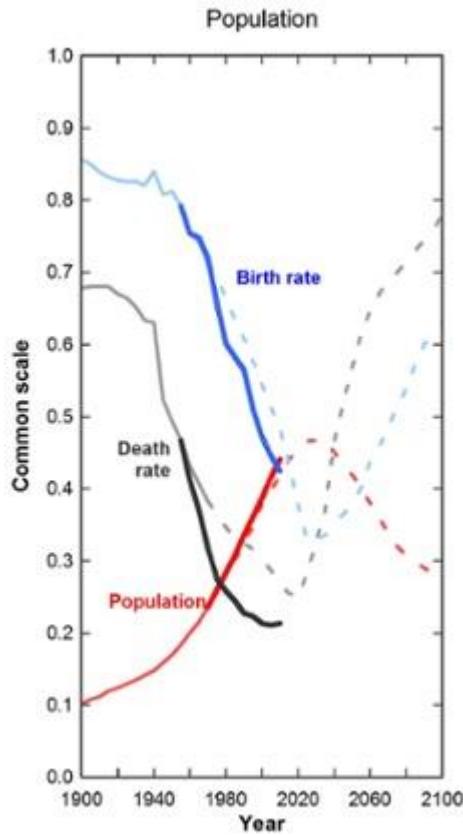
PRÓLOGO DE FEDERICO MAYOR ZARAGOZA
Y EPÍLOGO DE JORGE RIECHMANN



Revisiones externas

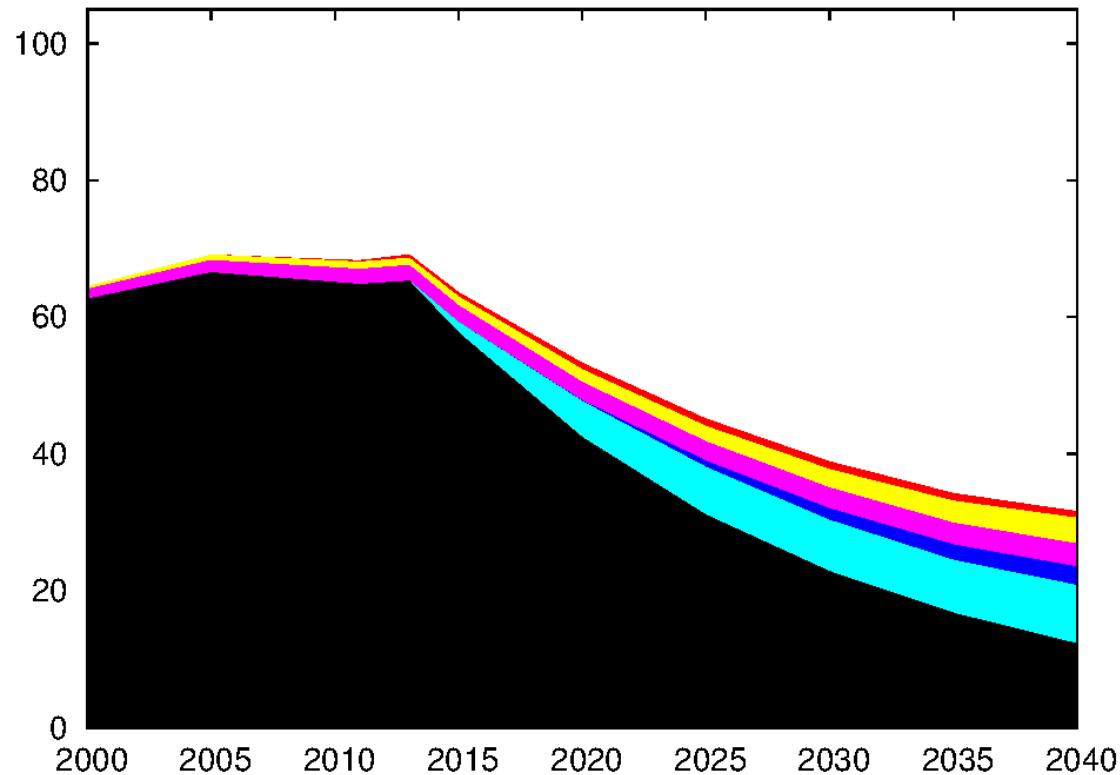


Última revisión (agosto 2014)



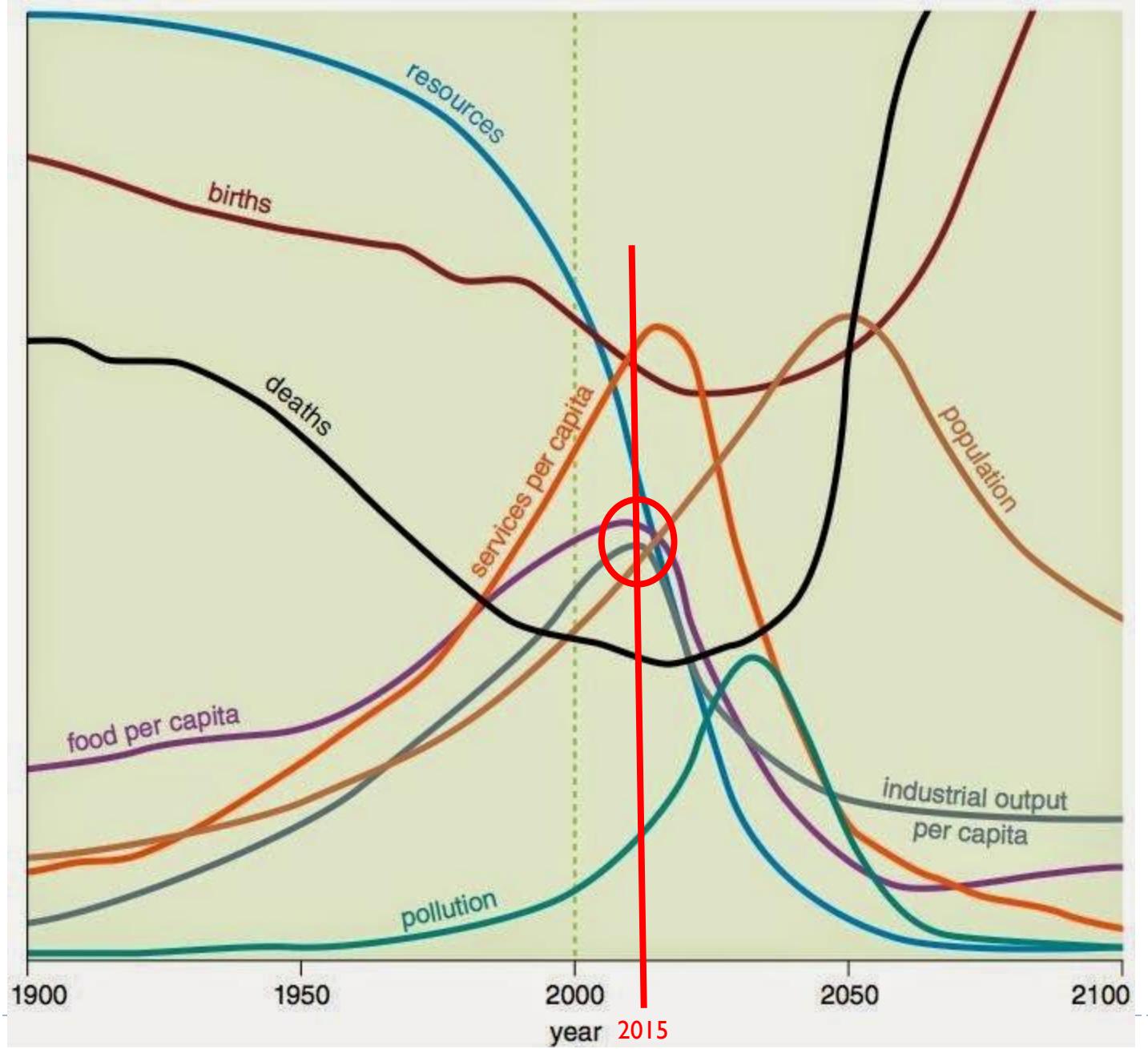
Graham Turner and Cathy Alexander - Limits to Growth was right. New research shows we're nearing collapse - The Guardian, 02/09/2014 - <http://www.theguardian.com/commentisfree/2014/sep/02/limits-to-growth-was-right-new-research-shows-were-nearing-collapse>

Energía neta procedente del petróleo



Evolución de la producción de energía neta a partir de hidrocarburos líquidos en un escenario más realista, de acuerdo con el WEO 2014 (Fuente: Antonio Turiel, 2015)







Contents lists available at ScienceDirect

Energy
journal homepage: www.elsevier.com/locate/energy



Fossil fuel depletion and socio-economic scenarios: An integrated approach

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ABSTRACT

The progressive reduction of high-quality-easy-to-extract energy is a widely recognized and already ongoing process. Although depletion studies for individual fuels are relatively abundant, few of them offer a global perspective of all energy sources and their potential future developments, and even fewer include the demand of the socio-economic system.

This paper presents an Economy-Energy-Environment model based on System Dynamics which integrates all those aspects: the physical restrictions (with peak estimations for oil, gas, coal and uranium), the techno-sustainable potential of renewable energy estimated by a novel top-down methodology, the socio-economic energy demands, the development of alternative technologies and the net CO₂ emissions.

We confront our model with the basic assumptions of previous Global Environmental Assessment (GEA) studies. The results show that demand-driven evolution, as performed in the past, might be unfeasible: strong energy-supply scarcity is found in the next two decades, especially in the transportation sector before 2020. Electricity generation is unable to fulfill its demand in 2025–2040, and a large

Keywords:

Renewable limits

Fossil fuel depletion

Global warming

System dynamics

Peak oil

Global Environmental Assessment

Iñigo Capellán et al (2015)

- ▶ No contempla
 - ▶ Intermitencia renovables
 - ▶ TRE
 - ▶ Efecto rebote ganancias eficiencia
 - ▶ Conflictos y desastres inexistentes
 - ▶ Sólo emisiones CO₂
 - ▶ Absorción constante por biosfera
 - ▶ No aumento temperatura por menos aerosoles
 - ▶ No realimentación energía-economía (no consenso...)
- ▶ Resultados
 - ▶ No compatibles con agencias internacionales
 - ▶ Problemas antes de 2020 en *todos los* escenarios



Y más

REVIEW

doi:10.1038/nature11018

Approaching a state shift in Earth's biosphere

Anthony D. Barnosky^{1,2,3}, Elizabeth A. Hadly⁴, Jordi Bascompte⁵, Eric L. Berlow⁶, James H. Brown⁷, Mikael Fortelius⁸, Wayne M. Getz⁹, John Harte^{9,*}, Alan Hastings¹¹, Pablo A. Marquet^{12,13,14,15}, Neo D. Martinez¹⁶, Arne Mooers¹⁷, Peter Roopnarine¹⁸, Geerat Vermeij¹⁹, John W. Williams²⁰, Rosemary Gillespie⁹, Justin Kitzes⁹, Charles Marshall^{1,2}, Nicholas Matzke¹, David P. Mindell²¹, Eloy Revilla²² & Adam B. Smith²³

Localized ecological systems are known to shift abruptly and irreversibly from one state to another when they are forced across critical thresholds. Here we review evidence that the global ecosystem as a whole can react in the same way and is approaching a planetary-scale critical transition as a result of human influence. The plausibility of a planetary-scale 'tipping point' highlights the need to improve biological forecasting by detecting early warning signs of critical transitions on global as well as local scales, and by detecting feedbacks that promote such transitions. It is also necessary to address root causes of how humans are forcing biological changes.

“La comparación de la intensidad actual del cambio planetario con la situación que caracterizó cambios de estado de escala global en el pasado, y los enormes forzamientos que seguimos ejerciendo, sugieren que una nueva transición a escala global es altamente plausible en el plazo de décadas o siglos, si no se ha iniciado ya.”

Ecological Economics 101 (2014) 90–102

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Methodological and Ideological Options

Human and nature dynamics (HANDY): Modeling inequality and use of resources in the collapse or sustainability of societies

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^a School of Public Policy and Department of Mathematics, University of Maryland; and National Socio-Environmental Synthesis Center (SESYNC)

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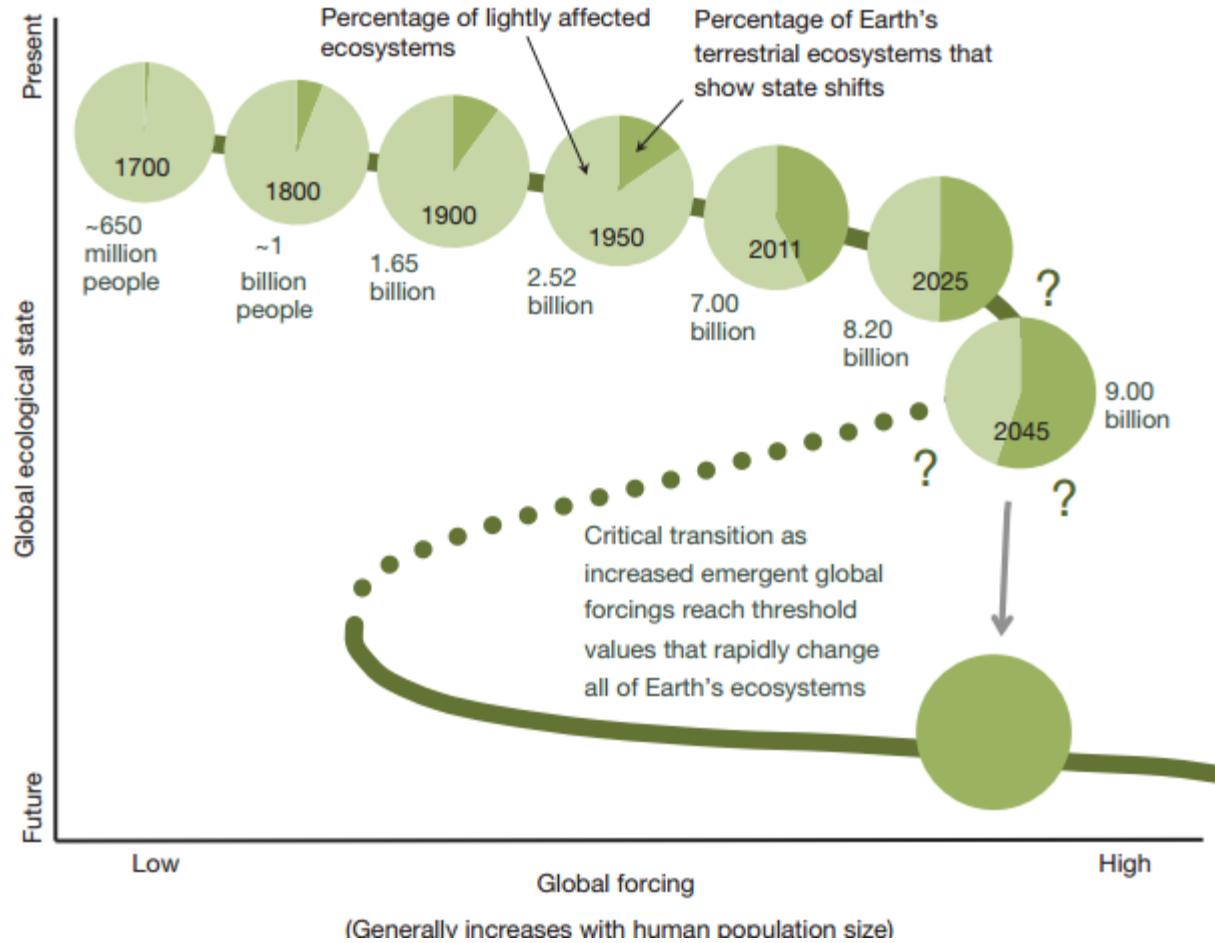
ABSTRACT

There are widespread concerns that current trends in resource-use are unsustainable, but possibilities of overshoot/collapse remain controversial. Collapses have occurred frequently in history, often followed by centuries of economic, intellectual, and population decline. Many different natural and social phenomena have been invoked to explain specific collapses, but a general explanation remains elusive. In this paper we build a human population dynamics model by adding accumulated wealth and economic in-

“Mientras algunos miembros de la sociedad pueden estar haciendo sonar la alarma mostrando cómo el sistema se mueve hacia un colapso inminente y que, por lo tanto, es preciso adoptar medidas de cambio estructural para evitarlo, las élites y sus seguidores, que se oponen a estos cambios, pueden recurrir a la larga trayectoria sostenible ocurrida ‘hasta ahora’ para defender la inacción.”



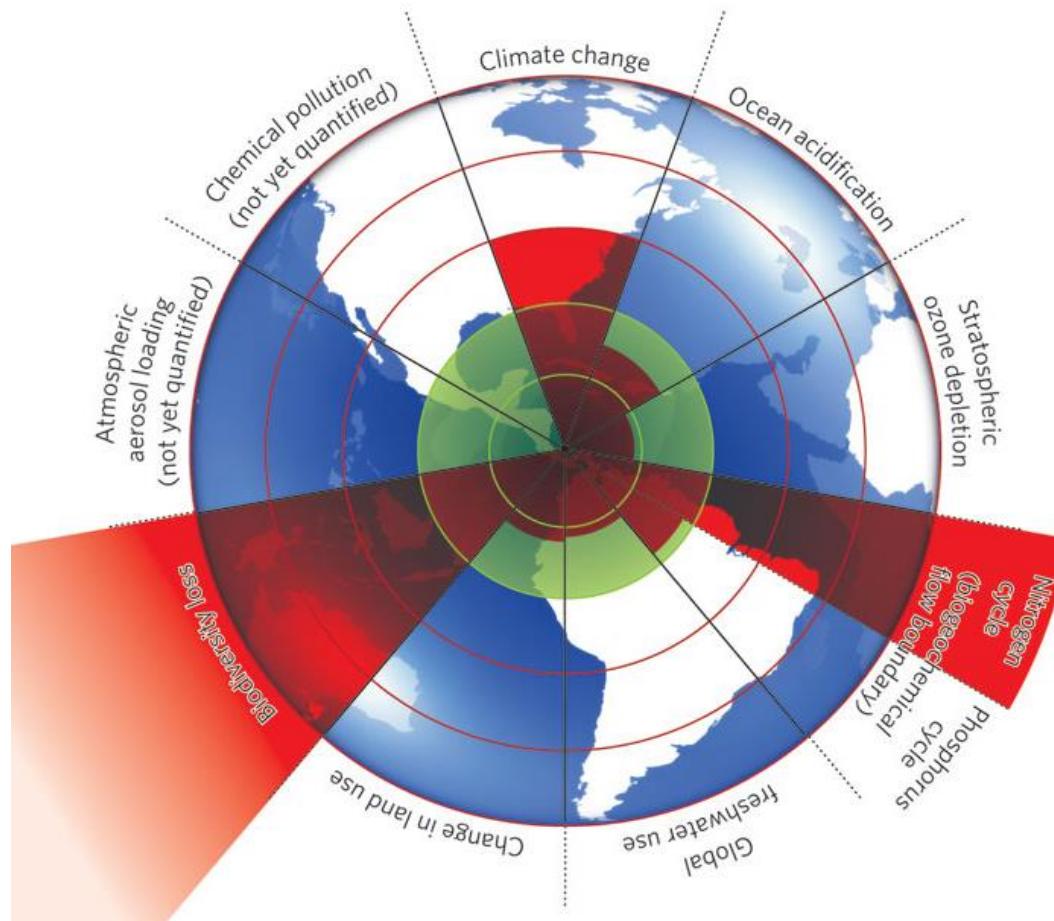
Cambio de estado de la biosfera



- ▶ Approaching a state shift in Earth's biosphere - Anthony D. Barnosky et al (2012) – Nature 486:52-58 doi:10.1038/nature11018
- Department of Integrative Biology, + Museum of Paleontology + 3 Museum of Vertebrate Zoology, University of California

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- ▶ “... Nuestros estilos de vida, costumbres, instituciones, patrones de interacción, valores y expectativas han sido conformadas por una herencia cultural originada en una época en que la capacidad de carga del planeta era superior al forzamiento humano. Una herencia cultural puede persistir tras las condiciones que la produjeron. El exceso de capacidad de carga ha desaparecido ya, erosionada tanto por el incremento poblacional como por la inmensa ampliación de los apetitos tecnológicos y los impactos medioambientales.
 - ▶ La vida humana transcurre ahora en el marco de una era de déficit creciente de la capacidad de carga. Todos los aspectos familiares de la vida social humana se encuentran ahora bajo fuerte presión de cambio en esta nueva era en la que la carga excede cada vez más su capacidad en muchas regiones locales y en un planeta finito.
 - ▶ Asistiremos a una escalada de desorganización social, fricciones crecientes, conflictos y desmoralización.”

A safe operating space for humanity



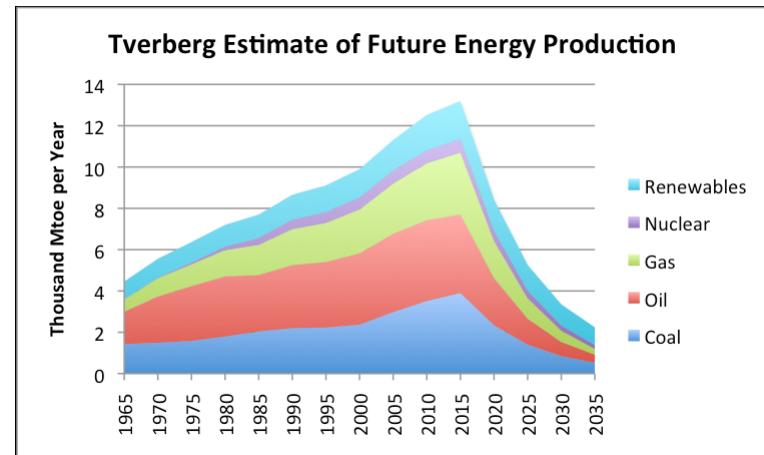
¿Peor todavía?

► Colapso catabólico

“El proceso que conduce al colapso de las civilizaciones tiene una base sorprendentemente simple: el desajuste entre los costes de mantenimiento del capital y los recursos disponibles para ello. Capital, aquí, se emplea en el sentido más amplio de la palabra, e incluye todo aquello en la que una civilización invierte su bienestar: edificios, carreteras, expansión imperial, infraestructura urbana, recursos de información, personal formado, etc.”

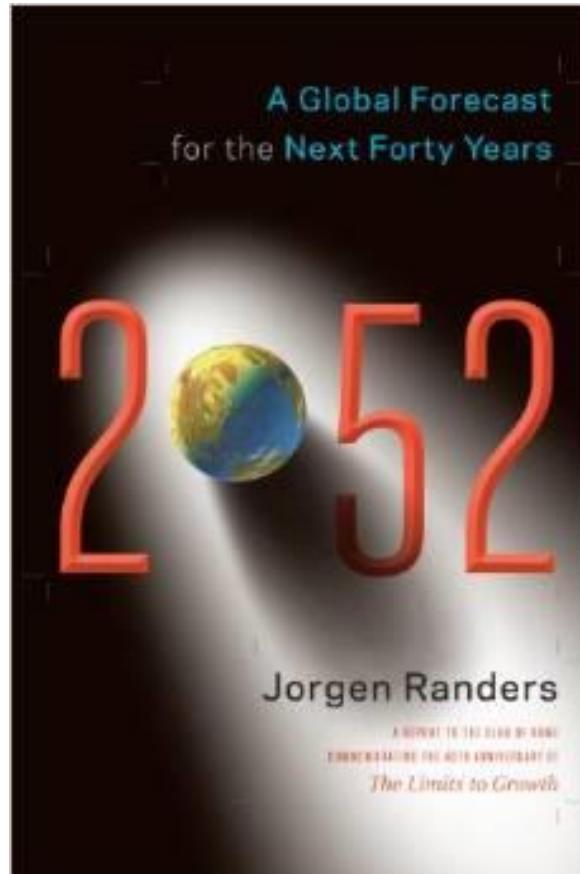
John Michael Greer, 2014

► Influencia de la deuda



Gail Tverberg, 2014

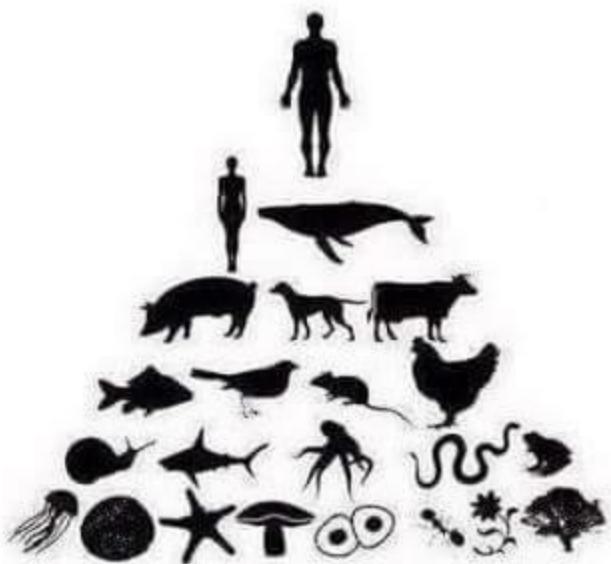
El mejor escenario



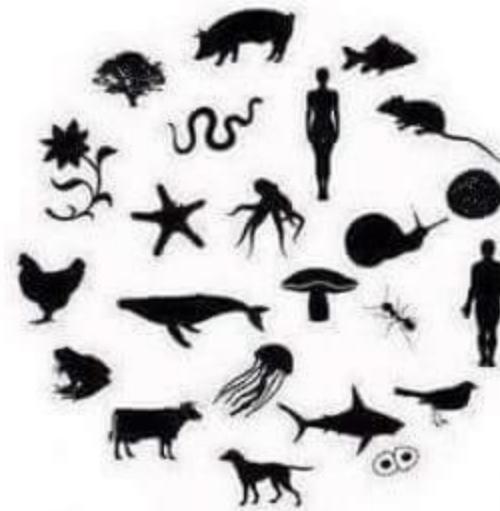
Overshoot and decline



EGO



ECO



Gracias

<http://ustednoselocree.com>

