Bharathidasan University

Programme: MSc Environmental Science and Sustainable Management

Course Title: ECOSYSTEM SERVICES AND SUSTAINABILITY
Course Code: 21PGEC04-1

Unit- I Natural capital and human capital

Prof. R. Mohanraj
Dept. of Environmental Science and Management

THE HINDU

Tiger reserves: Economic and environmental win-win JULY 22, 2017

"Saving 2 tigers gives more value than Mangalyaan"'

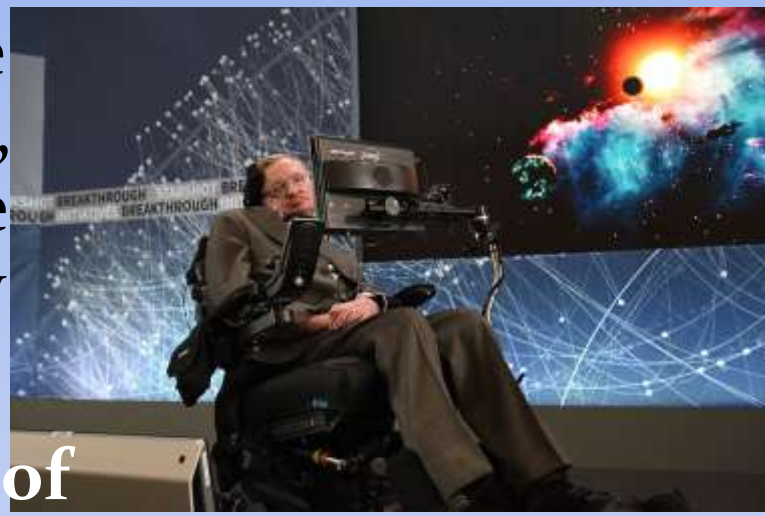
Saving two tigers yields a capital benefit of ₹520 crores, while Mangalyaan cost us ₹450 crores

Trees offer multiple benefits — don't kill them, breed them

- Hundred trees remove 53 tons of carbon dioxide and 430 pounds of other air pollutants per year
- In 1979, Dr. T.M. Das of Calcutta University estimated that the monetary value of a tree, during a life span of 50 years, amounted to about **$2,00,000** (at 1979 rates)
- Healthy trees mean healthy environment — 100 mature trees catch about 1,40,000 gallons of rain water per year

Stephen Hawking's warning: Find another planet

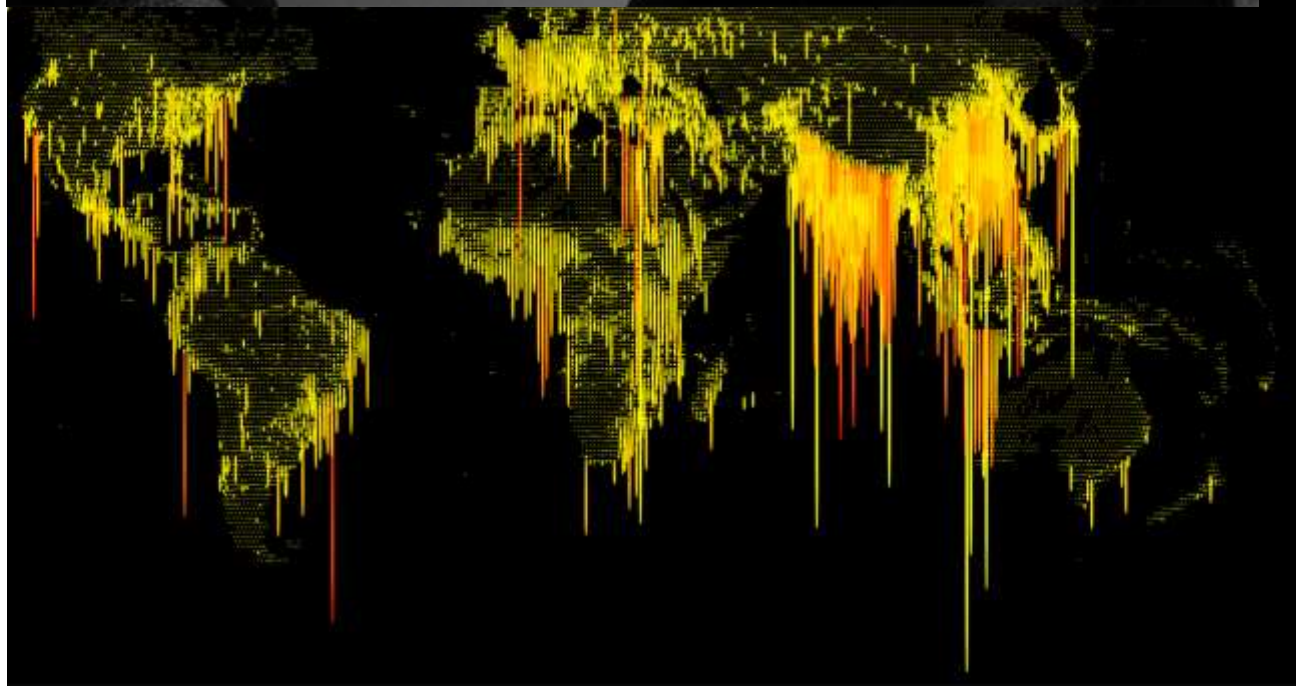
Within the next 100 years, he warned, we need to colonize Mars and other planets. If we don't, we may not survive climate change, disease, and other versions of doom we're bound to inflict on ourselves this century

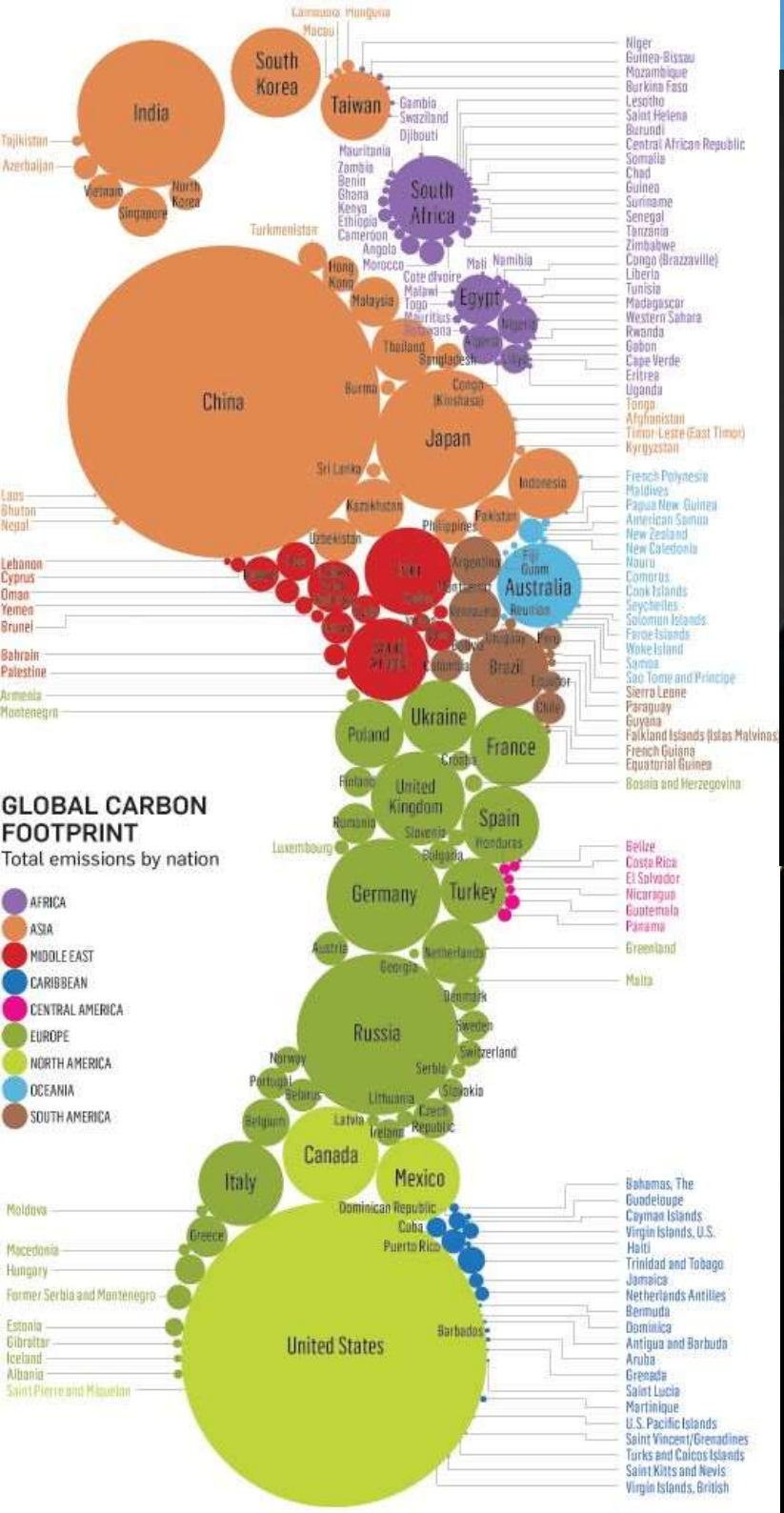


- **Why Stephen Hawking is more afraid of capitalism than robots**

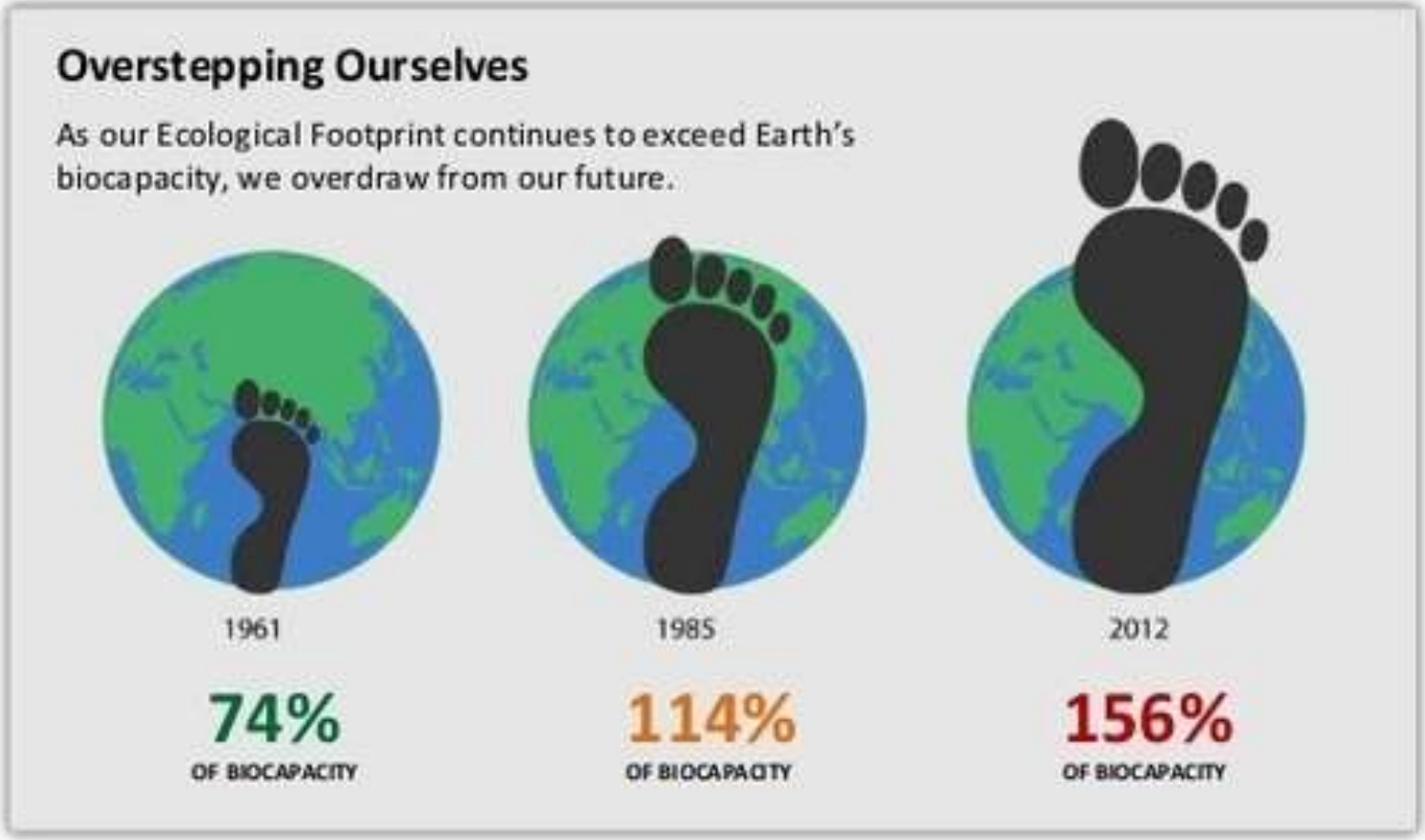
Everyone can enjoy a life of luxurious leisure if the machine-produced wealth is shared, or most people can end up miserably poor if the machine-owners successfully lobby against wealth redistribution. So far, the trend seems to be toward the second option, with technology driving ever-increasing inequality

Human Vs Earth

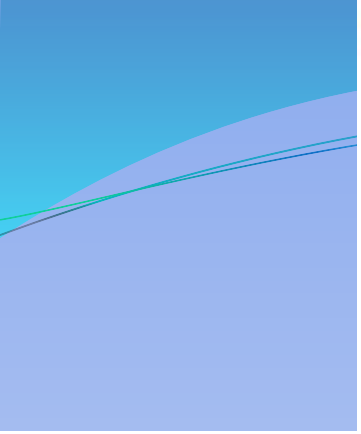




We need 1.5 planets to sustain current consumption patterns ...



Plastic Pollution



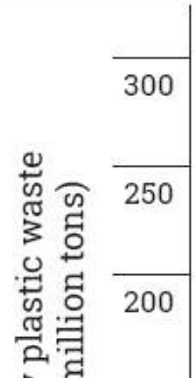
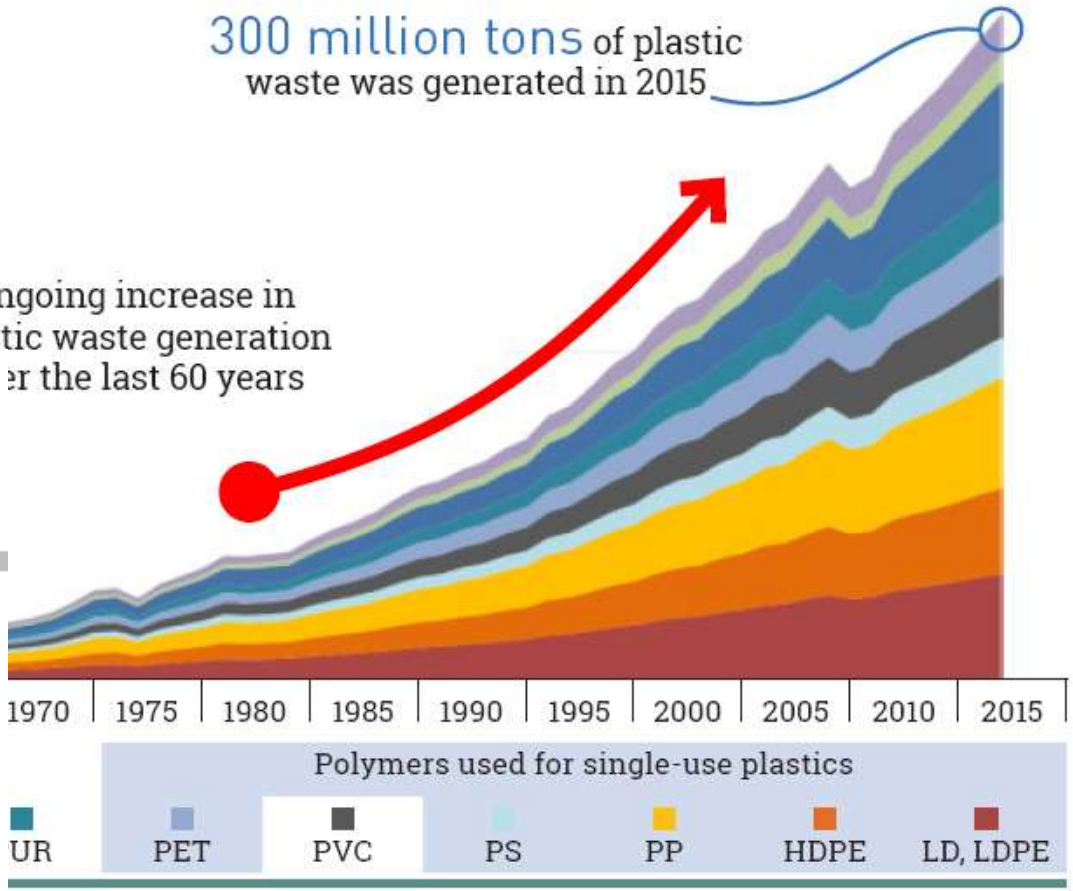
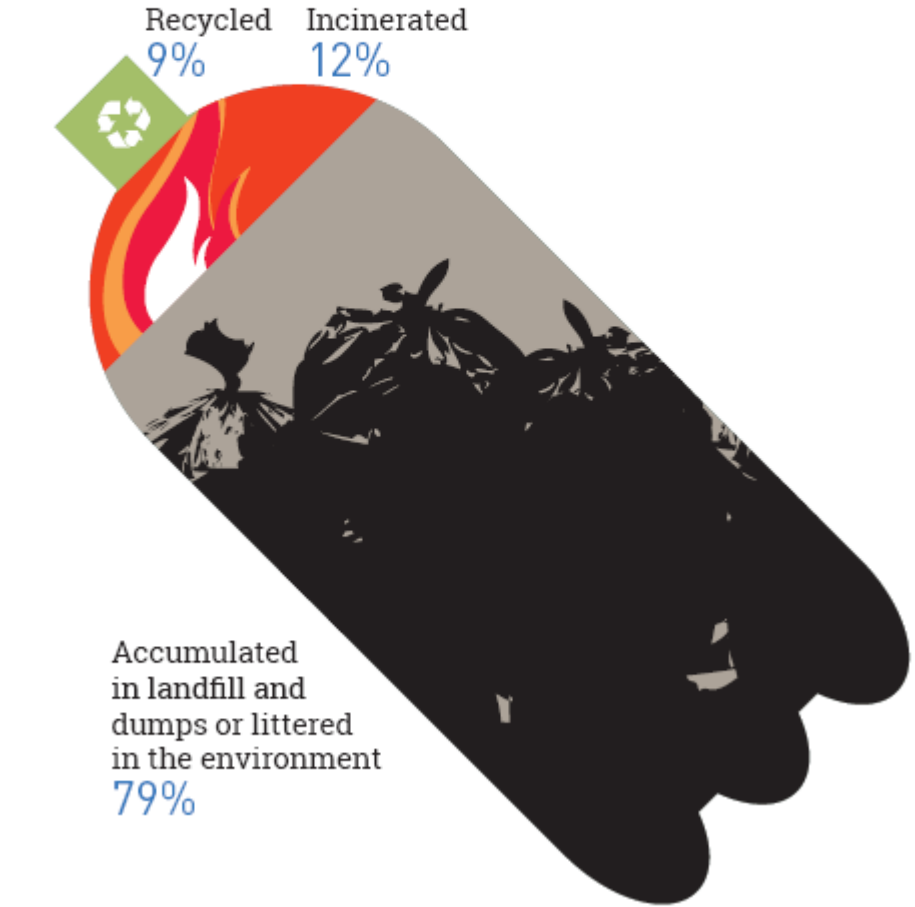
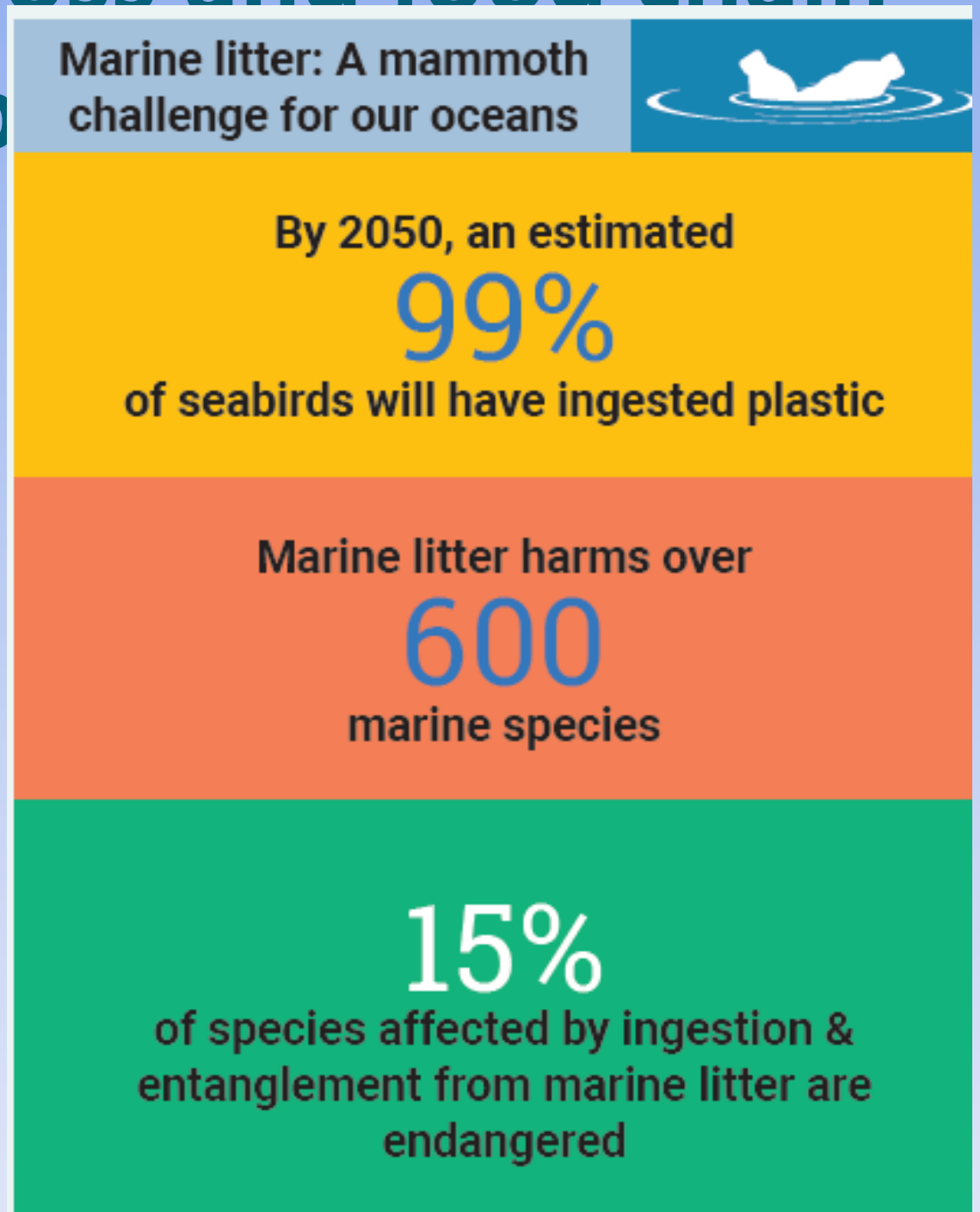


Figure 1.6. Disposal of all plastic waste ever generated (as of 2015)





Biodiversity loss and food chain contaminatio



Arctic Tern

44,300Miles /year

During its lifetime they found it equalled three round trips to the Moon – or more than 1.25 million miles

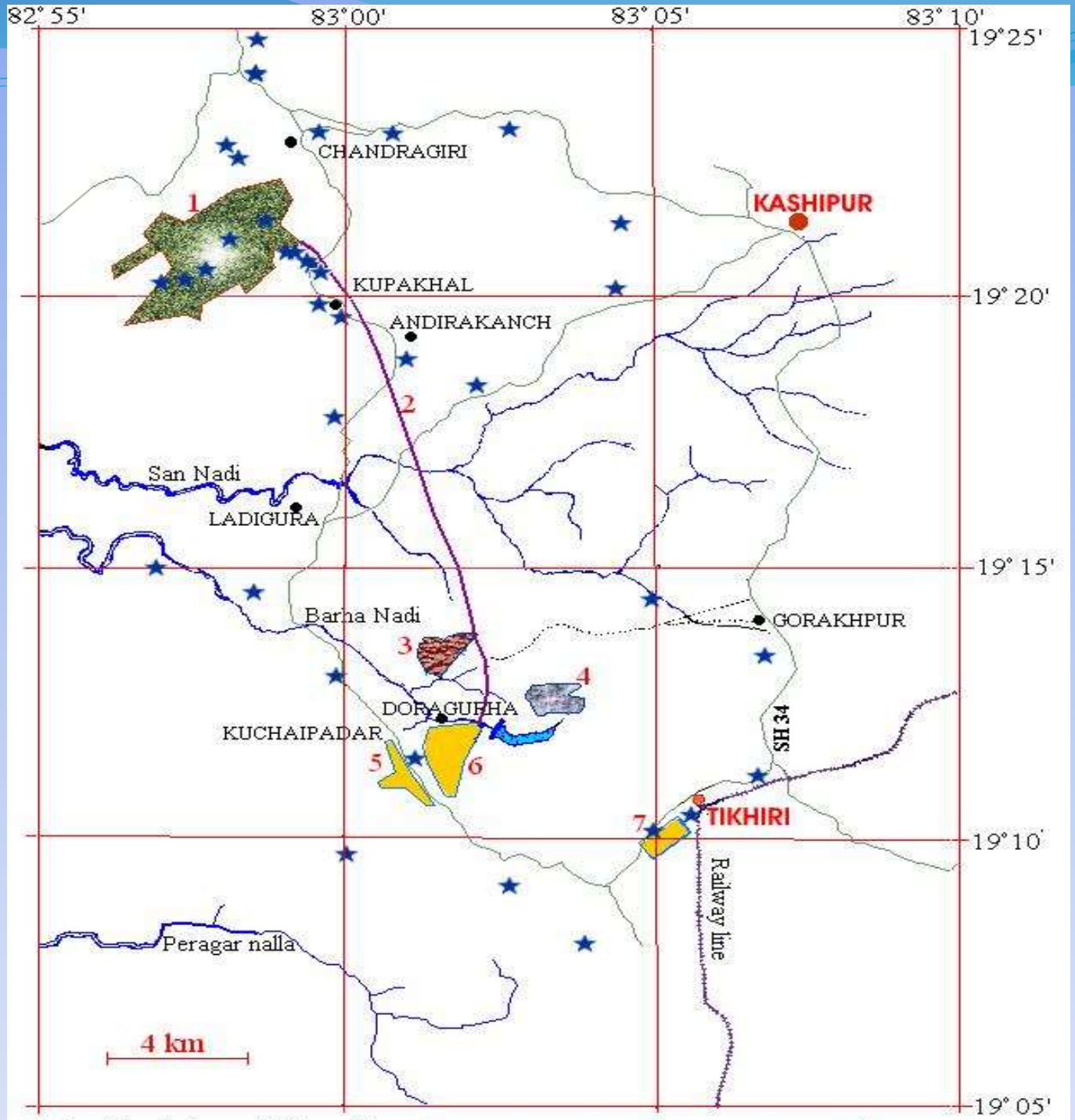
Arctic terns travel the longest regular migratory route of any animal on earth. Every year these sea birds travel from pole to pole and back, so they experience two summers per year. The round trip is roughly 44,300 miles. Breeding takes place in summer in the Arctic and sub-Arctic areas of North America, Asia and Europe

UTKAL ALUMINA INTERNATIONAL LIMITED, RAYAGADA, ORISSA – Case Analysis

- The Utkal Alumina International Ltd (UAIL), sets up an Alumina plant at Doragurha in the Kashipur block of the Rayagada district, Orissa. The plant envisages to utilize the bauxite deposit of Baphlimali plateau.
- A conveyor belt of approximately 20km connecting it with the mine at the Baphlimali plateau, facilities for red mud and ash disposal, road network, 12 km railway siding, airstrip and a township.

Mine Area

- About 200 million tons of bauxite
- Most of the plateau will be mined leaving aside a 15m barrier at the periphery (to check erosion from the mining site)
- administrative office,Work force of around 300 people.



1. Baphlimali plateau (Mining site) 2 Conveyor route 3 Redmud pond 4 Ash pond
5 Township 6 Plant area 7 Air strip ★ Sampling location

Figure 1 Map showing the project sites and the sampling locations

Today

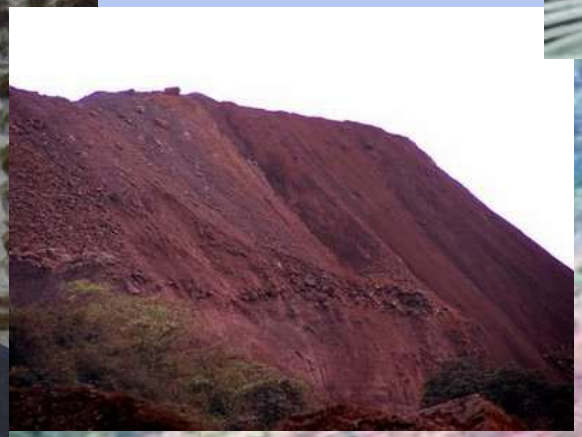
Agricultural land has been polluted by toxic waste and dust due to mining

Conveyor beltline near Lundrukana village –A threat

Orissa > Mining > Vedanta

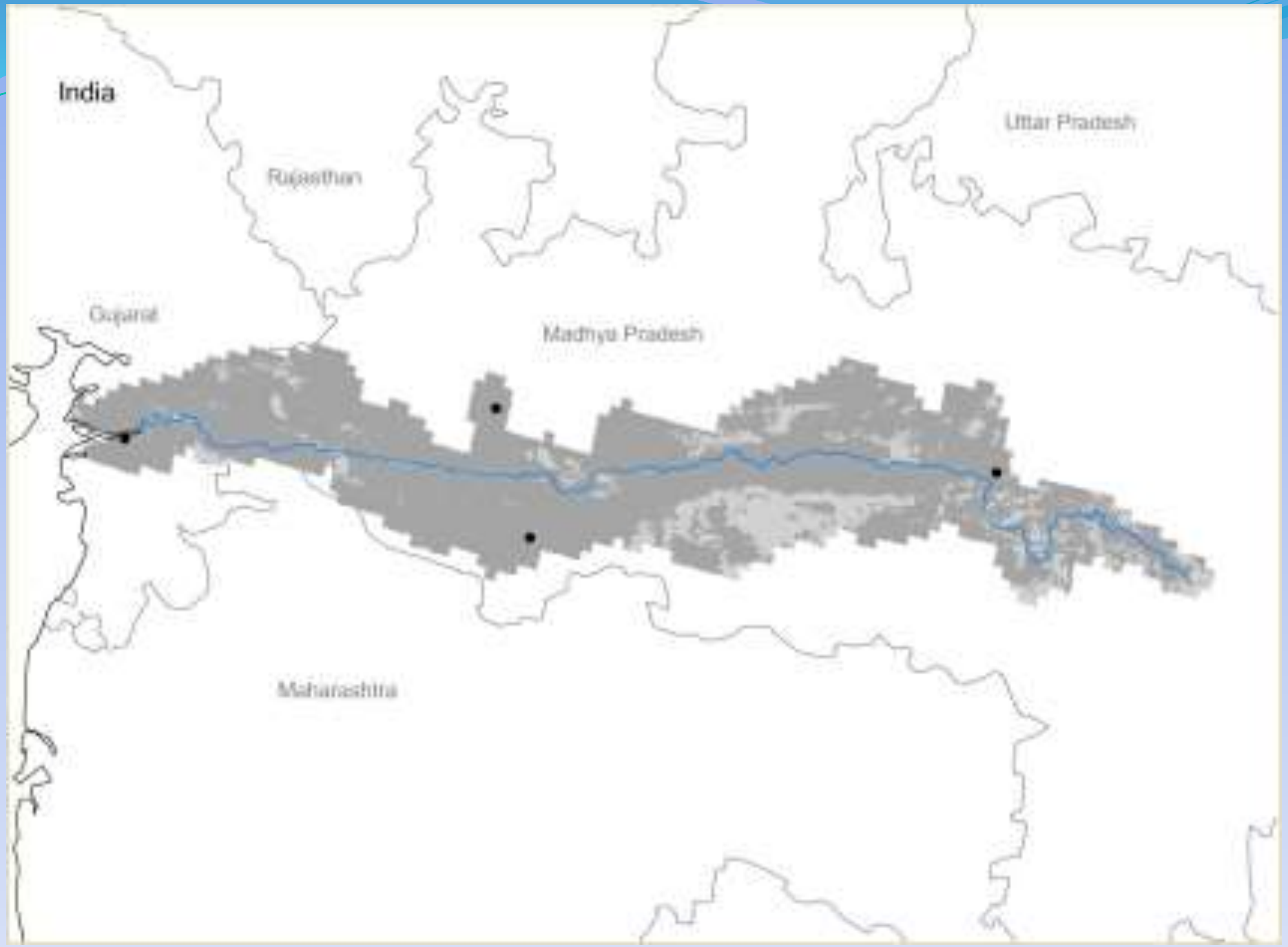
This Tribe In Odisha Lost Everything

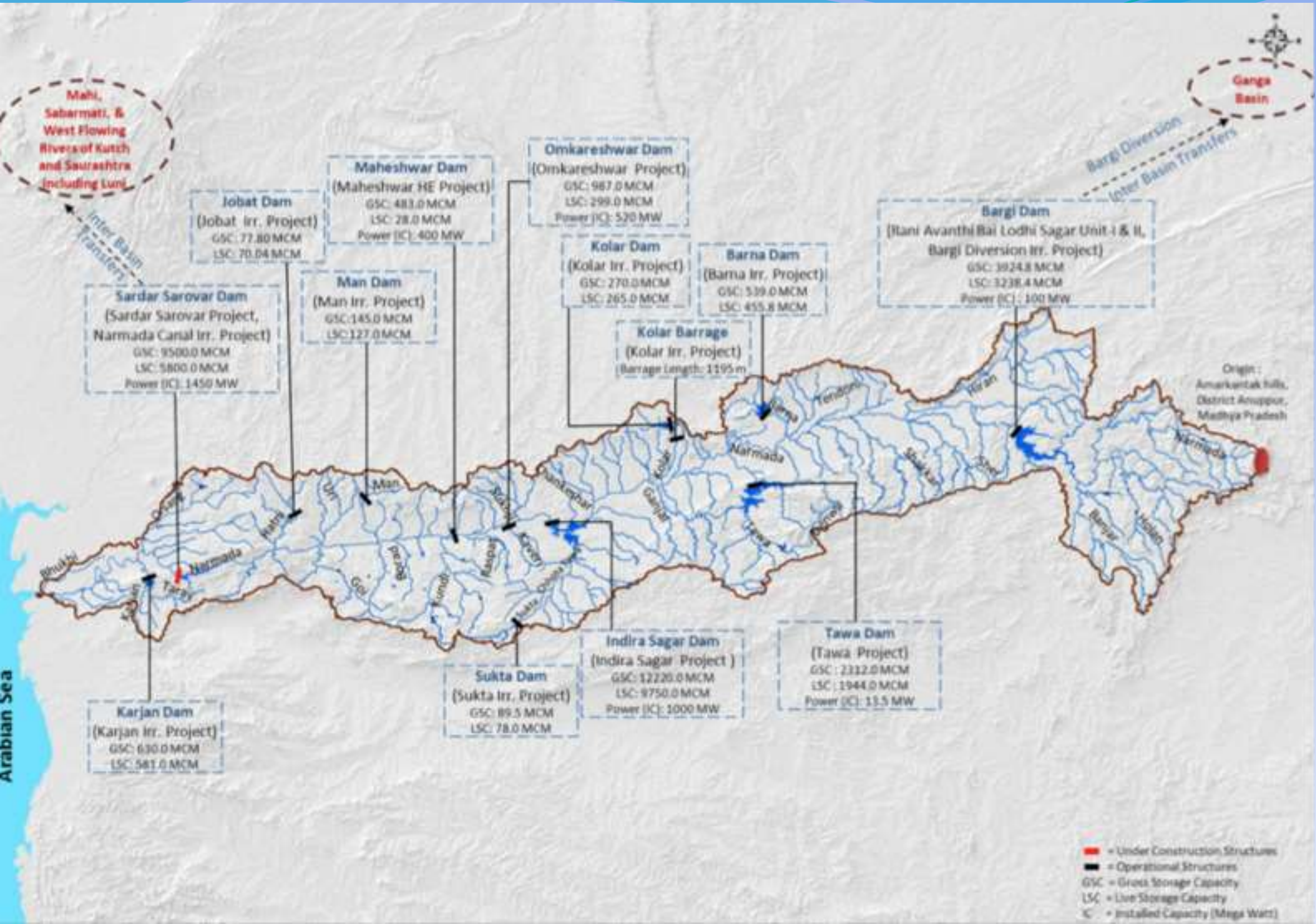
8000 population in Niyamgiri hills



Narmada Valley
Sardar Sarovar Project

- Conceived in the mid-1960s under Nehru
- Building postponed due to disagreement between three states impacted by project:
  - Madhya Pradesh
  - Gujarat
  - Maharashtra


India
Rajasthan
Uttar Pradesh
Gujarat
Madhya Pradesh
Maharashtra



Mahi, Sabarmati, & West Flowing Rivers of Kutch and Saurashtra including Luni
Inter Basin Transfers
Ganga Basin
Bargi Diversion
Inter Basin Transfers
Jobat Dam
(Jobat Irr. Project)
GSC: 77.80 MCM
LSC: 70.04 MCM
Maheshwar Dam
(Maheshwar HE Project)
GSC: 483.0 MCM
LSC: 28.0 MCM
Power (IC): 400 MW
Omkareshwar Dam
(Omkareshwar Project)
GSC: 987.0 MCM
LSC: 299.0 MCM
Power (IC): 520 MW
Kolar Dam
(Kolar Irr. Project)
GSC: 270.0 MCM
LSC: 265.0 MCM
Barna Dam
(Barna Irr. Project)
GSC: 539.0 MCM
LSC: 455.8 MCM
Bargi Dam
(Rani Avanthi Bai Lodhi Sagar Unit-I & II, Bargi Diversion Irr. Project)
GSC: 3924.8 MCM
LSC: 3238.4 MCM
Power (IC) : 100 MW
Sardar Sarovar Dam
(Sardar Sarovar Project, Narmada Canal Irr. Project)
GSC: 9500.0 MCM
LSC: 5800.0 MCM
Power (IC): 1450 MW
Man Dam
(Man Irr. Project)
GSC: 145.0 MCM
LSC: 127.0 MCM
Kolar Barrage
(Kolar Irr. Project)
Barrage Length: 1195 m
Origin : Amarkantak hills, District Anuppur, Madhya Pradesh
Narmada
Man
Kolar
Tawa
Karjan
Arabian Sea
Karjan Dam
(Karjan Irr. Project)
GSC: 630.0 MCM
LSC: 581.0 MCM
Sukta Dam
(Sukta Irr. Project)
GSC: 89.5 MCM
LSC: 78.0 MCM
Indira Sagar Dam
(Indira Sagar Project)
GSC: 12220.0 MCM
LSC: 9750.0 MCM
Power (IC): 1000 MW
Tawa Dam
(Tawa Project)
GSC : 2312.0 MCM
LSC : 1944.0 MCM
Power (IC): 13.5 MW
= Under Construction Structures
= Operational Structures
GSC = Gross Storage Capacity
LSC = Live Storage Capacity
IC = Installed Capacity (Mega Watt)

Sardar Sarovar dam

Dedicated to the nation on Sep 17, 2017, almost 56 years after its foundation stone was laid

Ecosystem Services

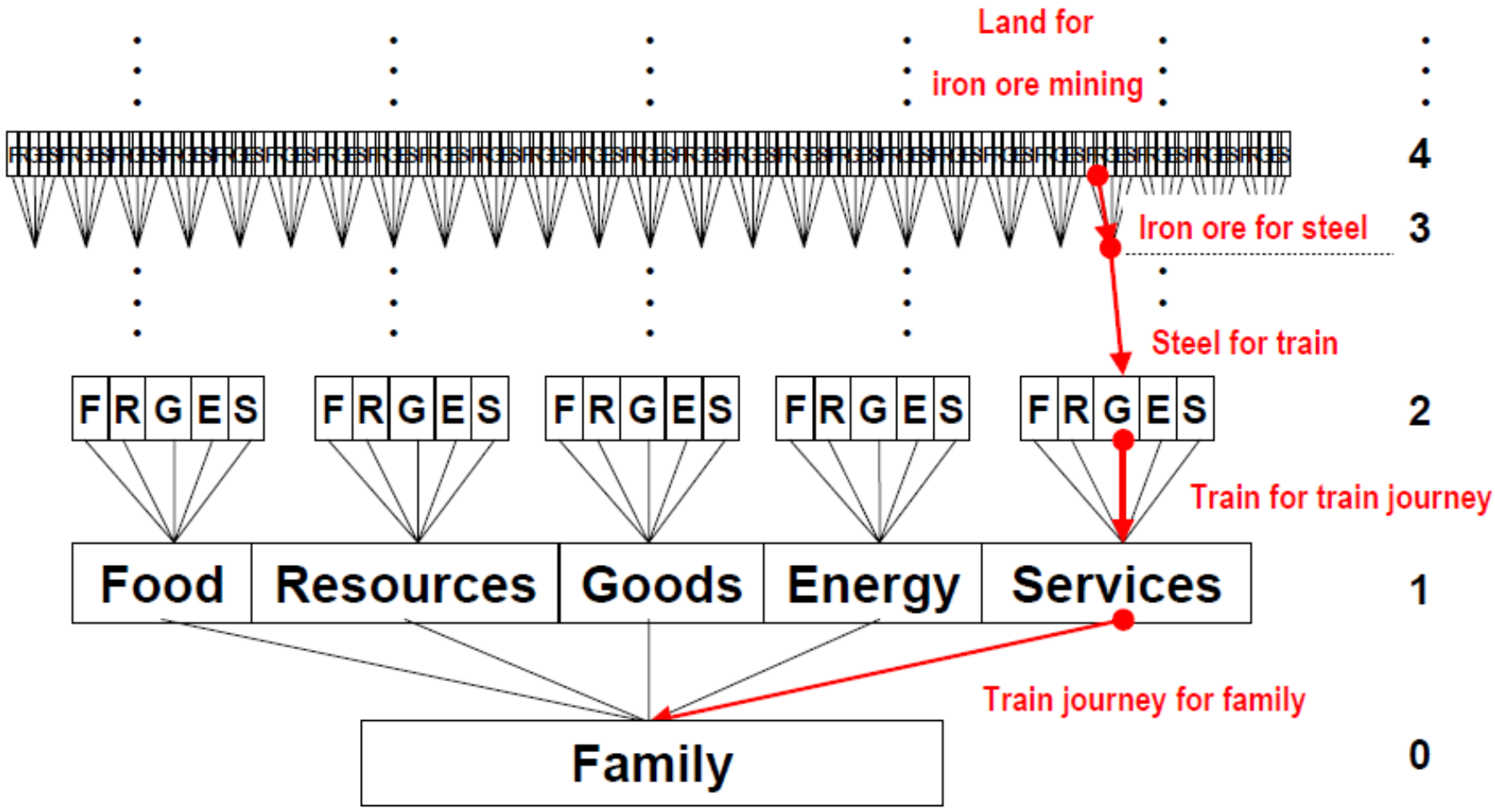


Fig. 2: Production layers and input paths in the ecological footprint of a family.

The value of the world's ecosystem services and natural capital

Robert Costanza*†, Ralph d'Arge‡, Rudolf de Groot§, Stephen Farber‖, Monica Grasso†, Bruce Hannon¶, Karin Limburg#☆, Shahid Naeem, Robert V. O'Neill††, Jose Paruelo‡‡, Robert G. Raskin§§, Paul Sutton‖‖ & Marjan van den Belt¶¶**

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‡ *Economics Department (emeritus), University of Wyoming, Laramie, Wyoming 82070, USA*
§ *Center for Environment and Climate Studies, Wageningen Agricultural University, PO Box 9101, 6700 HB Wageninengen, The Netherlands*
‖ *Graduate School of Public and International Affairs, University of Pittsburgh, Pittsburgh, Pennsylvania 15260, USA*
¶ *Geography Department and NCSA, University of Illinois, Urbana, Illinois 61801, USA*
# *Institute of Ecosystem Studies, Millbrook, New York, USA*
** *Department of Ecology, Evolution and Behavior, University of Minnesota, St Paul, Minnesota 55108, USA*
†† *Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831, USA*
‡‡ *Department of Ecology, Faculty of Agronomy, University of Buenos Aires, Av. San Martin 4453, 1417 Buenos Aires, Argentina*
§§ *Jet Propulsion Laboratory, Pasadena, California 91109, USA*
‖‖ *National Center for Geographic Information and Analysis, Department of Geography, University of California at Santa Barbara, Santa Barbara, California 93106, USA*
¶¶ *Ecological Economics Research and Applications Inc., PO Box 1589, Solomons, Maryland 20688, USA*

The services of ecological systems and the natural capital stocks that produce them are critical to the functioning of the Earth's life-support system. They contribute to human welfare, both directly and indirectly, and therefore represent part of the total economic value of the planet. We have estimated the current economic value of 17 ecosystem services for 16 biomes, based on published studies and a few original calculations. For the entire biosphere, the value (most of which is outside the market) is estimated to be in the range of US$16–54 trillion ($10^{12}$) per year, with an average of US$33 trillion per year. Because of the nature of the uncertainties, this must be considered a minimum estimate. Global gross national product total is around US$18 trillion per year.

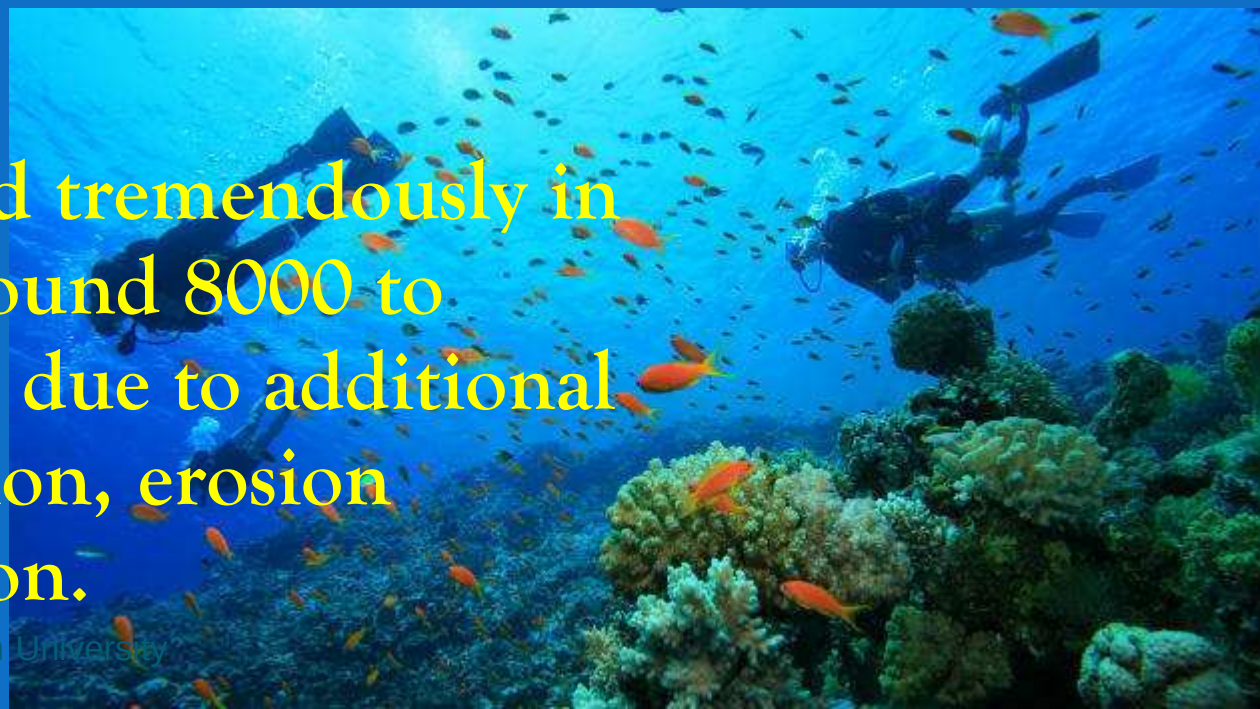
NATURE | VOL 387 | 15 MAY 1997

Valuing Ecosystem Service (Costanza 2014)

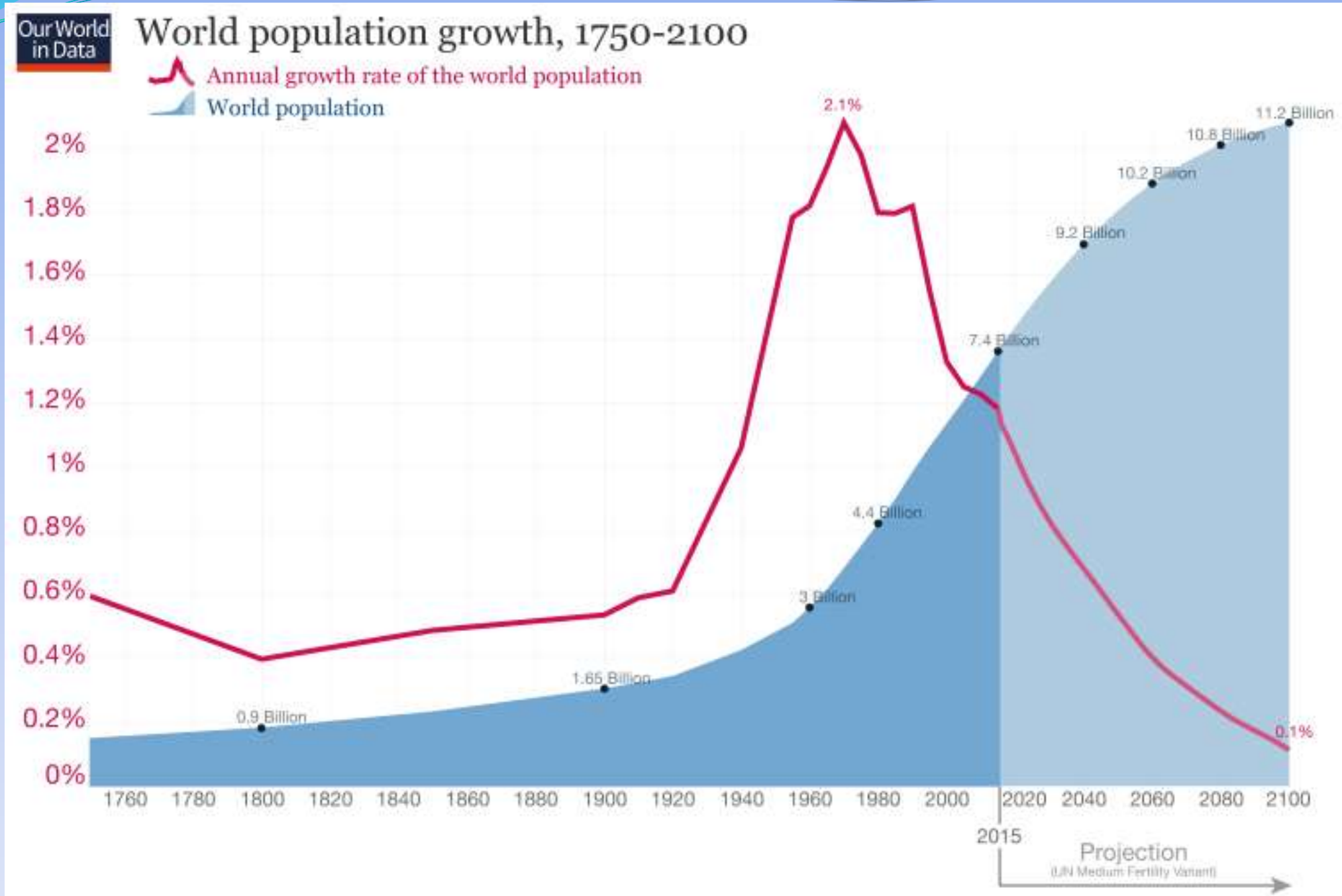
Some biomes showed significant increases in value. For example, tidal marsh/mangroves increased from abound 14,000 to around 194,000 $/ha/yr.

This is largely due to new studies of the storm protection, erosion control, and waste treatment values of these systems.

Coral reefs also increased tremendously in estimated value from around 8000 to around 352,000 $/ha/yr due to additional studies of storm protection, erosion protection, and recreation.



Human Population – A Trigger



Data sources: Up to 2015 OurWorldInData series based on UN and HYDE. Projections for 2015 to 2100: UN Population Division (2015) – Medium Variant.
The data visualization is taken from OurWorldInData.org. There you find the raw data and more visualizations on this topic.

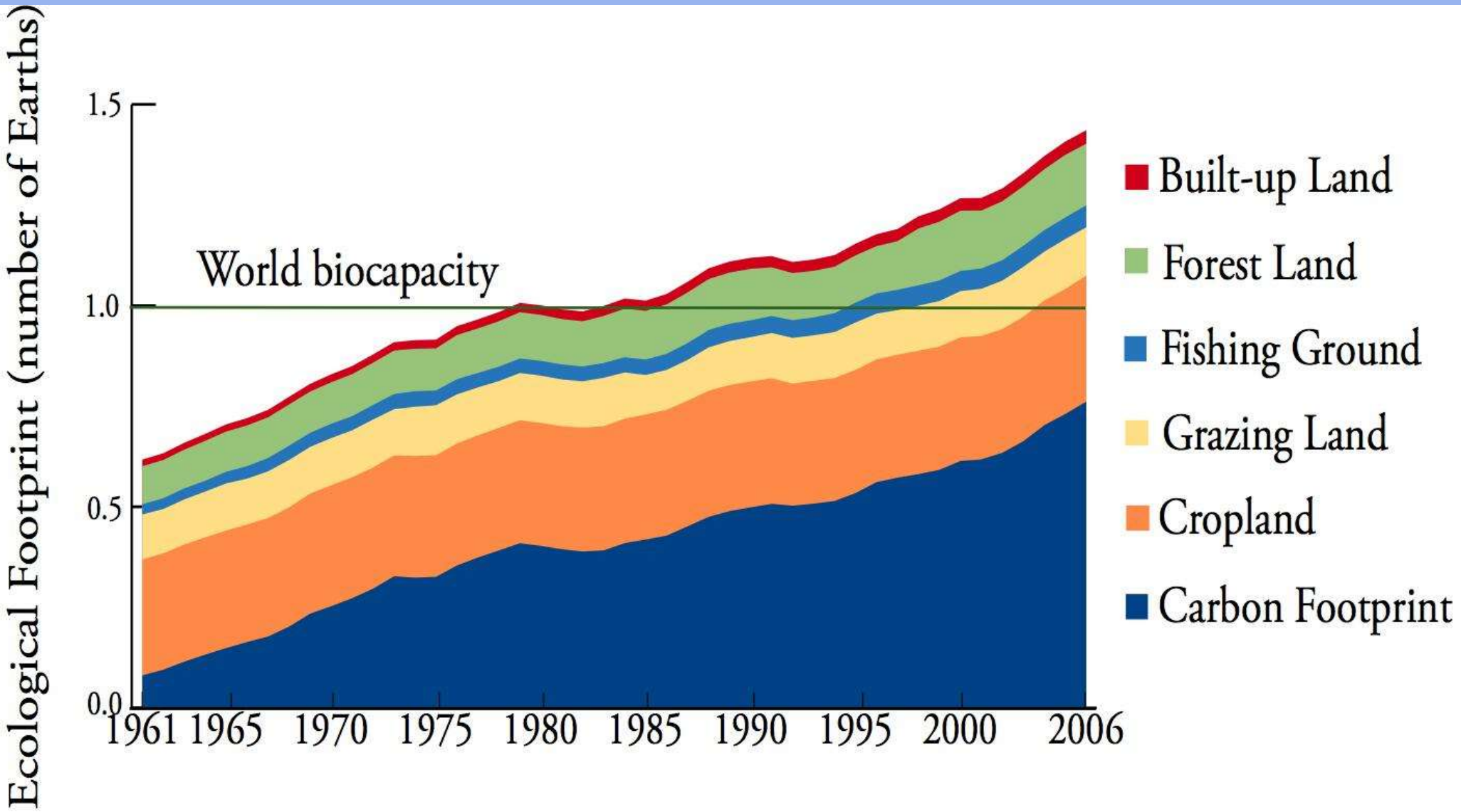


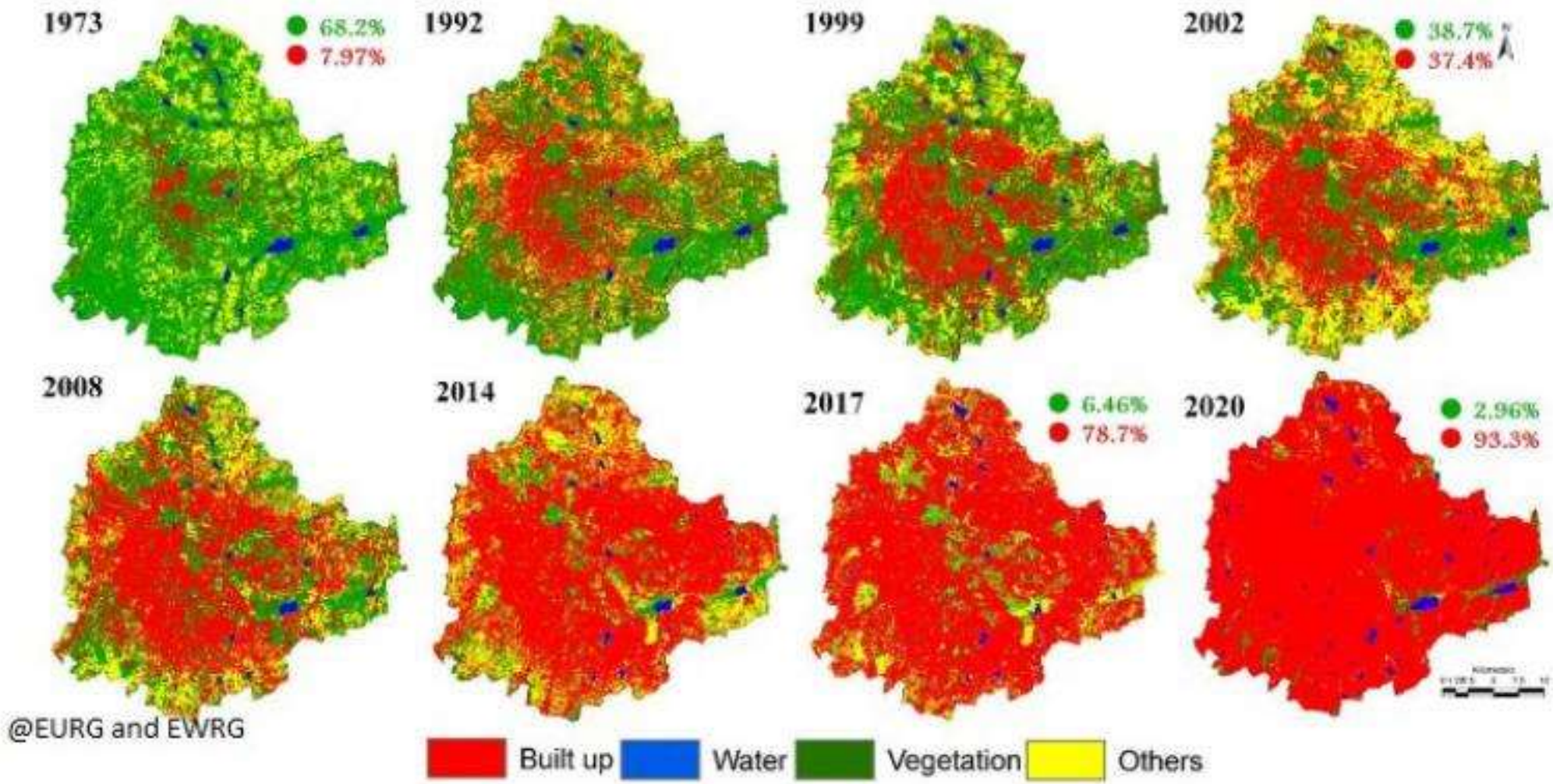
Figure 3. Humanity's Ecological Footprint, 1961-2006

Urban Footprints

- **Consumed Land**
  - **Built environment**

Urban Footprints

- **Bangalore City Land use changes**



Land use dynamics in Bengaluru

Transportation Footprints

- If one person travels 5 kilometers twice each workday:
  - **Bicycle: 122 sq meters**
  - **Buses : 301 sq meters**
  - **Cars: 1,442 sq meters**

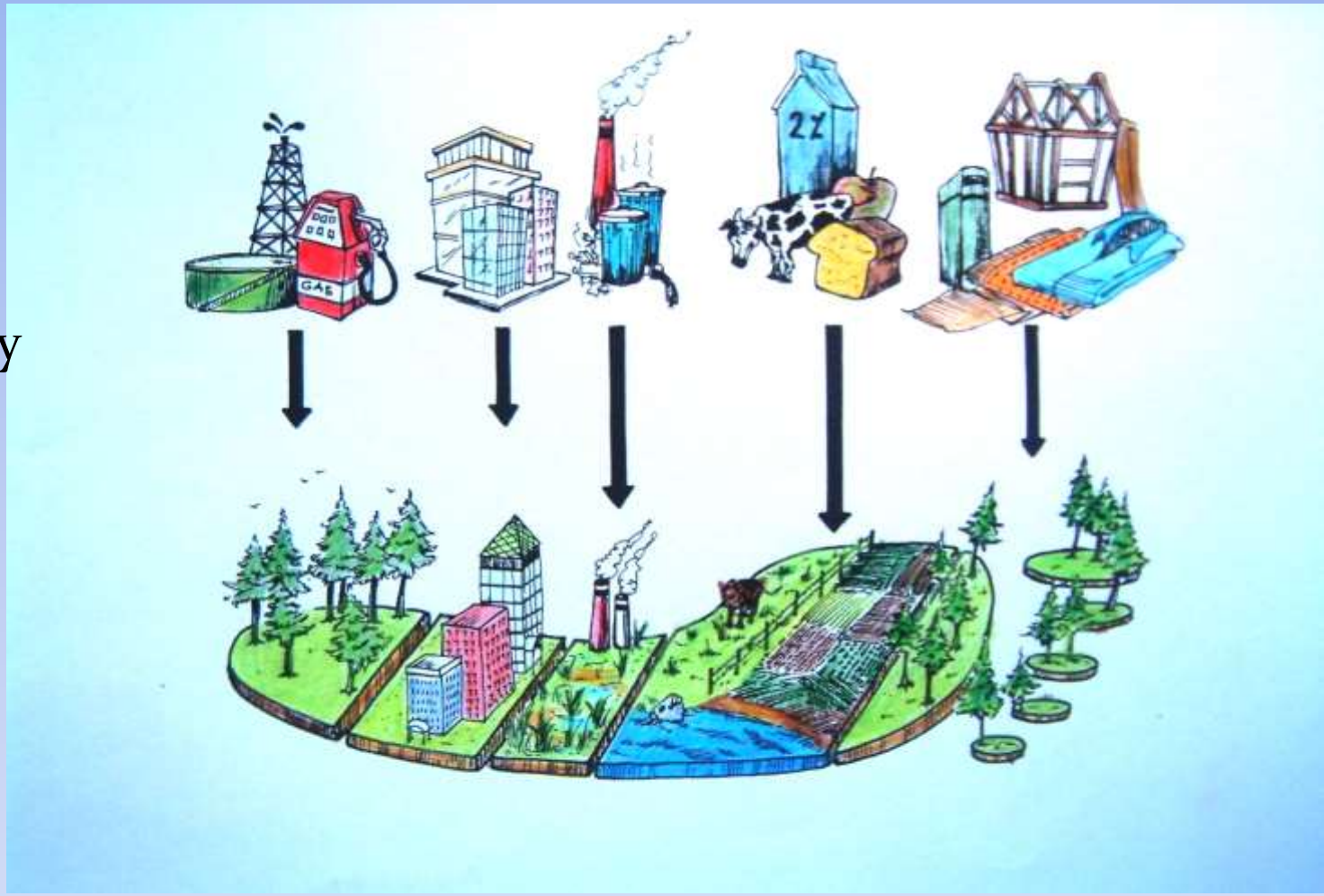
Agricultural Footprints

- **Open Field production of tomatoes takes up more land than greenhouse production**
- **But Greenhouse production has a much larger ecological footprint (10-20x)**
  - **Energy**
  - **Fertilizer**
  - **Other inputs**

Products and the Environment

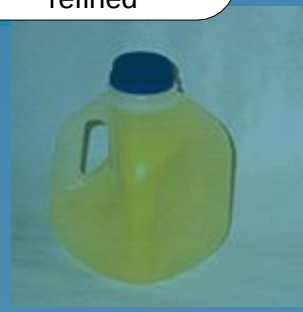
- At first glance, the relationship between products & our environment may seem clear,

BUT….



[Hoekstra & Chapagain, 2008]

WATER FOOT PRINTS



Cotton plant → Harvesting → Seed-cotton → Ginning

Ginning → 0.63/0.18 → Cotton seed → Hulling/extraction

Hulling/extraction → 0.16/0.47 → Cotton seed oil → 1.07/1.00 → Cotton seed oil, refined

Hulling/extraction → 0.51/0.33 → Cotton seed cake

Hulling/extraction → 0.10/0.20 → Cotton linters

Ginning → 0.35/0.82 → Cotton lint → 1.00/1.00 → Cotton, not carded or combed → Carding/Spinning

Carding/Spinning → 0.05/0.10 → Garnetted stock

Carding/Spinning → 0.95/0.99 → Cotton, carded or combed (yarn) → Knitting/weaving

Knitting/weaving → 0.95/0.99 → Grey fabric → Wet processing → 1.00/1.00 → Fabric → Finishing → 1.00/1.00 → Final textile

Knitting/weaving → 0.05/0.10 → Yarn waste

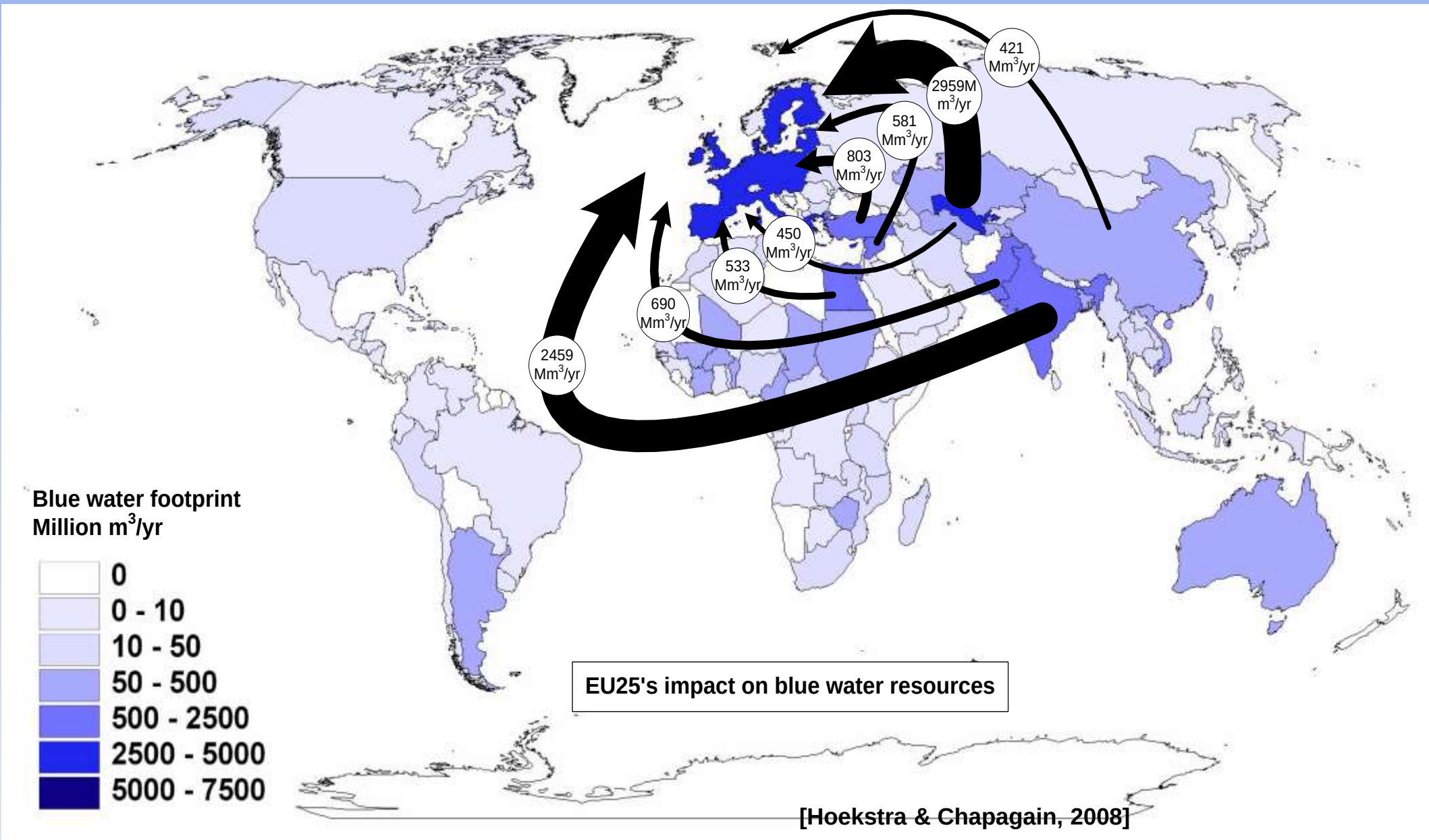
Legend

$\frac{0.35}{0.82}$

- Product fraction
- Value fraction

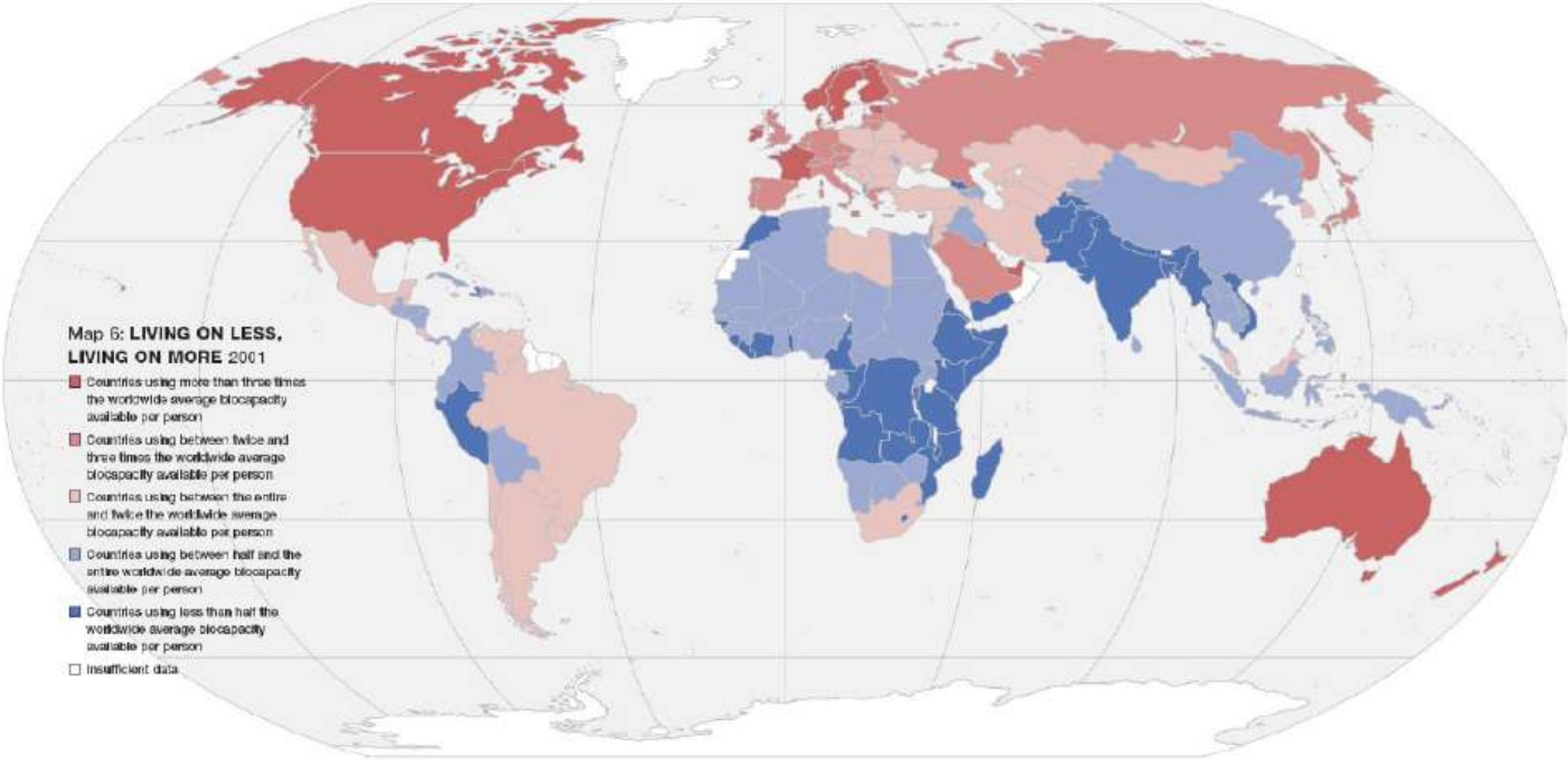
Polluted Waters – River Noyyal

Water footprint of EU's cotton consumption (blue water)

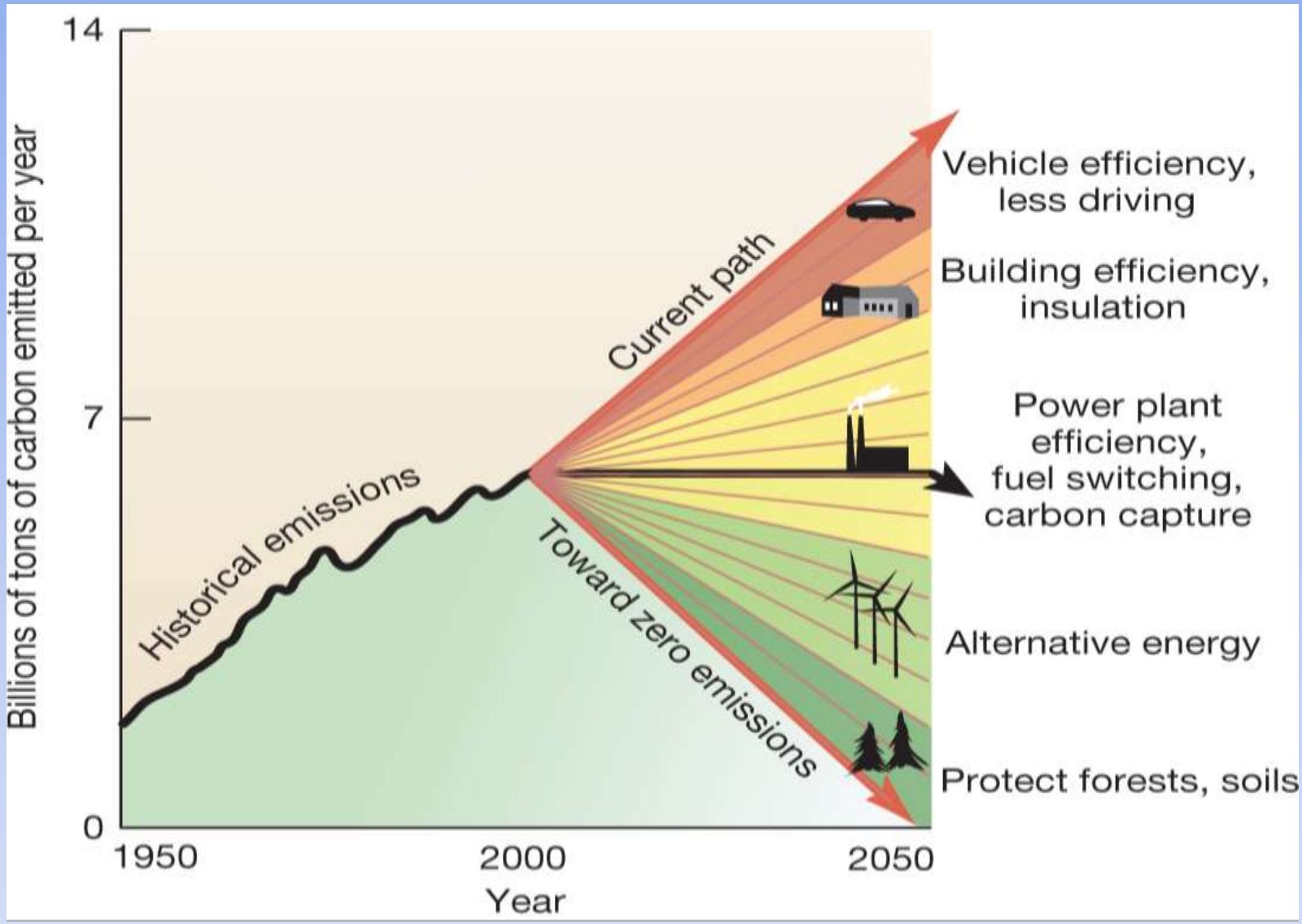


[Hoekstra & Chapagain, 2008]

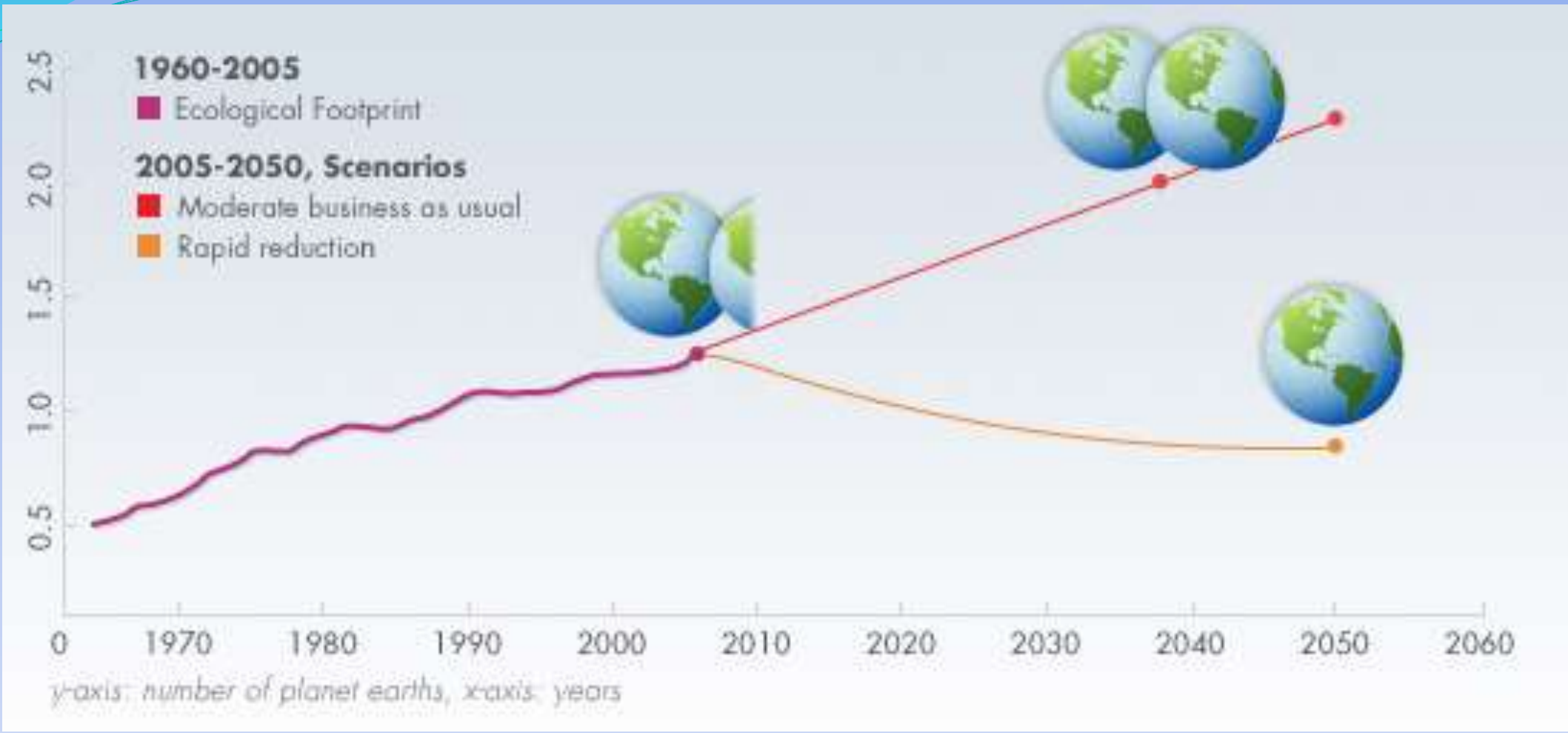
Living on Less, Living on More, 2001



Wedge Analysis

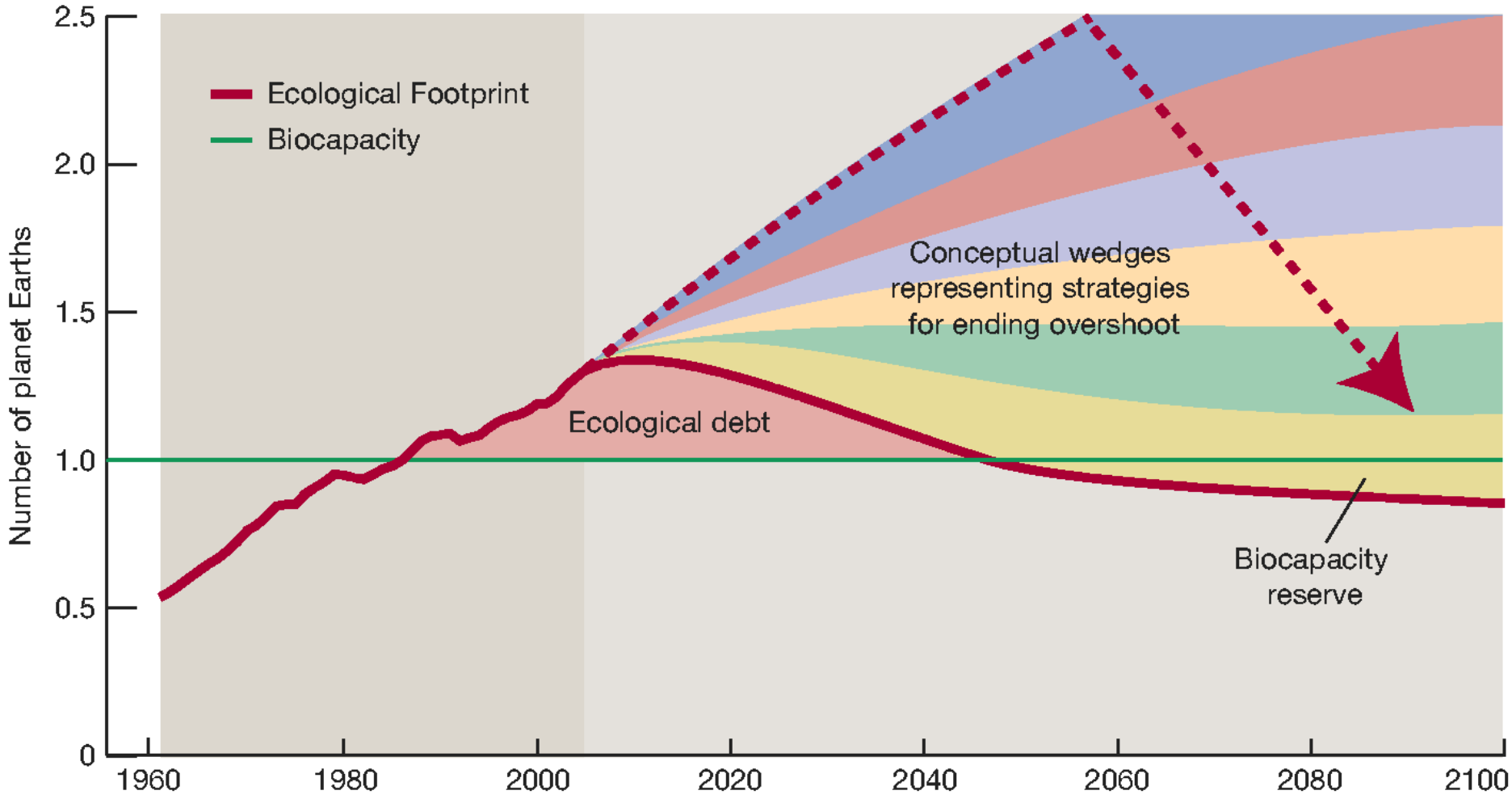


- Accomplishing just half of these wedges could level off our emissions. Accomplishing all of them could return to levels well below those envisioned in the Kyoto protocol

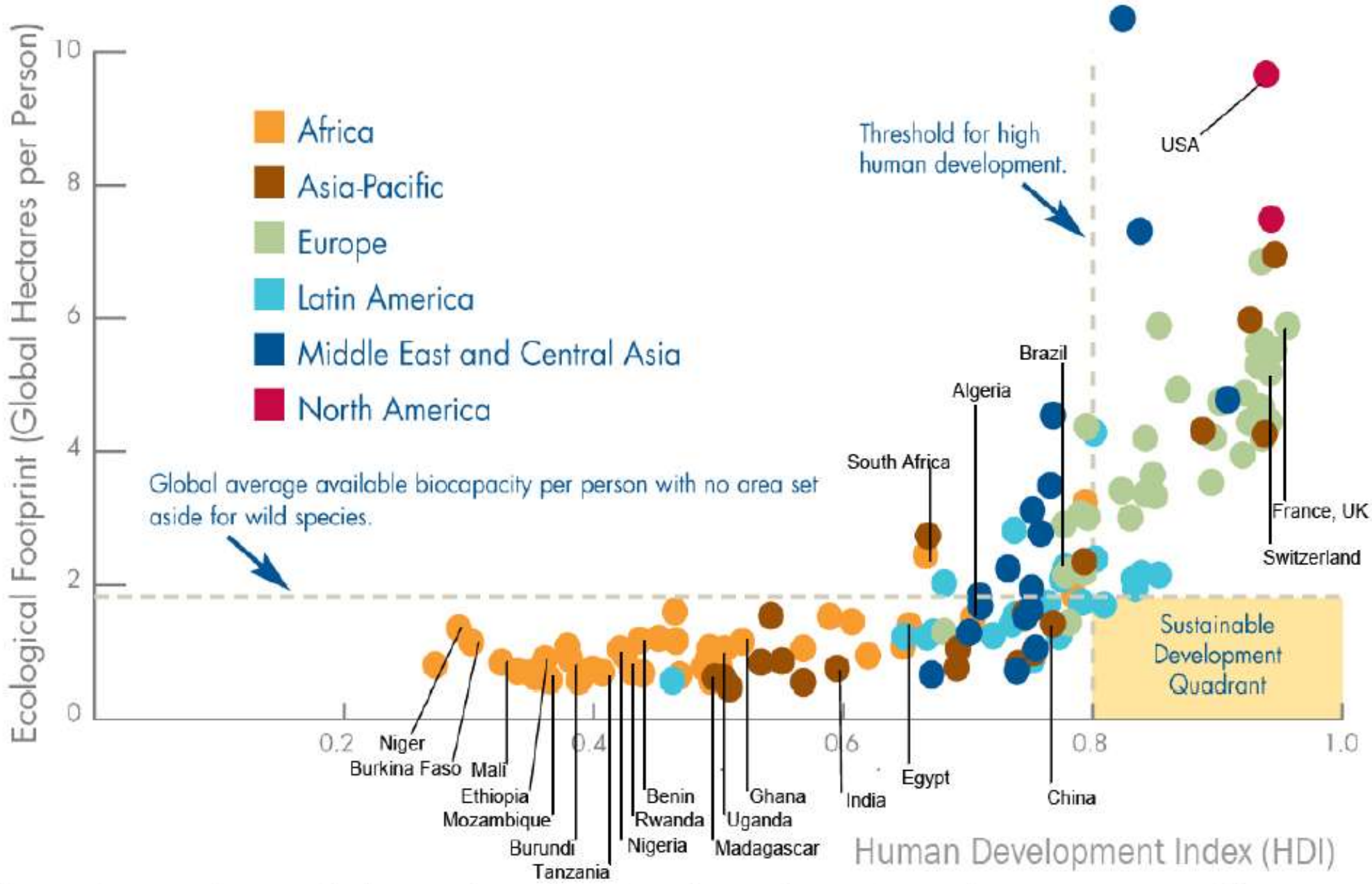

1960-2005
Ecological Footprint
2005-2050, Scenarios
Moderate business as usual
Rapid reduction
2.5
2.0
1.5
1.0
0.5
0
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
y-axis: number of planet earths, x-axis: years

Sustainability ?

Fig. 34: **SUSTAINABILITY WEDGES AND AN END TO OVERSHOOT**



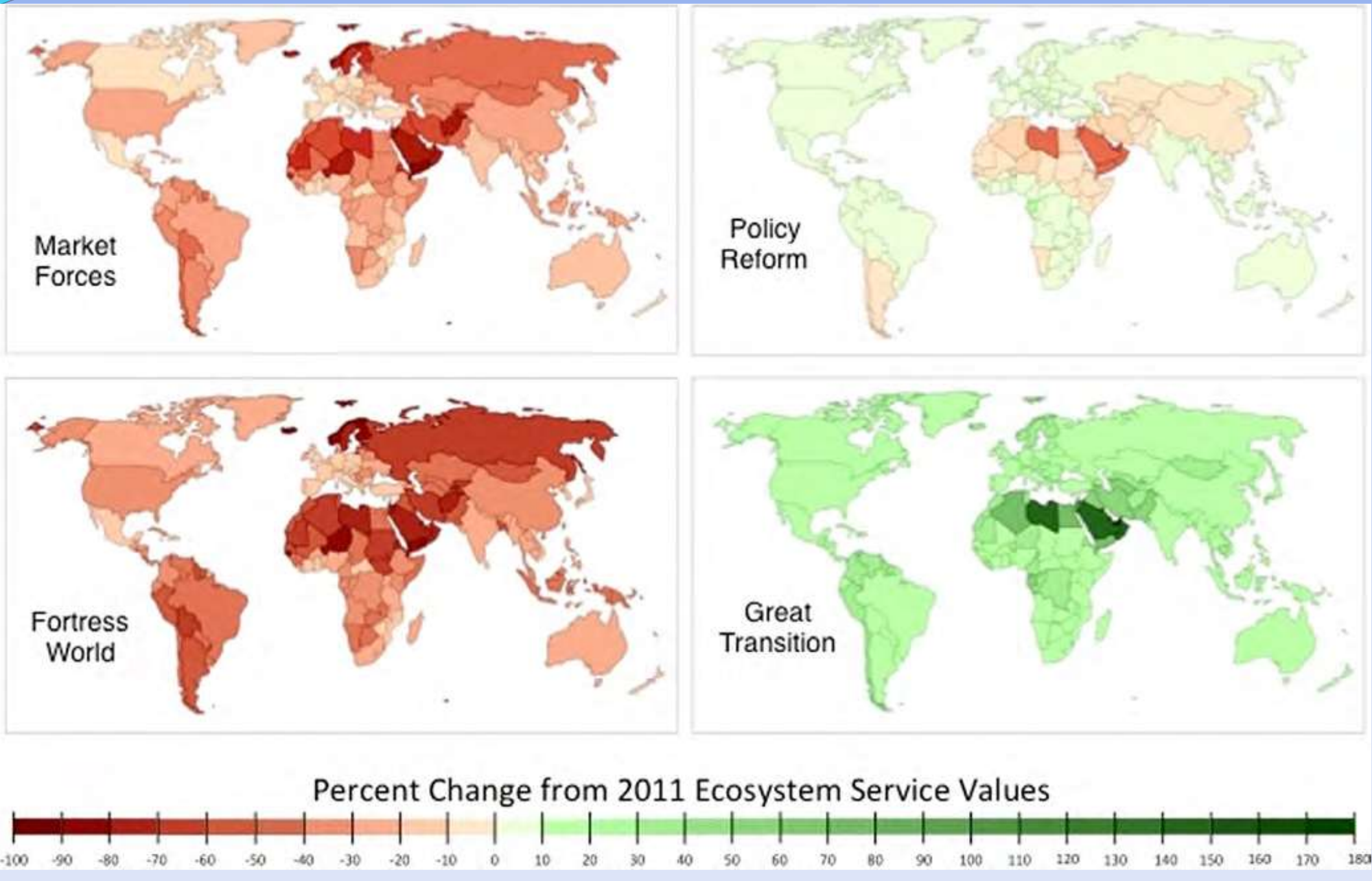
From Living Planet Report 2008, World Wildlife Fund, 2008.



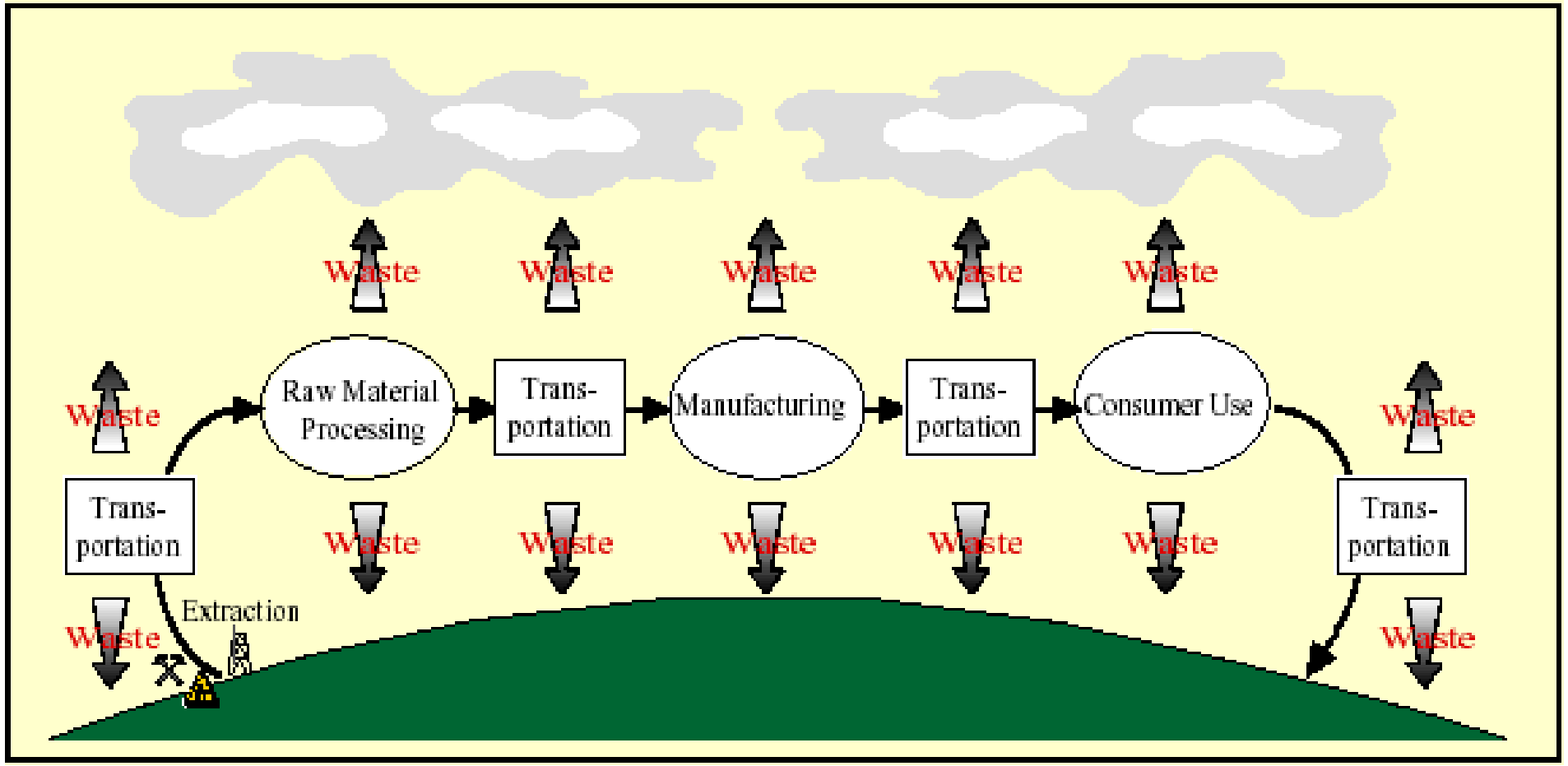
Development Index (HDI) as an indicator of socio-economic development, and the Ecological Footprint as a measure of human demand on the biosphere. The United Nations considers an HDI of over 0.8 to be "high human development." An Ecological Footprint less than 1.8 global hectares per person makes a country's resource demands globally replicable. Despite growing adoption of sustainable development as an explicit policy goal, most countries do not meet both minimum requirements.

Ecosystem Services ---- Future Scenarios (Kubiszewski etal. 2017)

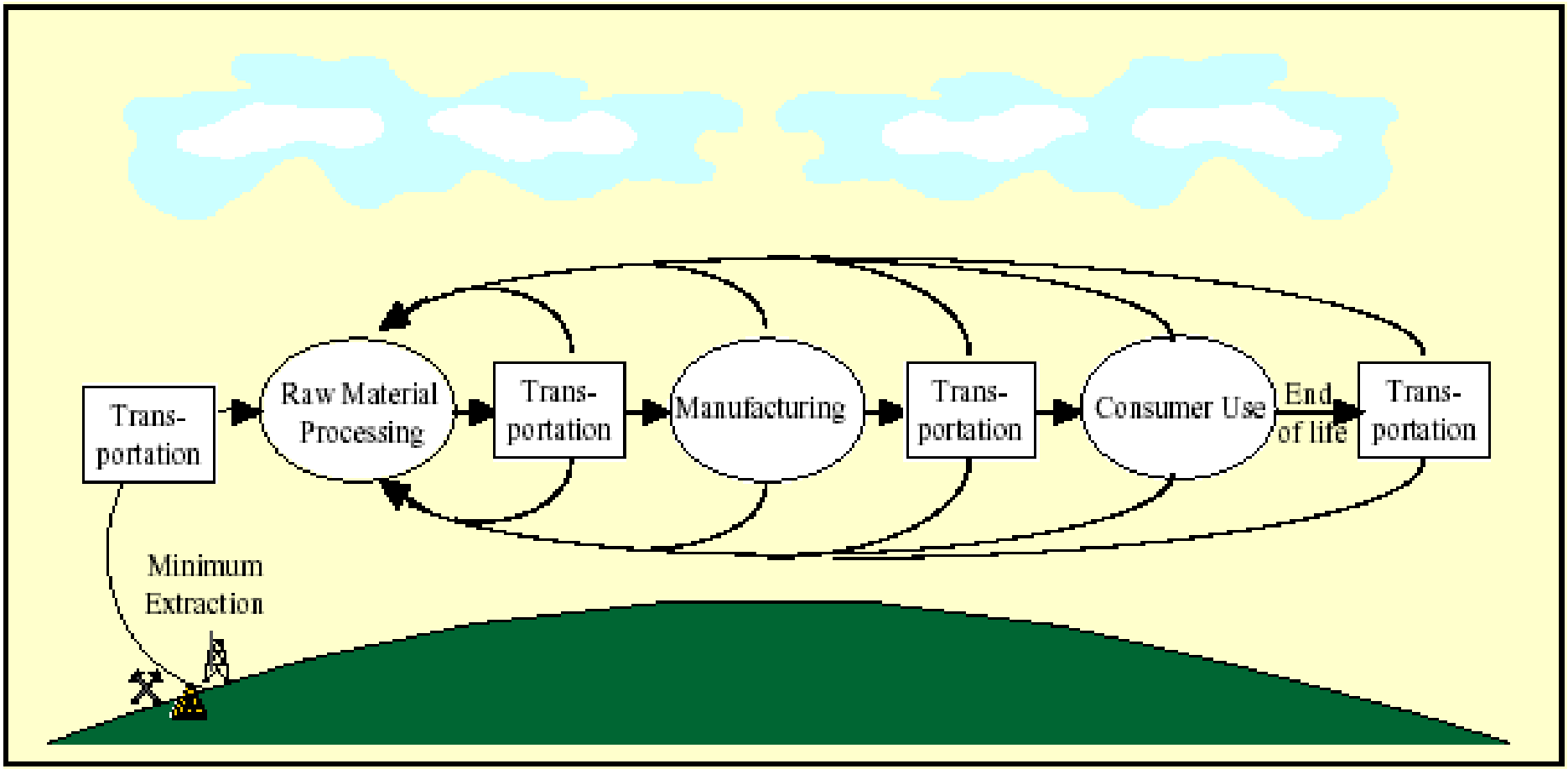
Ecosystem services value in each of the four scenarios from the 2011



The present state



Ideal Situation



Thank You