

Science and Education for *Sustainable Development*

Max Paoli

Programme Coordinator

The World Academy of Sciences

What is Sustainable Development?

"Sustainable development is development that meets the needs of the present, without compromising the ability of future generations to meet their own needs."



From the World Commission on Environment and Development's (the Brundtland Commission) report 'Our Common Future', 1987.

Young will pick up climate change bill, advisers warn

By Roger Harrabin
BBC environment analyst

🕒 28 June 2018 | 💬 285



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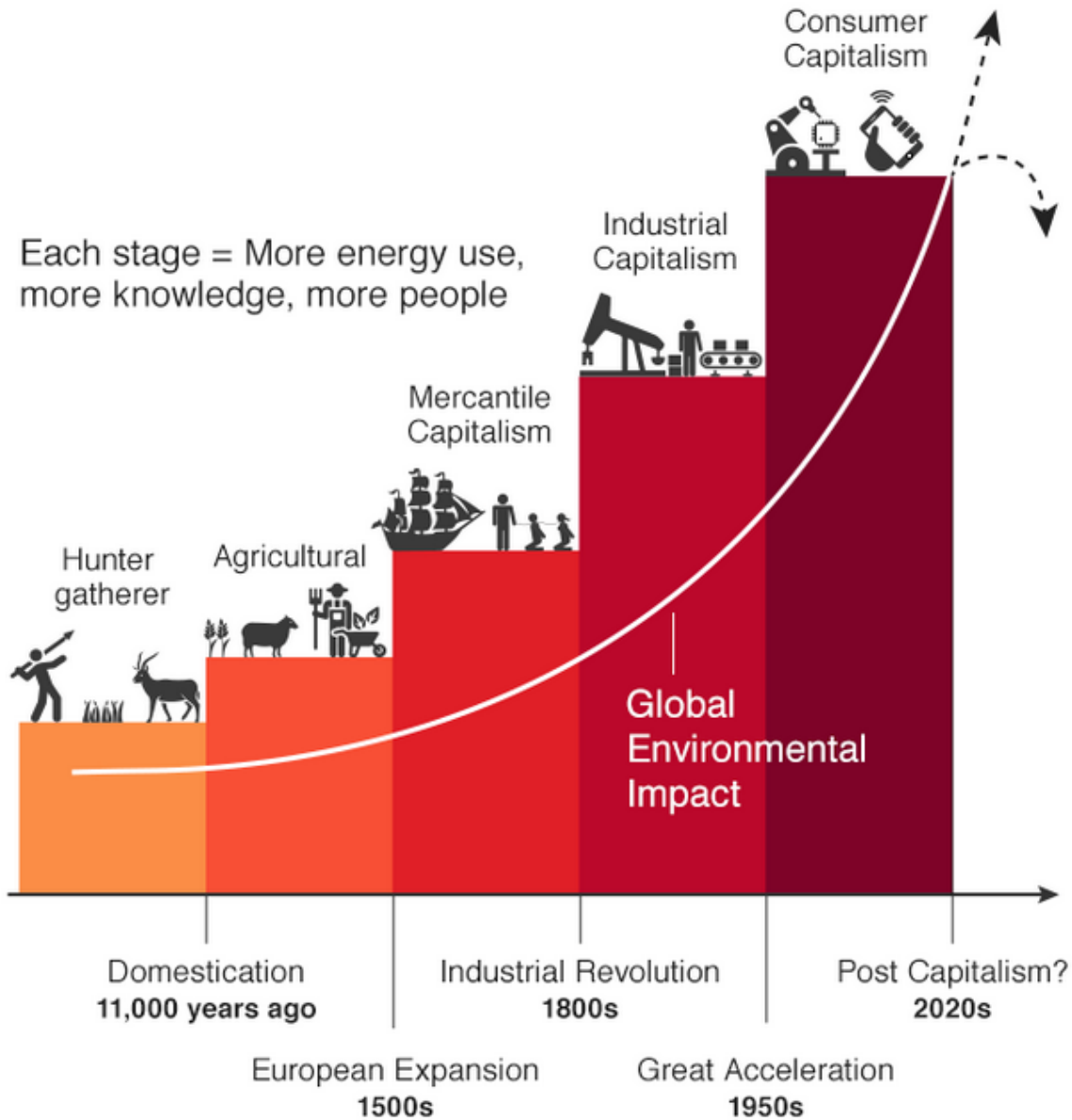
Transport pollution is rising

Young people will be left to pick up the bill for climate change because politicians are dodging the issue, a UK report warns.

GLOBAL CHALLENGES

- **Population growth**
- **Limited resources**
- **Energy demands**
- **CO₂ emissions and climate change**
- **Air and water pollution and environmental degradation**
- **Urban sprawl and mega-cities**
- **Infectious diseases, epidemics, antibiotic resistance**
- **Biodiversity loss**

Human societies and their increasing environmental impact



What kind of a science is sustainability science?

Robert W. Kates¹

Independent Scholar, Trenton, ME 04605

Sustainability science, as described by the PNAS website, is "...an emerging field of research dealing with the interactions between natural and social systems, and with how those interactions affect the challenge of sustainability: meeting the needs of present and future generations while substantially reducing poverty and conserving the planet's life support systems." Over the past 7 y, PNAS has published over 300 papers in its unique section on sustainability science and has received and reviewed submissions for many hundreds more. What kind of a science is sustainability science?

The article by Bettencourt and Kaur (1) on the evolution and structure of sustain-

pressive thing about the very large number of papers and authors is where they were written and the disciplines from which they were drawn. Sustainability science, as represented by the authors' addresses and institutions, is widely distributed and includes many authors beyond the normal concentration in such centers of traditional science as Japan, the United States, and Western Europe. These include almost all the emerging BRICS (Brazil, Russia, India, China, South Africa) economies but also such developing countries as Kenya and Nigeria. Home cities and institutions for papers also differ from traditional centers, with many originating in political centers (e.g., Beijing, Canberra,

One such dimension is the balance in sustainable development papers between those that emphasize research on environment and those that emphasize research on development. Most insiders I know have backgrounds originally in the environmental sciences, and their research topics often reflect this despite their commitment to a science of both environment and development. In an analysis of titles of 232 research papers in the sustainability section of PNAS, 62% had a major focus on sustaining environmental life support systems, as contrasted with 38% that primarily addressed human well-being and a few that addressed poverty alleviation (7).

PLASTICS

Production, use, and fate of all plastics ever made

Roland Geyer,^{1*} Jenna R. Jambeck,² Kara Lavender Law³

Plastics have outgrown most man-made materials and have no robust global information, particularly about their end-of-life fate. We present data on production, use, and end-of-life management of plastics to present the first global analysis of all mass-produced plastics ever made. We estimate that 8.3 billion metric tons (Mt) of virgin plastics have been produced to date. Of this, 1.1 billion Mt had been generated, around 9% of which had been recycled, 12% incinerated, and 79% had gone to landfill or the natural environment. If current production and waste management trends continue, plastic waste will be in landfills or in the natural environment by 2050.

A paper authored by the industrial ecologist from the University of California, Santa Barbara, and colleagues appears in the journal *Science Advances*. It is described as the first truly global assessment of how much plastic has been manufactured, how the material in all its forms is used, and where it ends up. Here are some of its key numbers.

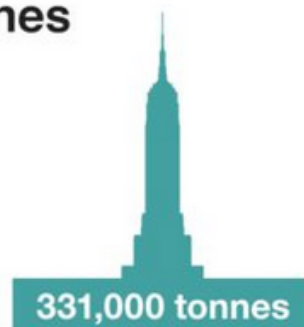
- 8,300 million tonnes of virgin plastics have been produced
- Half of this material was made in just the past 13 years
- About 30% of the historic production remains in use today
- Of the discarded plastic, roughly 9% has been recycled
- Some 12% has been incinerated, but 79% has gone to landfill
- Shortest-use items are packaging, typically less than a year
- Longest-use products are found in construction and machinery
- Current trends point to 12 billion tonnes of waste by 2050
- Recycling rates in 2014: Europe (30%), China (25%), US (9%)

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American Association
for the Advancement
of Science. No claim to

How heavy is 8.3 billion tonnes of plastic?



8.3 billion tonnes
plastic



331,000 tonnes
25,000 Empire State
buildings

OR



7.5 tonnes
1 billion
elephants

Source: University of Georgia

BBC



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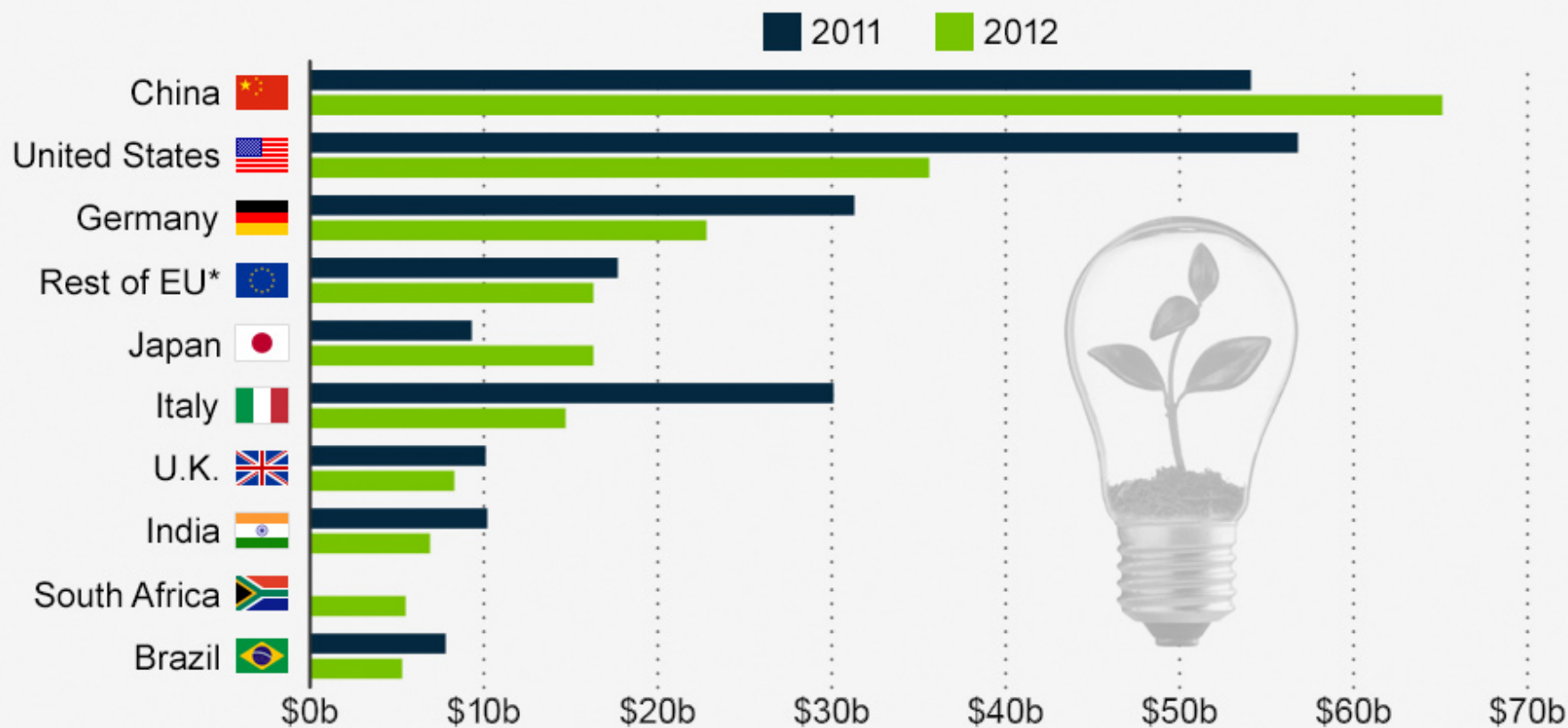


Green energy dropping out of mix in developing world

Copyright: Atul Loke / Panos

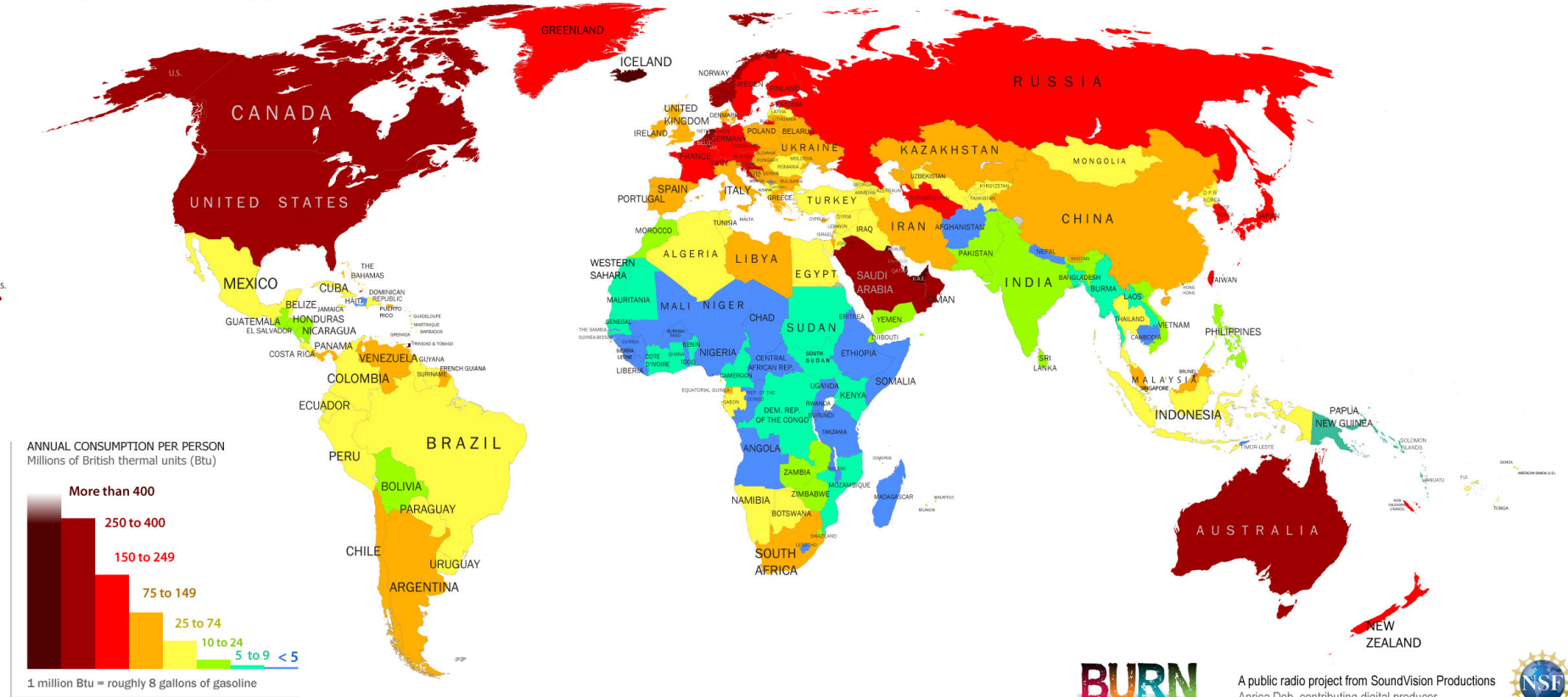
China Leads the Way in Renewable Energy Investment

Renewable energy investment in 2011 and 2012 (in billion U.S. dollars)



Energy Consumption Per Person, by country, 2010.

SOURCES: U.S. Energy Information Administration, International Energy Agency, CIA World Factbook, U.N. Dept of Economics and Social Affairs



BURN
an energy journal

A public radio project from SoundVision Productions
Anrica Deb, contributing digital producer



80N

World Solar Energy Map

60N

40N

20N

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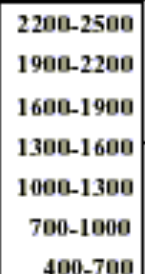
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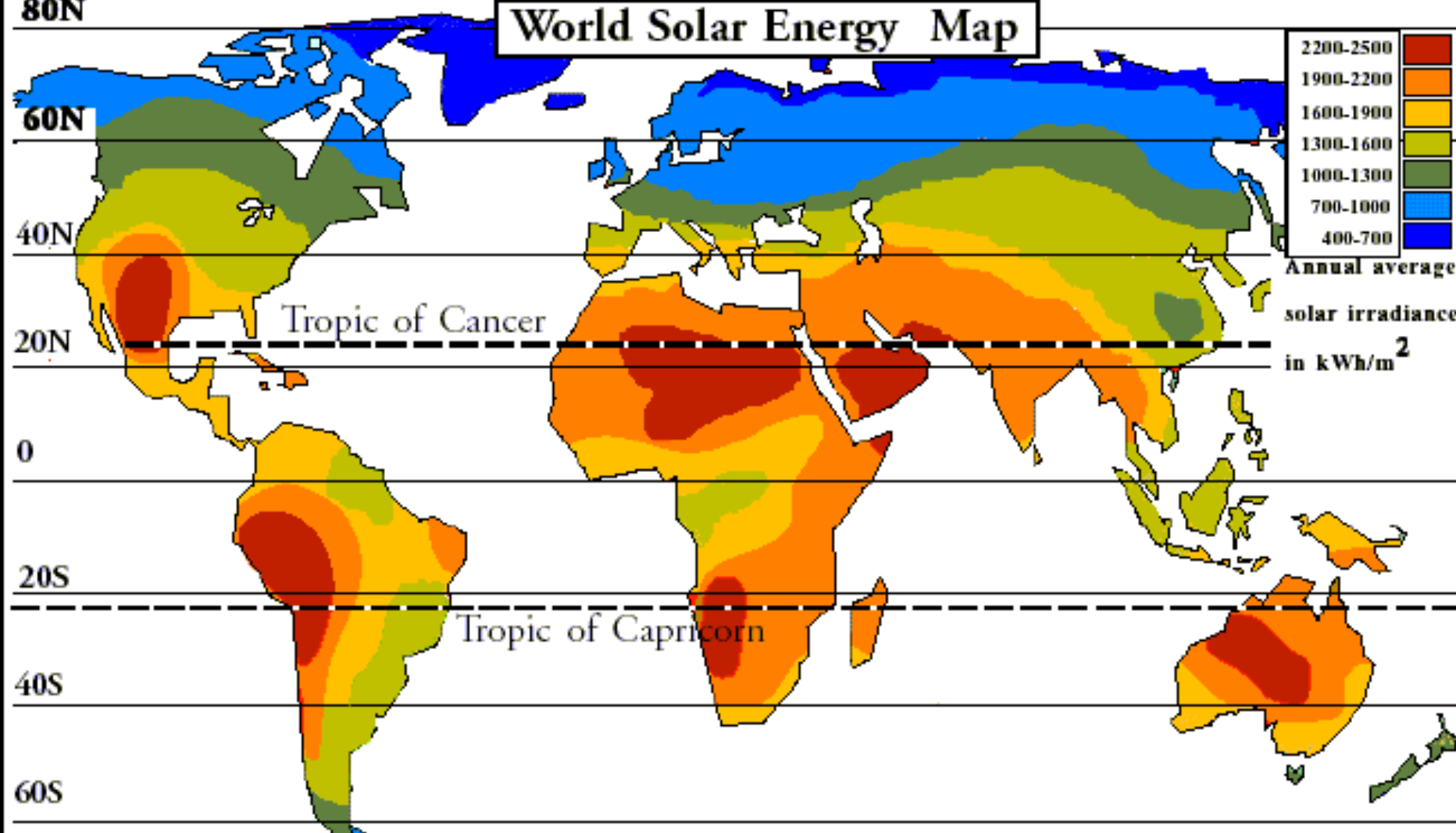
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Tropic of Cancer

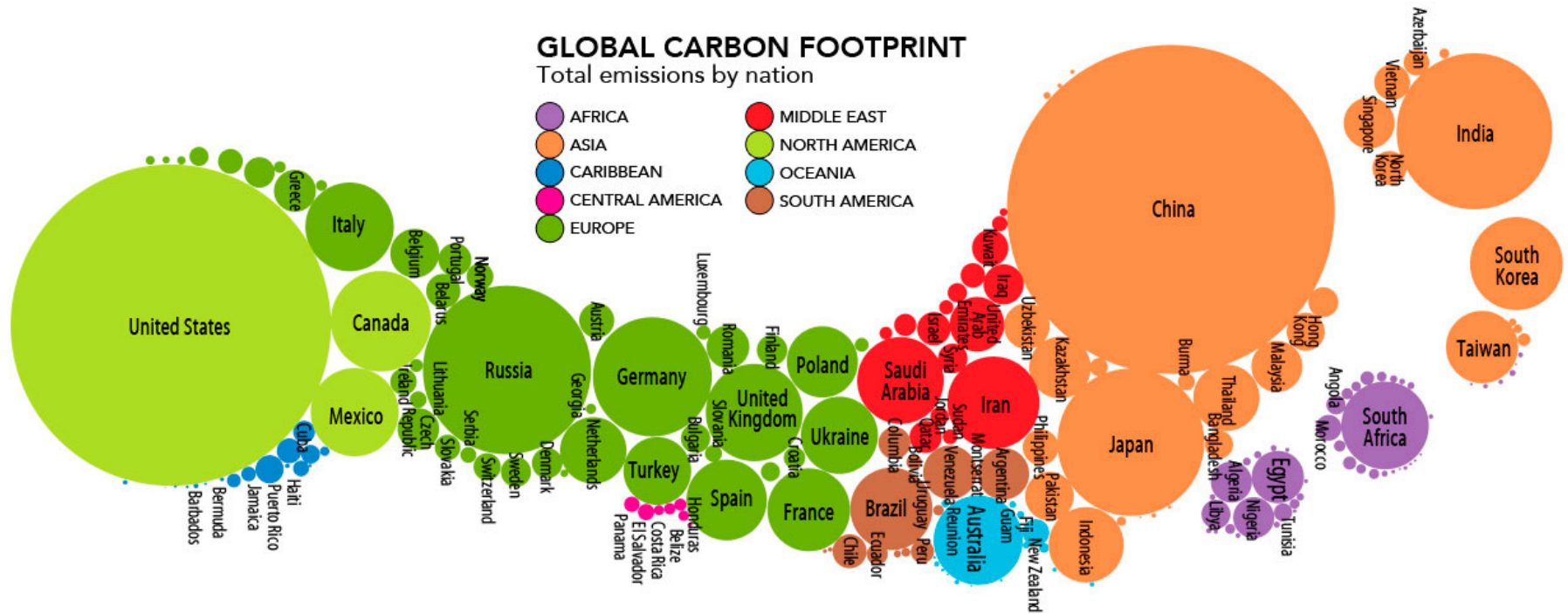
Tropic of Capricorn



Annual average
solar irradiance
in kWh/m²

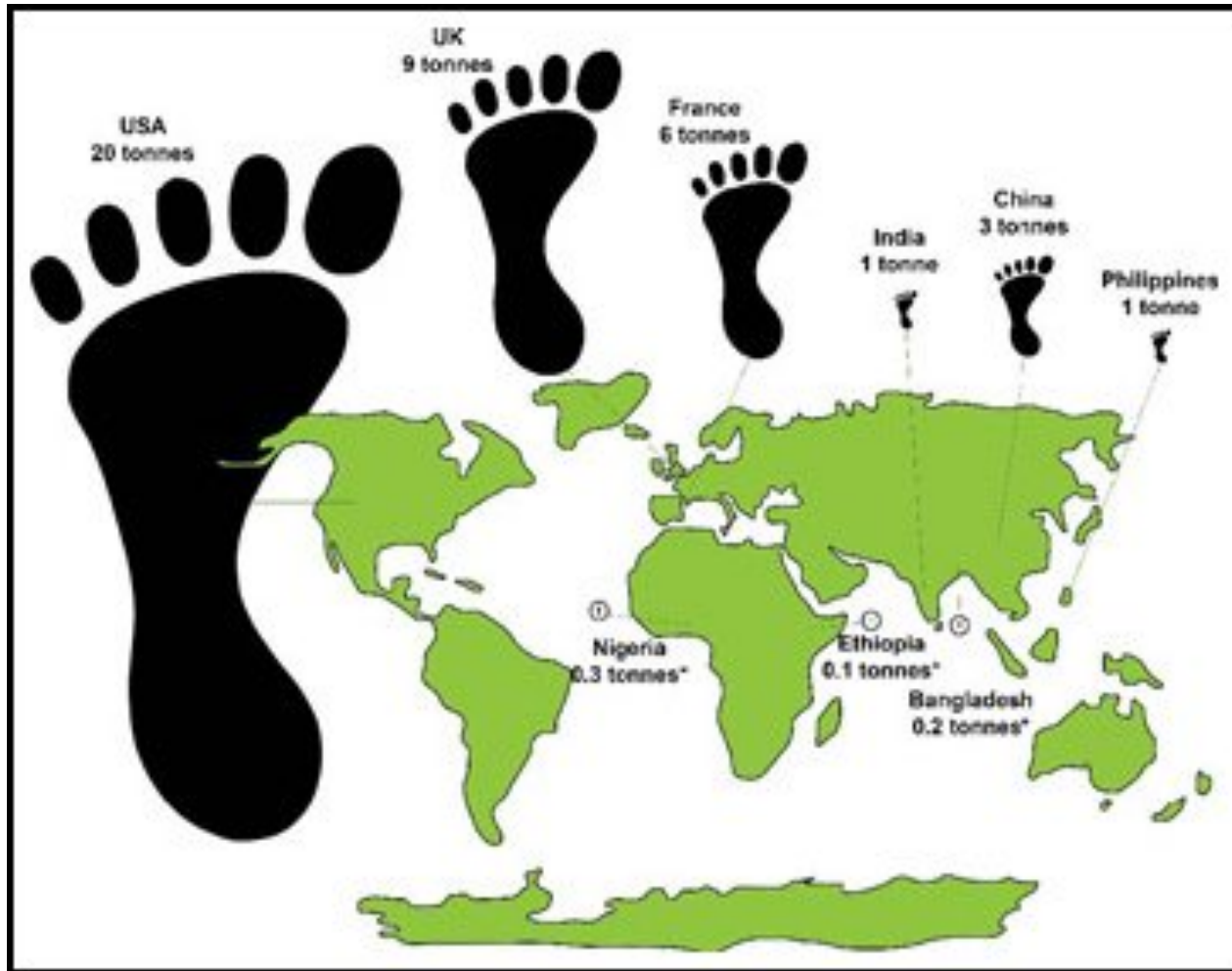


Carbon Footprints



Governments need to make a better effort to identify ways to reduce their carbon footprint.

Carbon Footprints – *per capita*



Credit: <http://www.transitionhelper.org/carbonfootprints.html>

How many Earths do we need?

By Charlotte McDonald
BBC News

🕒 16 June 2015 | Magazine

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It has been suggested that if everyone on the planet consumed as much as the average US citizen, four Earths would be needed to sustain them. But where does this claim originate, and how is it calculated?

The world's seven billion people consume varying amounts of the planet's resources. Compare the lifestyle of a subsistence farmer with that of a wealthy



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Earth Overshoot Day 2017 lands on August 2.



By August 2, 2017, we will have used more from nature than our planet can renew in the whole year.

We use more ecological resources and services than nature can regenerate through overfishing, overharvesting forests, and emitting more carbon dioxide into the atmosphere than forests can sequester.

Millennium Development Goals 2000-2015



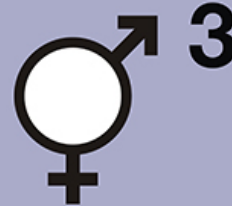
1

**ERADICATE
EXTREME POVERTY
AND HUNGER**



2

**ACHIEVE UNIVERSAL
PRIMARY EDUCATION**



3

**PROMOTE GENDER
EQUALITY AND
EMPOWER WOMEN**



4

**REDUCE
CHILD MORTALITY**

MILLENNIUM DEVELOPMENT GOALS



5

**IMPROVE
MATERNAL HEALTH**



6

**COMBAT HIV/AIDS,
MALARIA AND OTHER
DISEASES**



7

**ENSURE
ENVIRONMENTAL
SUSTAINABILITY**

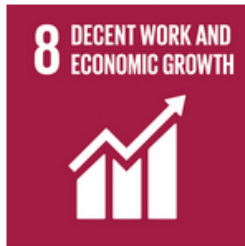


8

**A GLOBAL
PARTNERSHIP FOR
DEVELOPMENT**



SUSTAINABLE DEVELOPMENT GOALS



THE ROLE OF SCIENCE

- **Produce new knowledge**
- **Explain mechanisms, phenomena, changes**
- **Lead to solutions and novel technologies**
- **Educate, guide, sensitize**

Panda Green Energy — formerly known as United Photovoltaics — connected a 50 MW solar array to the grid this week in northwestern China.



China Merchants New Energy Group (CMNE) — Panda Green Energy's largest shareholder — signed an agreement with the UNDP last September to build panda-shaped PV projects, as part of efforts to raise awareness about sustainable development among young people in China.

Solar power

Keep it in the ground

Arthur Neslen

Thu 4 Feb 2016 11.47 GMT

Morocco to switch on first phase of world's largest solar plant

Desert complex will provide electricity for more than 1 million people when complete, helping African country to supply most of its energy from renewables by 2030



In Nepal, turning waste into wealth

Published on 21/06/2018, 3:01pm

Sponsored content: Nepal builds biogas capacity as it transitions to a lower-carbon economy



Tanzanian low-cost water filter wins innovation prize

🕒 2 June 2015

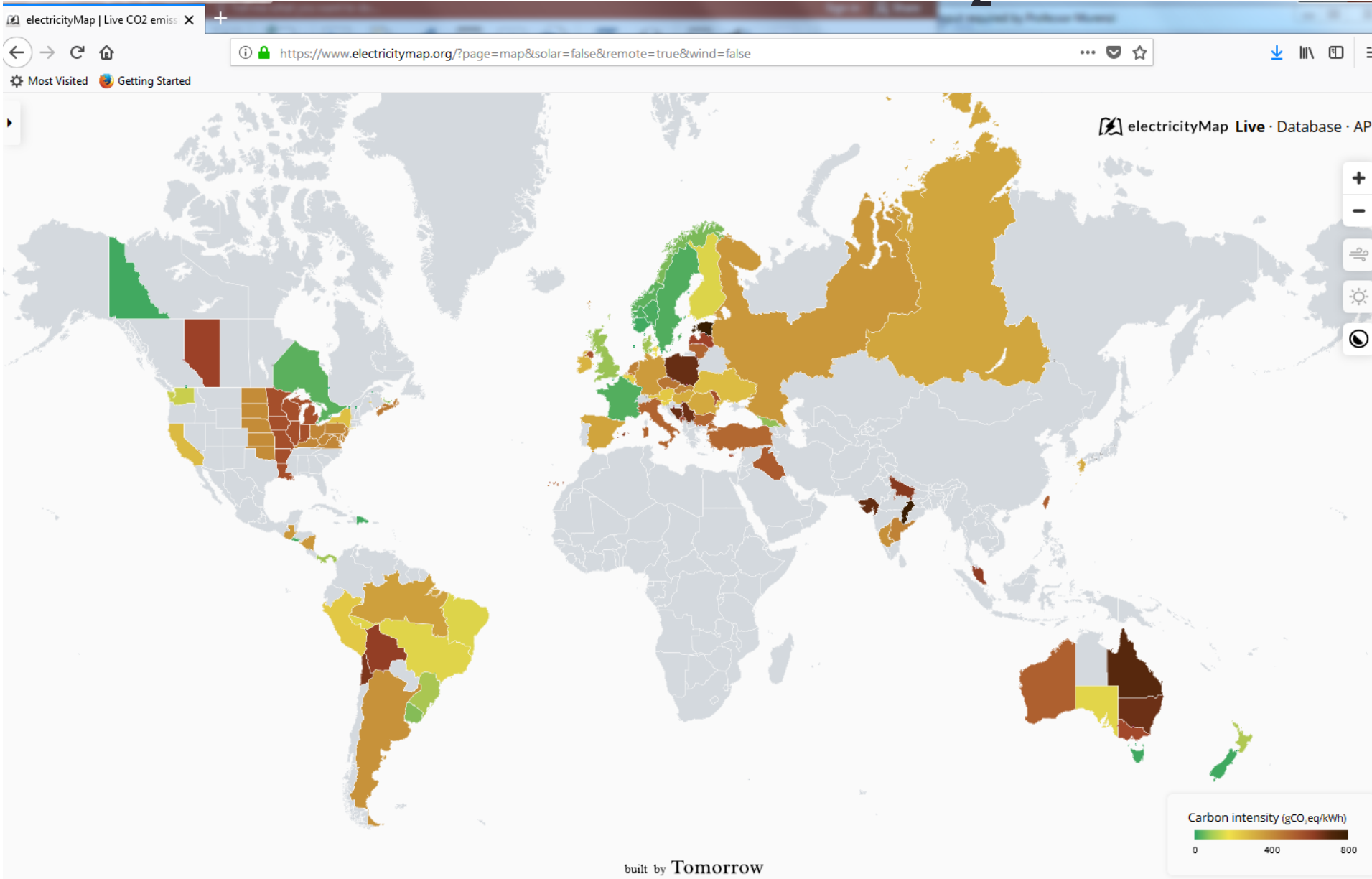


ROYAL ACADEMY OF ENGINEERING

Judge Malcolm Brinded (R) said Askwar Hilonga's water filter could change lives all over the world

A water filter which absorbs anything from copper and fluoride to bacteria, viruses and pesticides has won a prestigious African innovation prize.

Open Source Tool: **ELECTRICITY MAP LIVE**
WITH ASSOCIATED CO₂ EMISSIONS



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Greenhouse gas emissions

Guardian Environment Network

Fred Pearce for Yale environment 360, part of the Guardian Environment Network

Wed 26 Oct 2016 07.00 BST

What is causing the rapid rise in methane emissions?

Yale environment 360: New research finds some surprising culprits and shows that fossil-fuel sources have played a much larger role than previously estimated

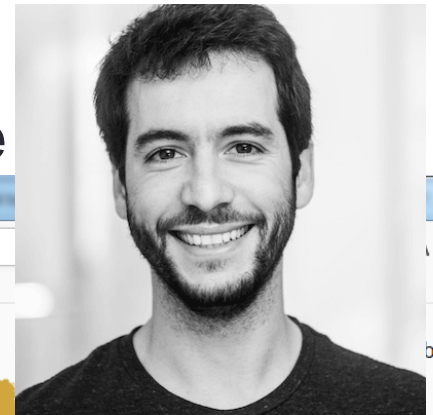


▲ Methane emissions from rice paddies in countries such as India have risen in recent years. Photograph: Fayaz Kabli/Reuters

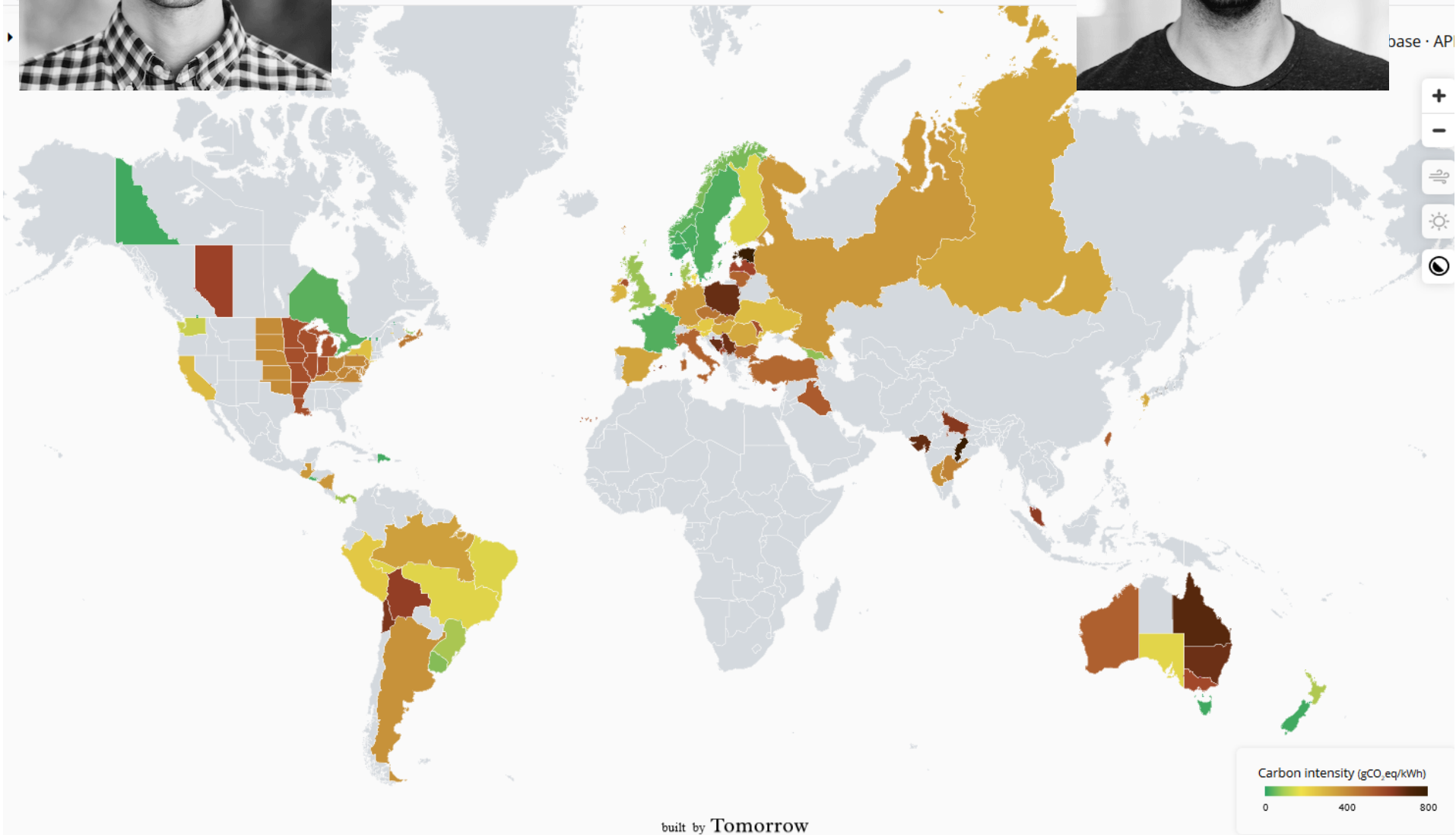


Olivier Corradi

Bruno Lajoie



www.electricitymap.org/?page=map&tsolar=false&remote=true&wind=false

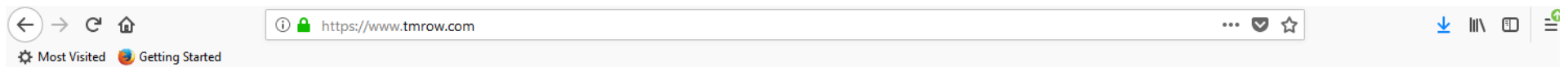




Olivier Corradi



Bruno Lajoie



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“We want to help humanity reach a sustainable state of existence by quantifying, and making widely accessible, the climate impact of the daily choices we make”

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Climate Change 🌡️ is the biggest challenge of our time, as the overwhelming majority of our daily activities still are based on processes that release greenhouse gases. [> read more](#)

Living sustainably 🌱 requires navigating through a jungle of complex trade-offs, not easily understood and not always accessible. Information has to precede action. [> read more](#)

We automatically quantify 📊 the greenhouse gas emissions of our daily activities, enabling anyone to understand the climate impact of their decisions.

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A handwritten signature in black ink, likely belonging to Professor Mark Moran.

Professor Mark Moran

Chair of Development Effectiveness, Institute for Social
Science Research

The University of Queensland

A handwritten signature in black ink, likely belonging to John Zornig.

John Zornig

Director, UQx

The University of Queensland

y that

no Paoli

ompleted and received a passing grade in

: The Science and Practice of Sustainable ment

dy offered by UQx, an online learning initiative of The University of
rough edX.

THREE MORE EXAMPLES OF LOW COST TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT

- **Edible cutlery**
- **Cleaning plastic debris**
- **Energy from the oceans**

THE ROLE OF SCIENCE

- **Produce new knowledge**
- **Explain mechanisms, phenomena, changes**
- **Lead to solutions and novel technologies**
- **Educate, guide, sensitize**

Environment ▶ **Climate change** Wildlife Energy Pollution

Greenhouse gas emissions

Agence France-Presse

Fri 29 Sep 2017 11.23 BST



4,694 1

Methane emissions from cattle are 11% higher than estimated

Bigger livestock in larger numbers in more regions has led to methane in the air climbing faster than predicted due to ‘out-of-date data’

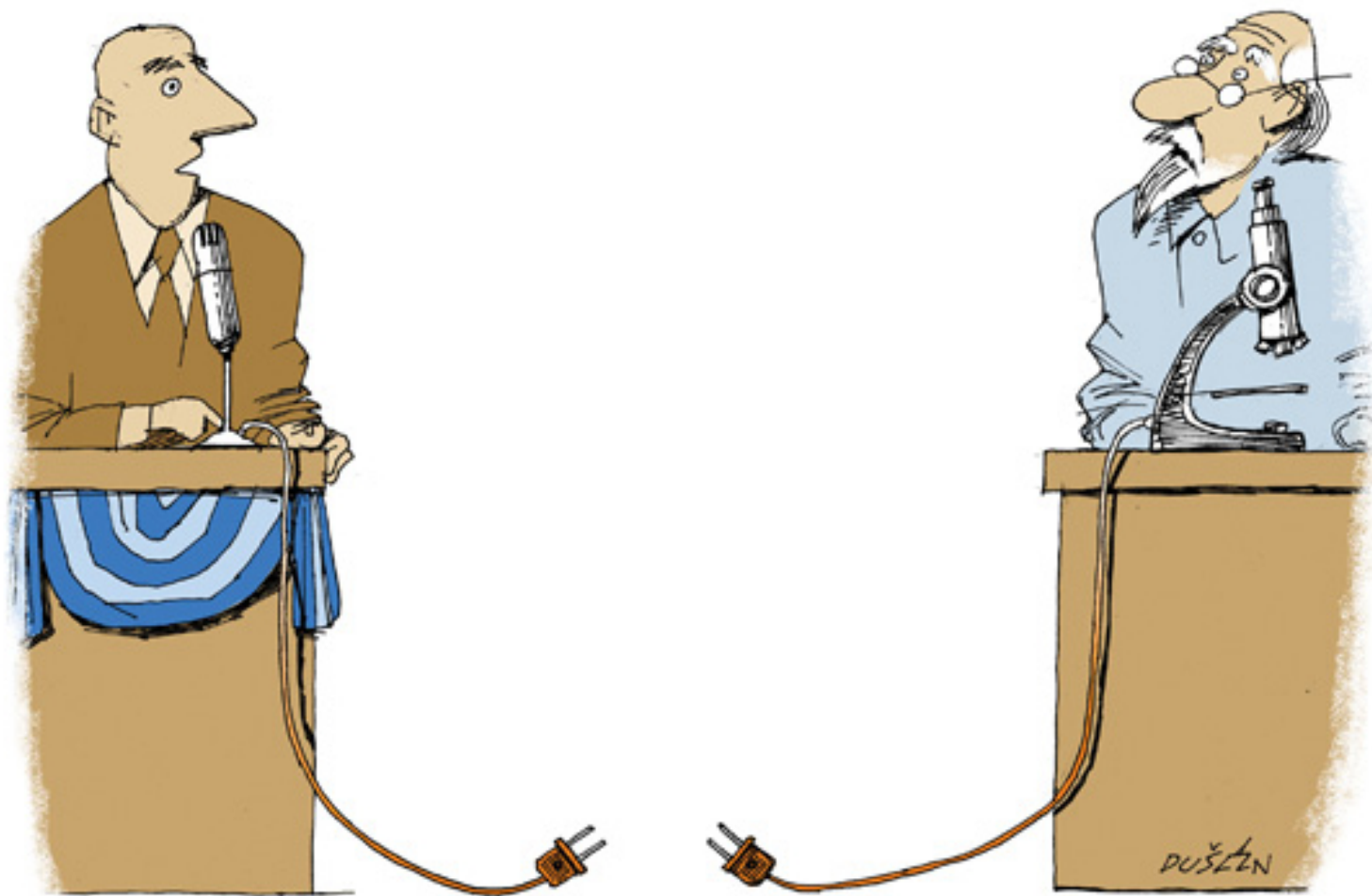


▲ A sharp rise in methane pollution could jeopardise the goal of capping global warming below 2C. Photograph: Graham Turner for the Guardian

The Great Divide

A two-way bridge between science and policy is desperately needed.

By Didier Schmitt | December 1, 2013



Plastic bags

Kenya brings in world's toughest plastic bag ban: four years jail or \$40,000 fine

Producing, selling and using plastic bags becomes illegal as officials say they want to target manufacturers and sellers first



12,634

Reuters

Monday 28 August 2017 15.27 BST



Travel ► UK Europe US

Belize holidays

On the radar

Graeme Green

Sun 14 Jan 2018 10.00 GMT

Belize bans oil activity to protect its barrier reef

Decision hailed as huge step forward that will safeguard both the marine environment and the country's lucrative dive tourism industry



▲ Reef encounter ... the ban will help protect Belize's Unesco-listed corals. Photograph: Alamy

Some good news for the new year: in what has been called a huge step forward in protecting oceans and marine life, the Belize government has announced bold legislation to end oil activity in all of its waters.



Bhutan Becomes the World's First Carbon Negative Country



“The Government shall ensure that, in order to conserve the country’s natural resources and to prevent degradation of the ecosystem, a minimum of sixty percent of Bhutan’s total land shall be maintained under forest cover for all time.”

Article 5 Section 3: Constitution of the Kingdom of Bhutan

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Climate change scepticism

Climate Consensus - the 97%

Scientists understood the climate 150 years ago better than the EPA head today

Scott Pruitt denies basic science that we've understood for over a century



10,095 440

[John Abraham](#)

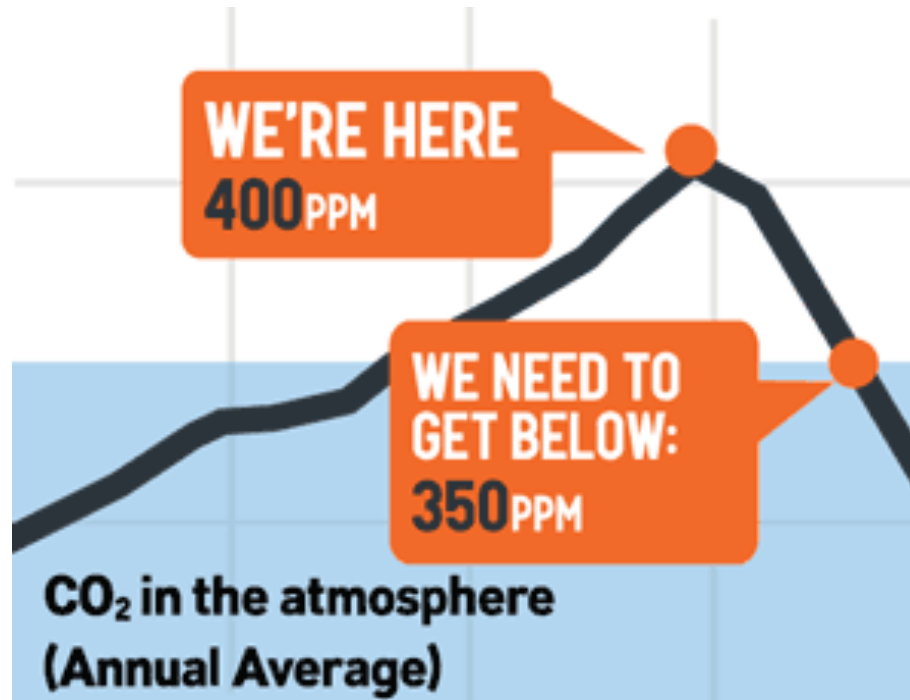
Friday 31 March 2017 11.00 BST



President Donald Trump and his EPA administrator Scott Pruitt shake hands at the signing of an executive order

Climate Change

Why is 450 ppm dangerous and 350 ppm safe?



The answer is complex:

- runaway greenhouse effect and irreversible conditions;
- associated temperature increases and consequences on adaptability of organisms.

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Fiji PM: Climate change threatens our survival

🕒 4 hours ago



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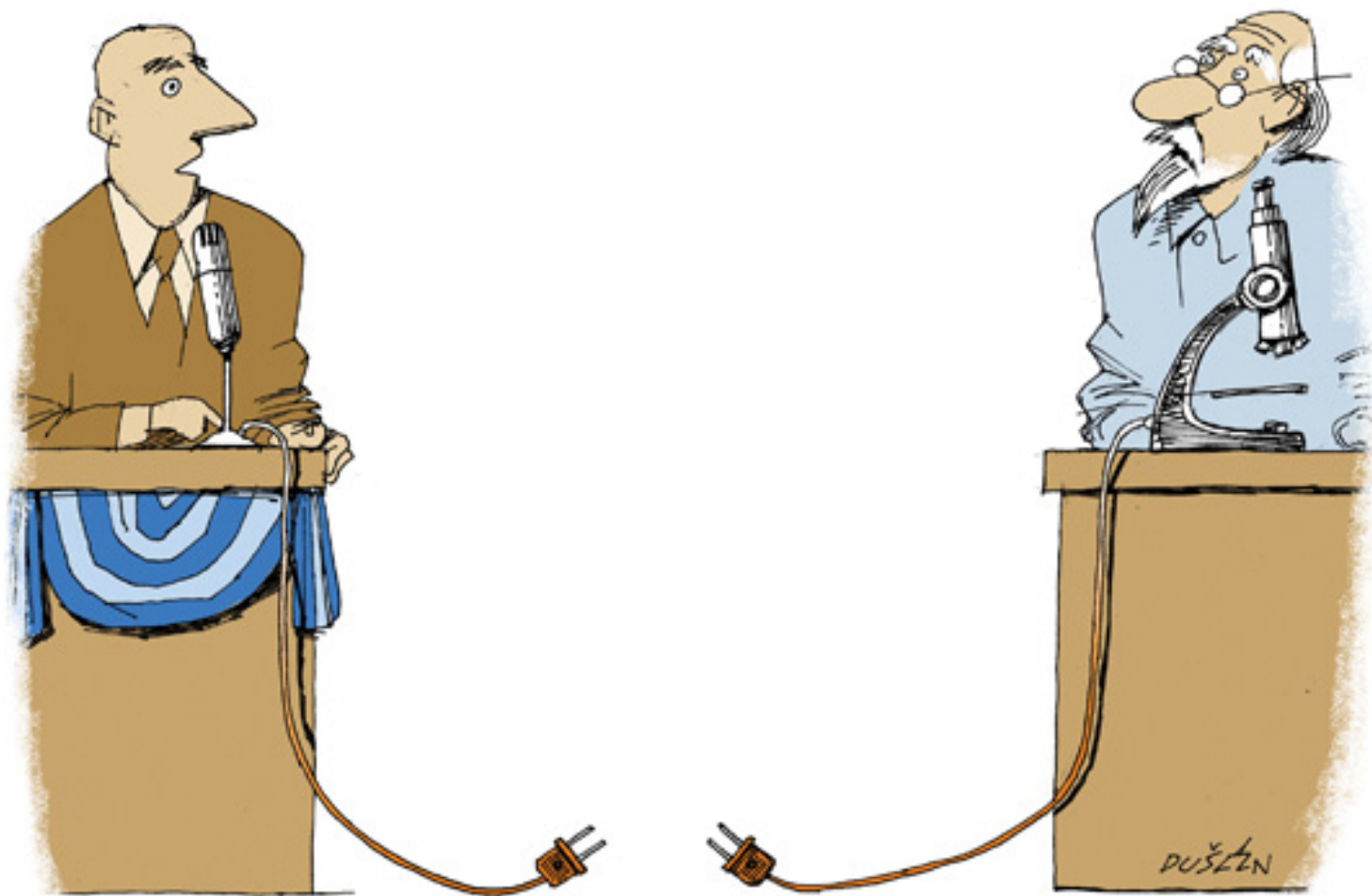
Flooding caused by Cyclone Josie, which has claimed several lives

Fiji's prime minister has said the Pacific island nation is in "a fight for survival" as climate change brings "almost constant" deadly cyclones.

The Great Divide

A two-way bridge between science and policy is desperately needed.

By Didier Schmitt | December 1, 2013





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Tuesday, 20 August, 2002, 14:36 GMT 15:36 UK

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Irish bag tax hailed success



Stores including Tesco have welcomed the tax

A tax on plastic shopping bags in the Republic of Ireland has cut their use by more than 90% and raised millions of euros in revenue, the government says.

The tax of 15 cents per bag was introduced five months ago in an attempt to curb litter, and the improvement had been immediate and "plain to see", said Environment Minister Martin Cullen.

He said that the 3.5 million euros in extra revenue raised so far would be spent on environmental projects.

The "plastax" is being closely watched by other countries, particularly neighbouring Britain.

“
The levy has been an outstanding success in achieving what it set out to do
 ”

**Environment
 Minister Martin
 Cullen**

See also:

- ▶ 04 Mar 02 | Europe
 Shoppers face plastic bag tax
- ▶ 04 Mar 02 | N Ireland
 NI shoppers 'would bring their own bags'
- ▶ 04 Jan 02 | Business
 Bangladeshi jute bag demand soars
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 A world drowning in litter
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HOW LONG UNTIL IT'S GONE?

Estimated decomposition rates of common marine debris items



Estimated based on best available data. Based on product composition and environmental conditions.

Source: NOAA National Oceanic and Atmospheric Administration, US / Woods Hole Sea Grant, US / Seagrass (Steve Lippert) / Resources for Sustainability (Dutch, 2018)

HOW LONG UNTIL IT'S GONE?

Estimated decomposition rates of common marine debris items



The tip of an iceberg

by Jorge Gamboa



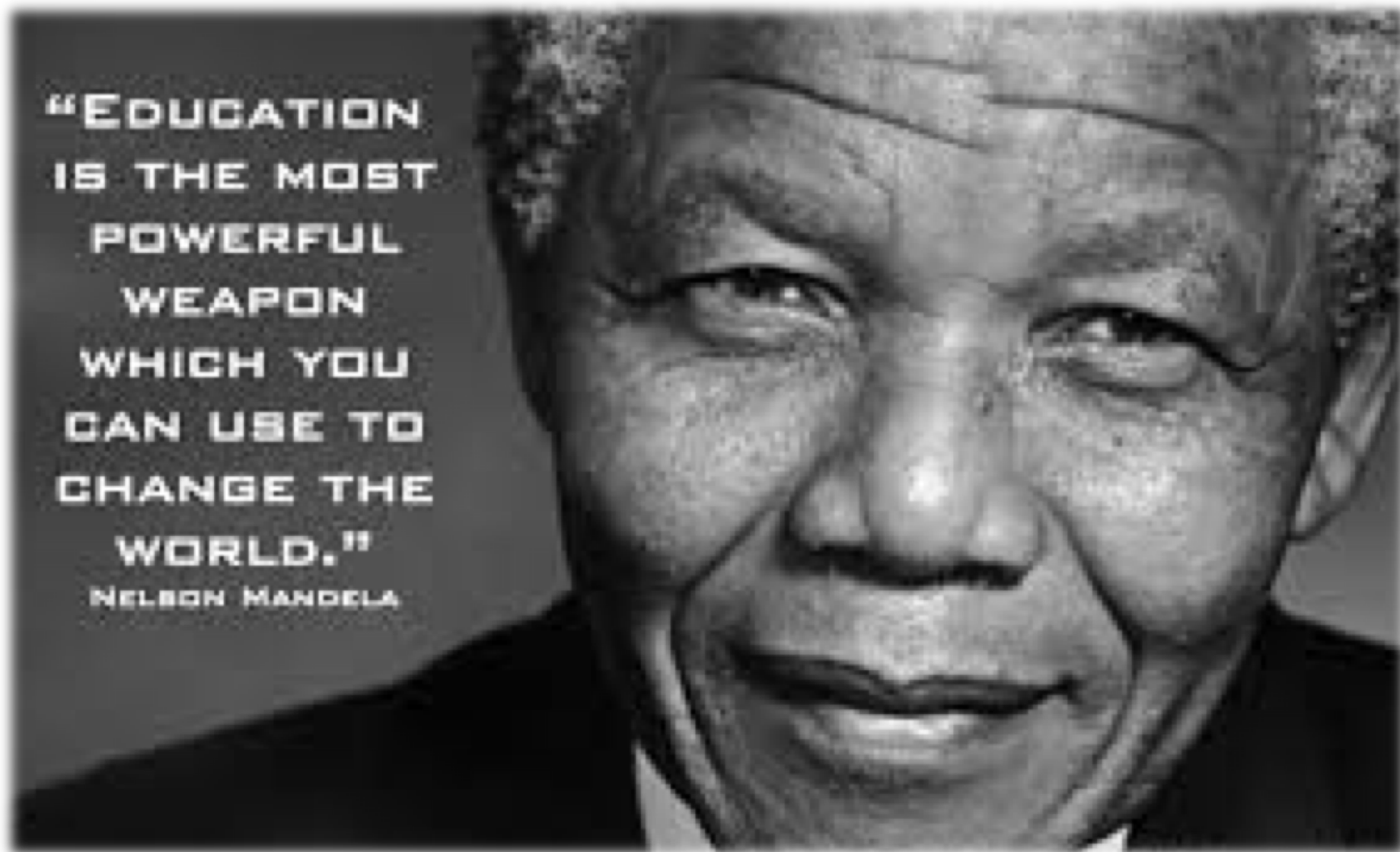
Plastics and associated fragments have been found in remote ocean areas such as the ocean floor and in the artic, as well as in sea salt, in fish tissue, in bottled water, in soil

***“There is a lot of information,
but there is no formation”***

**Professor Mauro Sola-Penna,
Department of Pharmacy,
Federal University of Brazil**

**"EDUCATION
IS THE MOST
POWERFUL
WEAPON
WHICH YOU
CAN USE TO
CHANGE THE
WORLD."**

NELSON MANDELA



2005-2014:

DECADE for the

*Education for
Sustainable
Development*

initiative led by

UNESCO



unesco.org

EDUCATION FOR THE FUTURE

WORLD CONFERENCE ON
EDUCATION FOR
SUSTAINABLE
DEVELOPMENT

Gavin O'Toole

Tue 5 Mar 2013 12.09 GMT

Sustainability education in Chile looks to shift consumer behaviour

Chilean authorities have responded strongly to a Unesco initiative which is trying to embed sustainability in schools



Unsustainable development and change of mind/behaviour

Education should play an important role in enabling people to live together in ways that contribute to sustainable development. However, at present, education often contributes to unsustainable living. This can happen through a lack of opportunity for learners to question their own lifestyles and the systems and structures that promote those lifestyles. It also happens through reproducing unsustainable models and practices. The recasting of development, therefore, calls for the reorientation of education towards sustainable development.

United Nations' Competencies for Sustainable Development:
Education for Sustainable Development (ESD)

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Education for Sustainable Development (ESD)

We have two paths that we can take:

1

Business
as Usual
Path

vs.

2

Sustainable
Development
Path

Thank you for your attention

**I wish that you behold a vision of
sustainability both in your mind
and in your heart**



Max Paoli

*TWAS Programme Coordinator
The World Academy of Sciences*
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