

Ecological Footprint



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Origins & Development

- created and developed by **Professor William Rees** and **Dr Mathis Wackernagel**, University of British Columbia, in early 1990s
- Mathis Wackernagel now heads **Global Footprint Network**, established 2004 in Oakland, California

www.footprintnetwork.org



Origins & Development

- GFN mission is:
to support a **sustainable economy** by advancing the Ecological Footprint, a **measurement and management tool** that makes the reality of **planetary limits** relevant to **decision makers** throughout the world
- GFN maintains National Footprint Accounts for over 150 countries

What is the Ecological Footprint?

The Ecological Footprint is both a **measurement** and a **communication** tool:

- enables sustainability to be defined in **specific** and **measurable** terms
- enables people to **understand** sustainability by linking their personal impact with global ecological capacity

What is the Ecological Footprint?

Measures how much biologically productive land & water area humanity uses to produce the resources it consumes and absorb waste it generates, using prevailing technology and resource management, wherever on earth those bioproductive areas are located



What is the Ecological Footprint?

Impact = Population x Affluence x Technology

Footprint of a nation or of humanity (I) =

- **number** of people **consuming** (P) x
- average **amount** of goods and services an average person **consumes** (A) x
- **resource intensity** of these goods and services (T)

What 'Footprint' Means

Footprint is **NOT** a general term for 'environmental impact'...

- eg. tonnes of carbon emitted is **NOT** the 'carbon footprint'...
- ...surface area of planet needed to sequester CO₂ emissions and maintain a stable climate **IS** the carbon footprint

Footprint Basis

- based on **science** (ecological & thermodynamic principles) - is not an arbitrary index
- based on an **empirical**, not a speculative, research question – ‘how many people can Australia support?’ is a speculative question (depends on how they want to live, how much they consume)



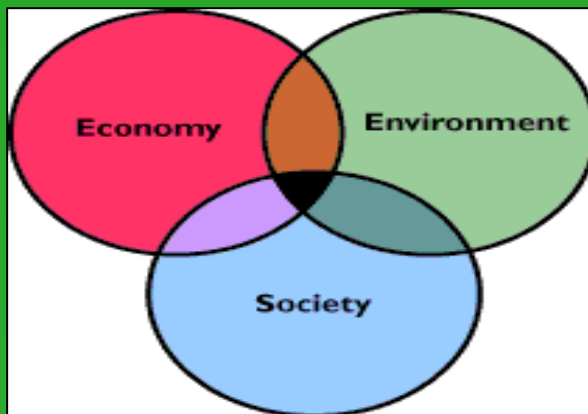
Footprint Basis

- ‘how much of the regenerative capacity of the biosphere does it take to support Australians?’ is **empirical, measurable**
- measures our use of nature, aggregates impacts on biosphere into one figure - bioproductive space occupied exclusively by a human activity, expressed in **hectares**
- inverts traditional concept of carrying capacity; **measures ecological load**

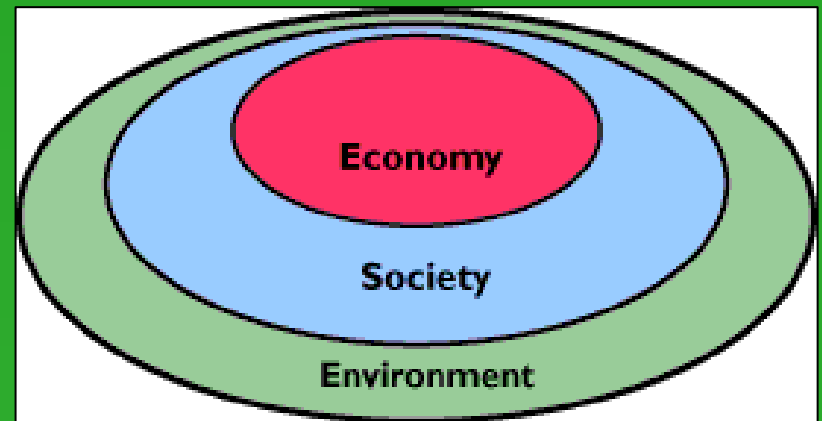
Key Concepts

- economy, environment and society are **NOT equal concepts** – functionally, the economy is part of society which in turn is part of the biosphere, or environment

FALSE



TRUE



Key Concepts: Overshoot

- the **regenerative capacity of biosphere** is **non-negotiable limiting factor** for sustaining life; resource use concern previously depletion of finite non-renewable resources (flows, not stocks)
- when humanity's demand on nature exceeds the biosphere's supply, or regenerative capacity, this global ecological deficit is called **overshoot**

Key Concepts: Overshoot

- overshoot erodes earth's natural capital stock; humanity liquidating 'assets' instead of living off of the 'interest'
- sustainability has a specific meaning - **avoiding ecological overshoot**
- avoiding overshoot is only a **minimum condition** for sustainability; but **sustainability is impossible without avoiding overshoot**

Key Concepts: Overshoot

‘Sustainability is like buying a chair...

There's no question whether the chair should be strong enough to sit on or not. That's the **non-negotiable condition**. The questions are: do you want a red one, a green one, a wooden one, a metal one?

...but not whether the chair is strong enough.’

Mathis Wackernagel, Footprint co-creator

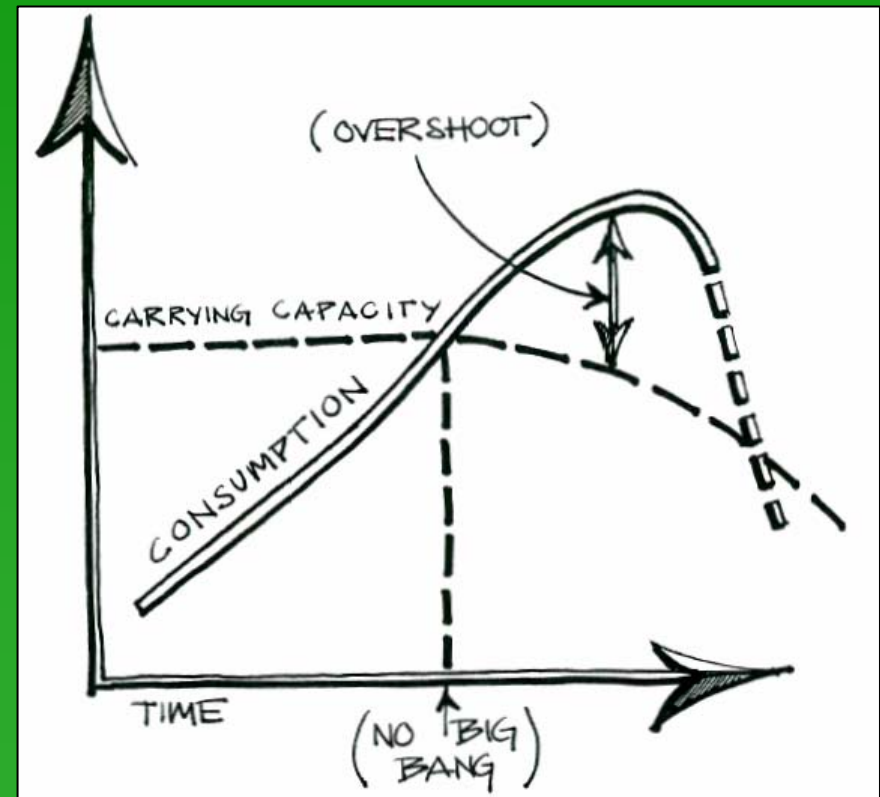
Key Concepts: Overshoot

- **invisibility** - consumer culture promotes abundance, people do not generally encounter ecological limits; psychologically as well as spatially divorced from dependence on nature
- **economic 'blind spot'** - ecological limits invisible through monetary lens; prices signal availability of a resource in market, not its availability in the biosphere



Key Concepts: Overshoot

- **‘elasticity’** - ecological limits can be easily transgressed; but overshoot eats up nature’s reserves, weakening its ability to regenerate



Key Concepts: Overshoot

- nature's biological limits are not 'rigid' - natural capital can be harvested faster than it regenerates
- nature reacts with inertia - gives the illusion that limits can be transgressed without apparent consequences
- **...how can we know whether we are in overshoot?**



Key Concepts: Overshoot

- ...by measuring **demand** (ecological footprint) and comparing it to **supply** (earth's biological capacity)
- individuals or businesses that do not track activities and keep accurate records run risk of **bankruptcy** - yet this is precisely the approach we take with the only planet within our reach capable of supporting life

Footprint Methodology

- the majority of the **resources** people **consume** and the wastes they generate can be **tracked**
- most resource and waste flows can be **converted** into **biologically productive area** required to maintain these flows

Footprint Methodology

- by scaling each area in proportion to its bioproductivity, different types of areas can be converted into the **common unit** of global hectares (hectares with world average bioproductivity)
- when both are expressed in global hectares, human **demand** (Ecological Footprint) can be directly compared to nature's **supply** (biocapacity) to determine whether we are in overshoot

Structure: Components

Comprised of six land-use types for human activities, which all compete for biologically productive space:

- **crop land** - arable land used for growing food, animal feed, fibre, oil and rubber
- **pasture land** - grazing animals for meat, hides, wool, and milk
- **forest land** - harvesting timber for wood fibre and fuelwood



Structure: Components

- **fishing grounds** – marine and inland fish harvest (continental shelves most bioproductive areas of ocean)
- **built up land** - infrastructure for housing, transportation, and industrial production
- **CO₂ land** – land required to sequester the carbon dioxide generated from burning fossil fuels (theoretical)

Structure: Data

- each country's National Footprint Account spreadsheet has over **2,000 data points**
- track domestic production, imports, exports and apparent consumption of over **600 resource categories** such as crop products, fibres, livestock, wild and farmed fish, timber, and fuelwood, and one major waste product – carbon dioxide

Structure: Data

- data in **biophysical units** (eg. tonnes) not monetary units; when data is only available in monetary units, estimates of actual physical quantities traded are made from monetary value
- data from **reputable sources** including FAO (United Nations Food & Agriculture Organisation) & IPCC (Intergovernmental Panel on Climate Change)

Structure: Data

- accounts updated annually based on most recent complete data sets = time lag of about three years
- comprehensive **ecological accounting** system that calculates Ecological Footprint and biocapacity of world and 150 nations from 1961-2006



Structure: Equivalence Factors

- countries have access to different land types of **varying quality**; direct comparison of actual land area exaggerates Footprints of countries compelled to use lower quality land
- figures **corrected for bioproductivity** allow more **meaningful comparisons**

Structure: Equivalence Factors

- adjust **productivity** of a **particular category of land** (eg. arable, pasture) land in relation to **world 'average' land** globally ie. arable land is scaled up compared to 'average' space, as it is more biologically productive
- **same for all countries; calculated for each year** to reflect changes in bioproductivity (land use change, declining/improving quality of land)

Structure: Equivalence Factors

World Average Land	1.00
Primary Cropland	2.21
Marginal Cropland	1.79
Forest	1.34
Pasture	0.49
Marine	0.36
Inland Water	0.36
Built Land *	2.21

* assumes built on land displaced arable land, same equivalence factor as primary cropland

Structure: Yield Factors

- adjust the productivity of a **country's land** (eg. arable) compared to **world average** productivity of (eg. arable) land
- reflect **how much more or less productive** a country's land is compared to same category of land across rest of world
- **differ between countries; calculated each year**, reflect changes in bioproductivity (quality, change of land use)

Structure: Yield Factors

	Cropland	Forest	Pasture	Fisheries
WORLD	1.0	1.0	1.0	1.0
Algeria	0.6	0.0	0.7	0.8
Guatemala	1.0	1.4	2.9	0.2
Hungary	1.1	2.9	1.9	1.0
Japan	1.5	1.6	2.2	1.4
Jordan	1.0	0.0	0.4	0.8
New Zealand	2.2	2.5	2.5	0.2
Zambia	0.5	0.3	1.5	1.0

Structure: Conversion Factors

- conversion factors are used to account for the efficiency of conversion of **raw** materials (eg. milk) to **manufactured** products (eg. cheese)
- adjusted conversion factors refine true conversion efficiencies to account for **secondary** animal products, such as hides and wool

Methodology: Approach

Footprint uses conservative approach which **underestimates human impact** and **overestimates available biological capacity** by:

- **counting each area only once**, even if the area provides two or more ecological services simultaneously (double counting would exaggerate the Footprint)

Methodology: Approach

- choosing the more **conservative** estimates when in doubt
- accounting for agricultural practices as if current industrial yields would not cause any **significant long-term damage** to soil productivity
- leaving out some human activities for which there is **insufficient data**

Methodology: Approach

- excluding activities which **systematically erode** nature's capacity to regenerate:
 - use of materials for which the biosphere has **no significant assimilation capacity** eg. plutonium, polychlorinated biphenyls (PCBs)
 - processes that **irreversibly damage** the biosphere (eg. species extinction, aquifer destruction, deforestation, desertification)

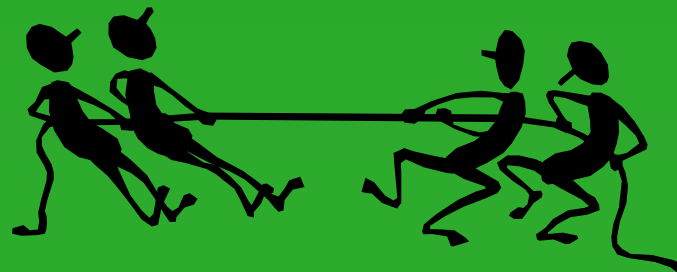


Biodiversity

- need to factor in bioproductive space for **other species** typically excluded from areas occupied for human uses
- Brundtland report figure of 12%; conservation biologists estimate necessary figure between 25-75%
- efforts to increase biocapacity (monocropping, use of pesticides) may increase pressure on biodiversity

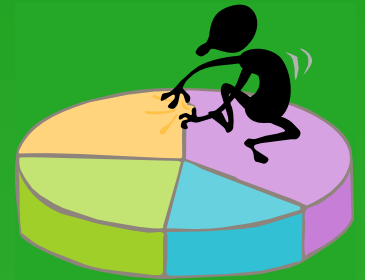
Competition for Biocapacity

- aggregated indicator **highlights connections of ecological functions**, documents human pressures on nature
- as Footprint exceeds biocapacity, human uses of nature become **competitive** with each other; biocapacity used by one economy unavailable to another



Competition for Biocapacity

- UK's arable land 5.7 million hectares; UK needs 25.9 million hectares to run its vehicles on biodiesel = **4.5 times its arable area**
- alleviating pressure may simply shift the load elsewhere; one impact may even exacerbate another - '**bedcover effect**'



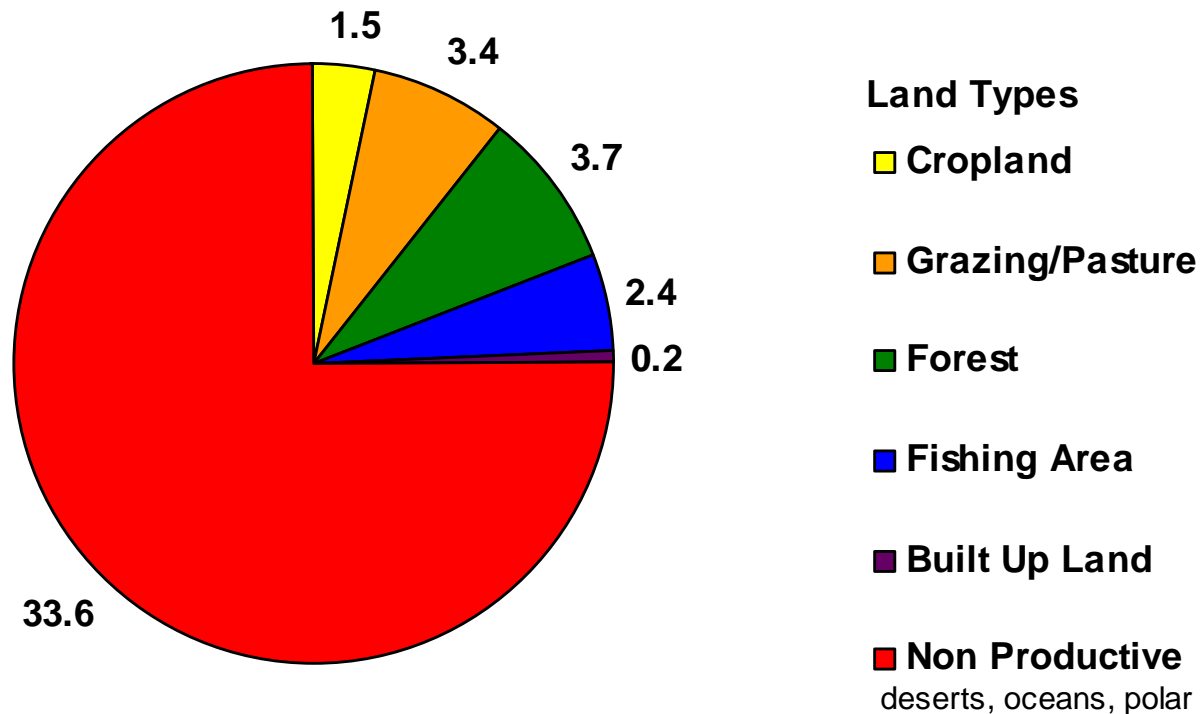
www.monbiot.com/archives/2004/11/23/feeding-cars-not-people

World Biocapacity

- the biosphere has **11.2 billion hectares** of **biologically productive area**, roughly one quarter of the planet's surface
- this bioproductive area consists of:
 - 2.4 billion hectares of water** (ocean shelves and inland water), and
 - 8.8 billion hectares of land**

World Biocapacity

World Biocapacity - 11.2 Billion Hectares (Approx)

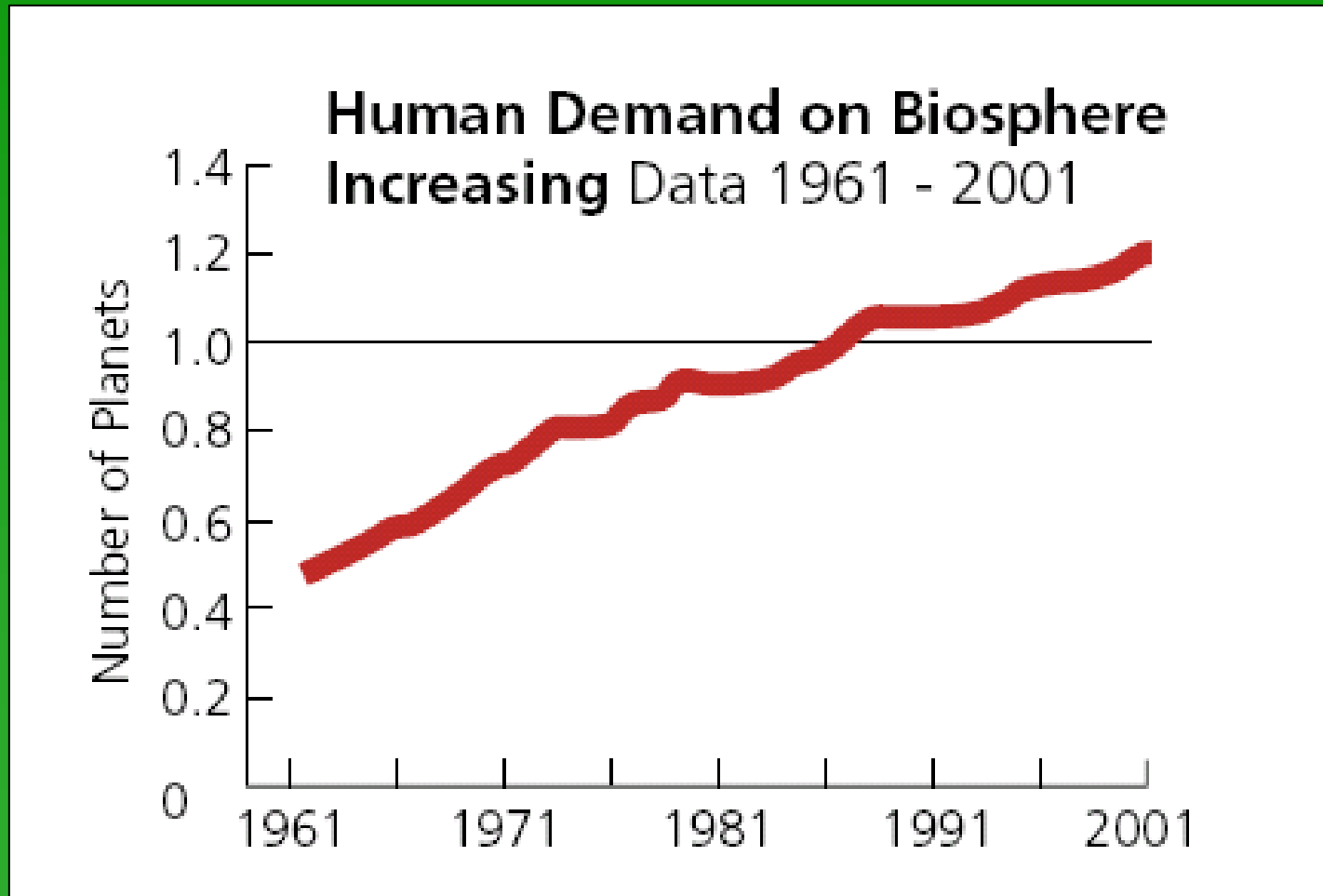


current world population: **6,301,500,000**

World Footprint

- available biocapacity (supply) per person:
1.8 global hectares
- average Footprint (demand) per person:
2.2 global hectares
- current level of **overshoot: 23%**
- it takes nature **one year and three months** to regenerate the resources humanity used in one year

World Footprint



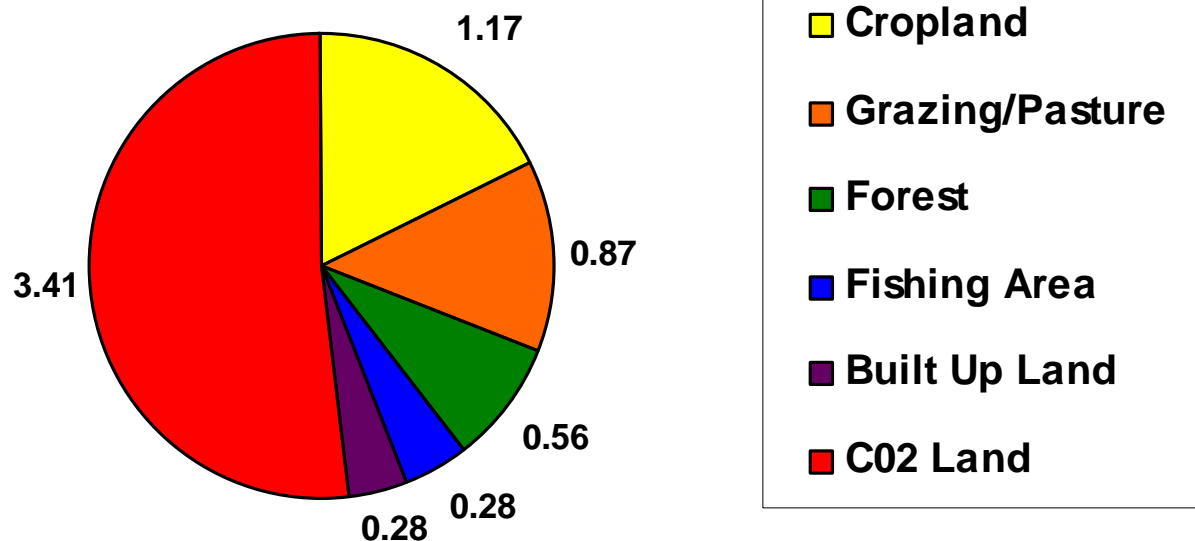
World Footprint

National Income Groups	Population (millions)	Average Footprint (hectares)
High	955.6	6.4
Medium	3,011.7	1.9
Low	2,303.1	0.8

Australia's Footprint

Footprint of average Australian:
6.6 hectares per person

Australia's Footprint - Hectares Per Person



Australia's Footprint

- **national biocapacity** per Australian:
12.4 hectares per person
- **ecological reserve** of 5.9 gha per person...
- ...this remainder is 'occupied' by countries running **ecological deficits**
- more useful to compare Footprint to **global (absolute)** rather than **national (relative) biocapacity**

Future Scenarios

- population of only **9 billion by 2050**, if everyone starts with two child families today (optimistic UN estimate)
- **halving of resource consumption** in OECD countries
- **adequate standard of living for all** (eg. 3.3 hectare Footprint, an 'average' Mexican, Ukrainian today; 'average' Australian Footprint is 6.6 hectares)

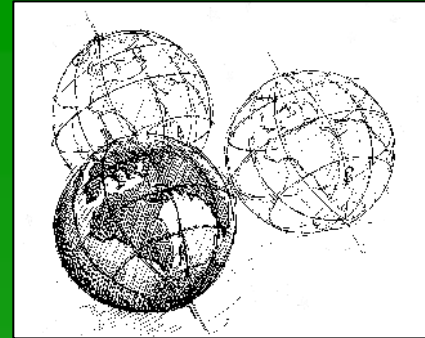
Future Scenarios

Biologically productive space needed to support 9 billion people living on a 3.3 hectare Footprint: **29.7 billion hectares**

Biologically productive space on the planet: **11.2 billion hectares**

Number of planets needed to sustain 9 billion people living on a 3.3 hectare Footprint: **2.65 planets**

Humanity's Challenge



Defining challenge of our age
(encompasses addressing climate change,
extreme poverty) not whether more than
six billion people can be sustained on
western industrial model of development...

...it is how to sustain the projected
global population at an
**adequate standard of living for all within
the regenerative biocapacity of one planet**

Future Scenarios

Overshoot can be eliminated on **demand** side by **reducing humanity's footprint**:

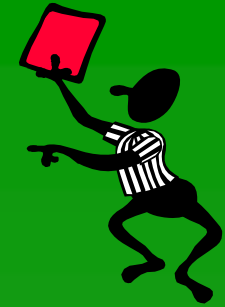
- lowering world **population**
- reducing per capita **consumption**
- implementing more **resource efficient technologies** for providing goods and services

Future Scenarios

Overshoot can be eliminated on **supply** side by **increasing global biocapacity**:

- expanding global **bioproductive area**
- improving **resource management**
- strengthening **ecosystems health**

Criticisms



- doesn't capture all sustainability aspects
- treats nature as collection of resources for use by humans
- is too simple – overaggregates data
- is too complex – methodology unclear

Need to maintain balance of robust, scientifically **credible** Footprint, and its **accessibility** as a communication tool

Research Agenda: Greenhouse

- inclusion of **C02 from non-fuel combustion sources** (fugitive emissions from flaring of oil and gas, cement production, tropical forest fires, biofuel combustion)
- inclusion of **greenhouse gases other than C02** (eg. methane)

Research Agenda: Nuclear

- **removal of nuclear**, currently accounted for as parity with fossil fuels (one MWh of nuclear electricity = carbon Footprint of one MWh average fossil-fuel electricity)
- value of nuclear land Footprint does not reflect salient scientific/political concerns associated with nuclear (radioactive waste, accidents, weapons), which are generally **unrelated to occupation of biological capacity**

Research Agenda: Water

- water not itself a material produced by the biosphere but **cycles through the biosphere**; use or withdrawal reflected indirectly by showing changing **levels of biocapacity**, generally **dependent on availability of water**
- biocapacity compromised by water use could be measured and this loss of biocapacity allocated to the water user

Research Agenda: Pollutants

- demand on ecosystems from releases of persistent pollutants is reflected indirectly via decrease in biocapacity where **capacity of ecosystems is compromised**
- biocapacity loss could be allocated to the activity releasing them

Research Agenda: Built Land

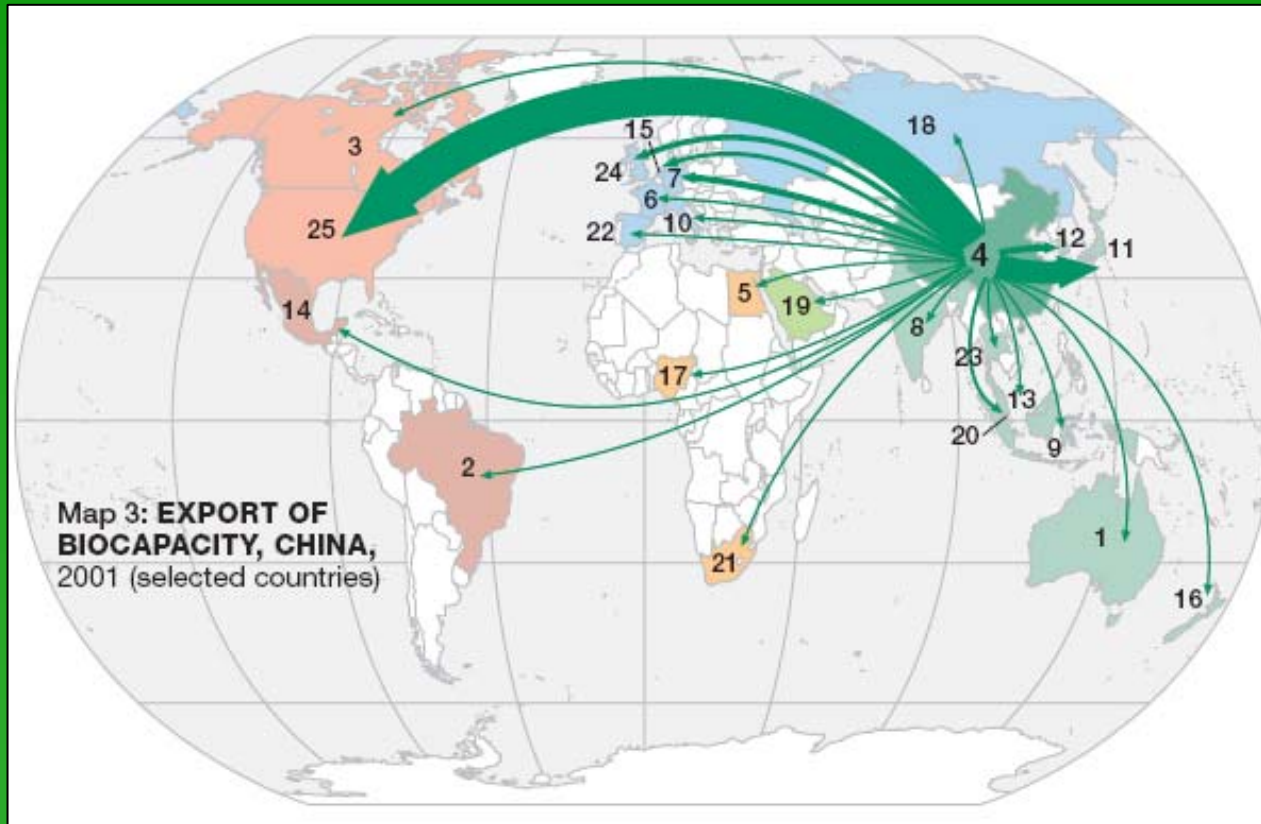
- accounts assume built-up land for infrastructure replaced cropland; proposal to calculate built land based on more accurate data about what land type the built infrastructure replaced
- ...OR removal of built land as a category altogether; **count out urban area as not 'productive'**, in same way as deserts, polar caps etc are excluded

Application: Global



- **trade relations** - identify resource dependence on overstressed regions; understanding effect of trade on footprint distribution
- **international negotiations** - framework for setting negotiation priorities and assessing international resource flows
- **security** - emerging risks associated with resource scarcity

Tracking Biocapacity Flows



including biocapacity imported and re-exported

Tracking Carbon Flows

UK consumers use products and services with a carbon footprint of 176.4 MtC (millions of tonnes of carbon per annum)

= 11.7 MtC greater than emissions of all UK production

UK a net importer of carbon intensive products and services from abroad; has

exported part of its carbon responsibility

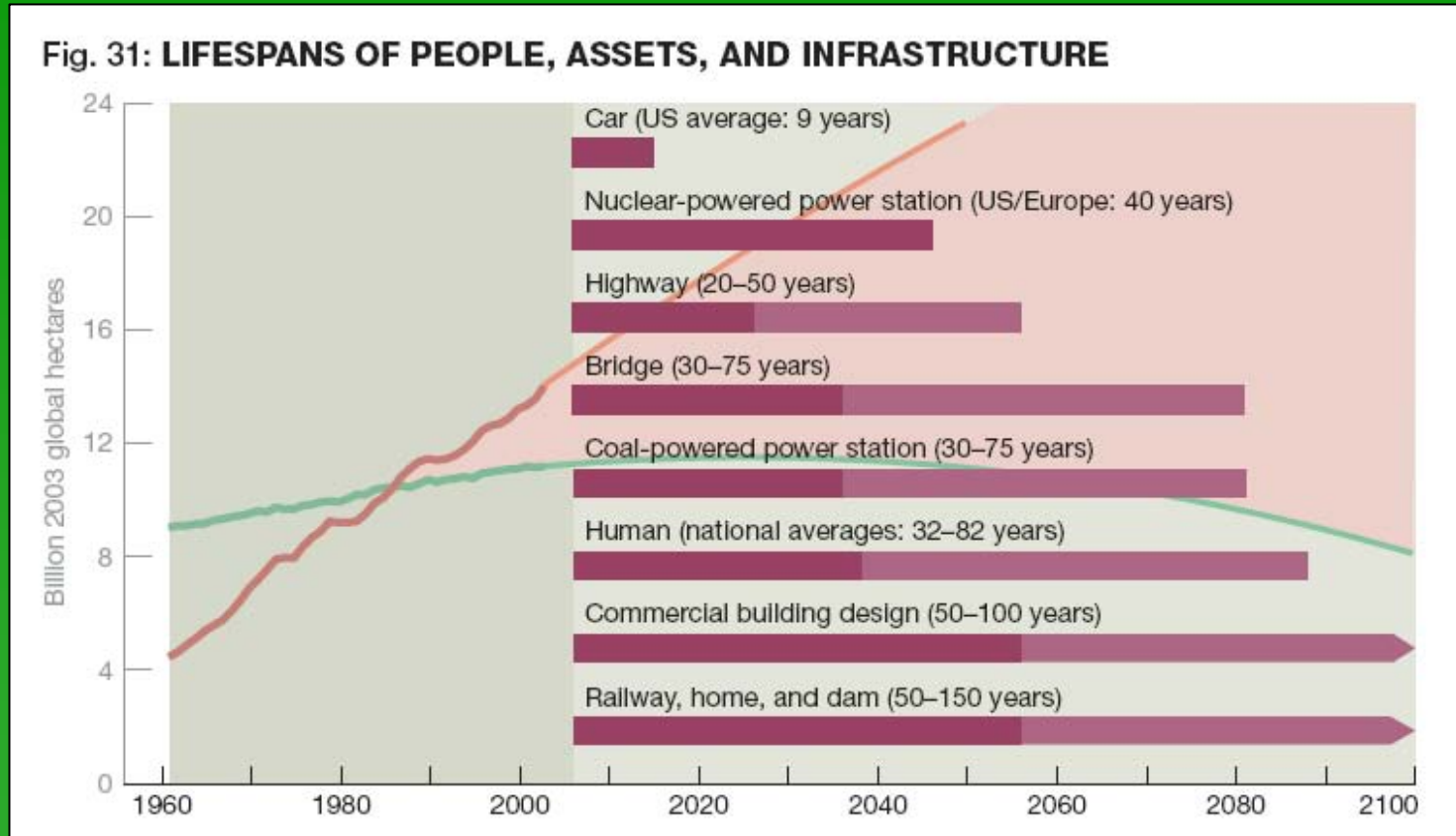
www.carbontrust.co.uk

Application: National



- **systematically account** for ecological assets and **measure progress** towards sustainability in tangible ways
- correlate economic activities and investment with environmental **risk**
- policy formulation and evaluation – best **allocation of resources, compound effects, identify opportunities**

Infrastructure Planning



address long-life infrastructure needs to avoid building **resource traps**; 'slow things first'

Complement to GDP

GFN's 'Ten In Ten Campaign'

- make Footprint as prominent a metric as the Gross Domestic Product (GDP) in 10 key nations by 2015
- institutionalising Footprint at national level requires acceptance of both methodology and data by statistical offices of national governments

Communication: Global

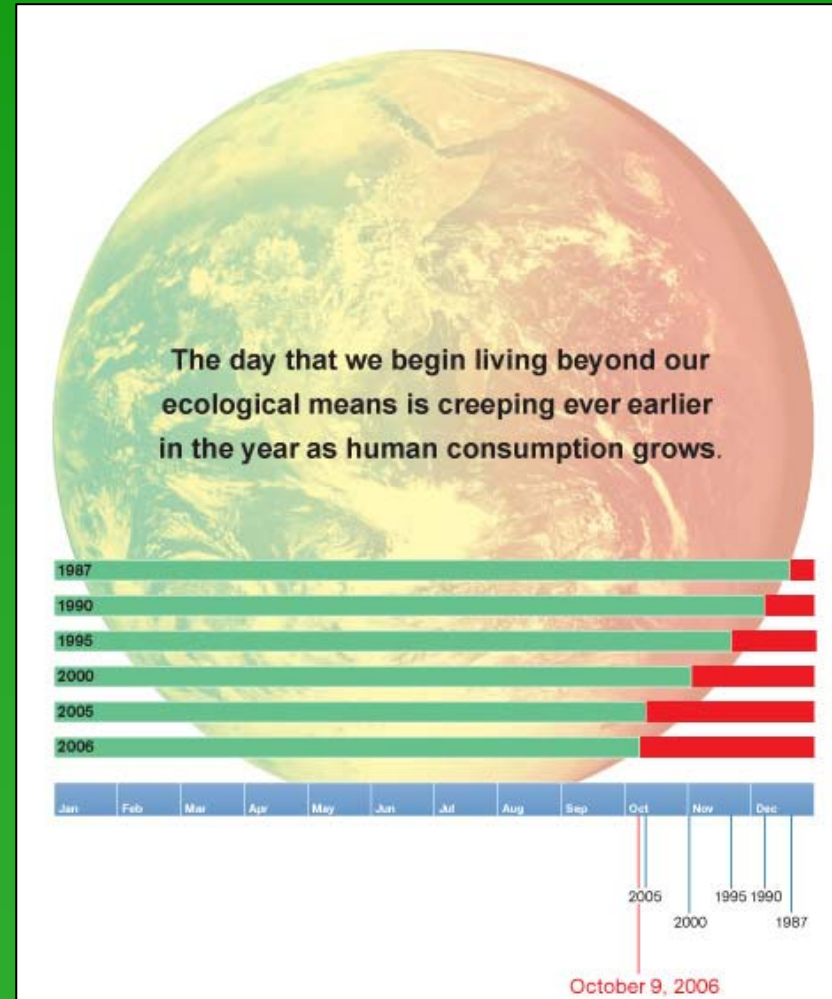
World Overshoot Day

...on **9 October 2006**,
humanity had already
consumed total amount
of resources nature
produced that year

World Overshoot Day in:

1995 - 21 November

1987 - 19 December



Communication: Individual

- calculators – personalising sustainability

ecological footprint
QUIZ

Food Footprint

1. How often do you eat animal based products? (beef, pork, chicken, fish, eggs, dairy products)

- Never (vegan)
- Infrequently (no meat, and eggs/dairy a few times a week (strict vegetarian))
- Occasionally (no meat or occasional meat, but eggs/dairy almost daily)
- Often (meat once or twice a week)
- Very often (meat daily)
- Almost always (meat and eggs/dairy in almost every meal)

2. How much of the food that you eat is processed, packaged and imported?

- Most of the food I eat is processed, packaged, and from far away
- Three quarters
- Half
- One quarter
- Very little. Most of the food I eat is unprocessed, unpackaged and locally grown.

Goods Footprint

3. Compared to people in your neighborhood, how much waste do you generate?

- Much less
- About the same
- Much more

Shelter Footprint

4. How many people live in your household?

- 1 person
- 2 people

quiz results

bookmark this page

CATEGORY	GLOBAL HECTARES
FOOD	0.6
MOBILITY	7
SHELTER	0.9
GOODS/SERVICES	6.1
TOTAL FOOTPRINT	14.6

IN COMPARISON, THE AVERAGE ECOLOGICAL FOOTPRINT IN YOUR COUNTRY IS 7.6 GLOBAL HECTARES PER PERSON.

WORLDWIDE, THERE EXIST 1.8 BIOLOGICALLY PRODUCTIVE GLOBAL HECTARES PER PERSON.

IF EVERYONE LIVED LIKE YOU, WE WOULD NEED 8.1 PLANETS.

TAKE ACTION!!

DONATE

ecological footprint
QUIZ

ECOLOGICAL FOOTPRINT CAMPAIGN

- ▶ Join the Campaign!
- ▶ Who are We?
- ▶ About the Footprint Quiz
- ▶ Support the EF Quiz

EMAIL

- ▶ Email a Friend
- ▶ Email Results to Yourself

WHAT YOU CAN DO

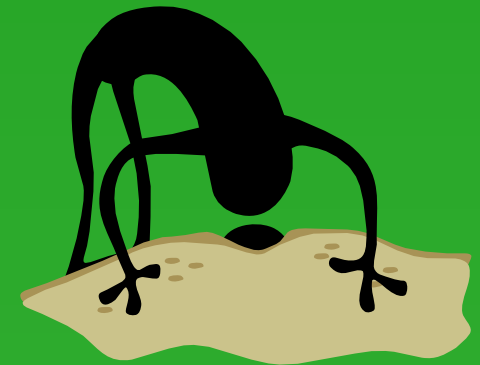
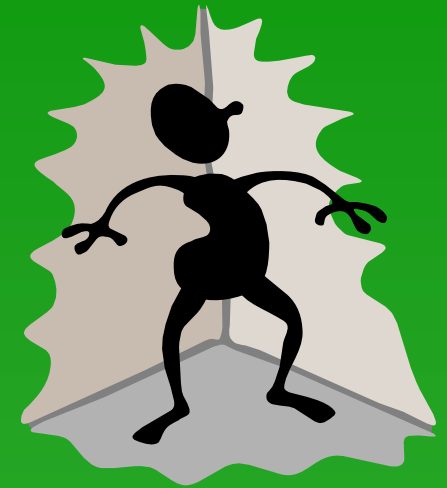
- ▶ Individuals
- ▶ Community Members and City Officials
- ▶ Businesses
- ▶ Nation
- ▶ Schools and Campuses

COMMENTS AND QUESTIONS

- ▶ Comment on the Footprint Quiz
- ▶ Frequently Asked Questions (FAQ)
- ▶ What about other Species?
- ▶ What about Population?

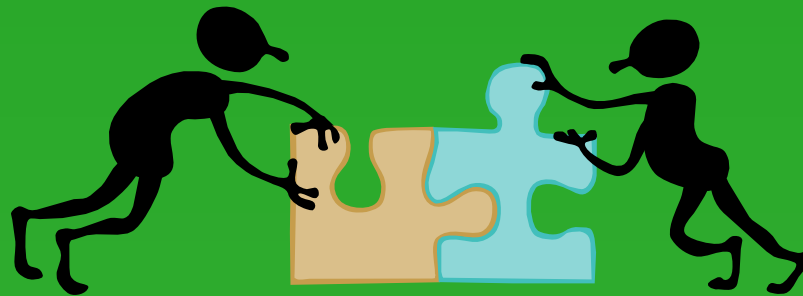
Communication Issues

- Footprint easy to interpret = double edged sword; can quickly dismiss if it doesn't fit with other deeply held beliefs
- people living in a culture where 'more' and 'faster' = better, hear 'reduce' as meaning 'less' and 'smaller' = worse



Communication Issues

- separate data from analysis - **sell the concern** instead of telling people what they should do
- fear and guilt are paralyzing; expressing concern **invites people's creativity**



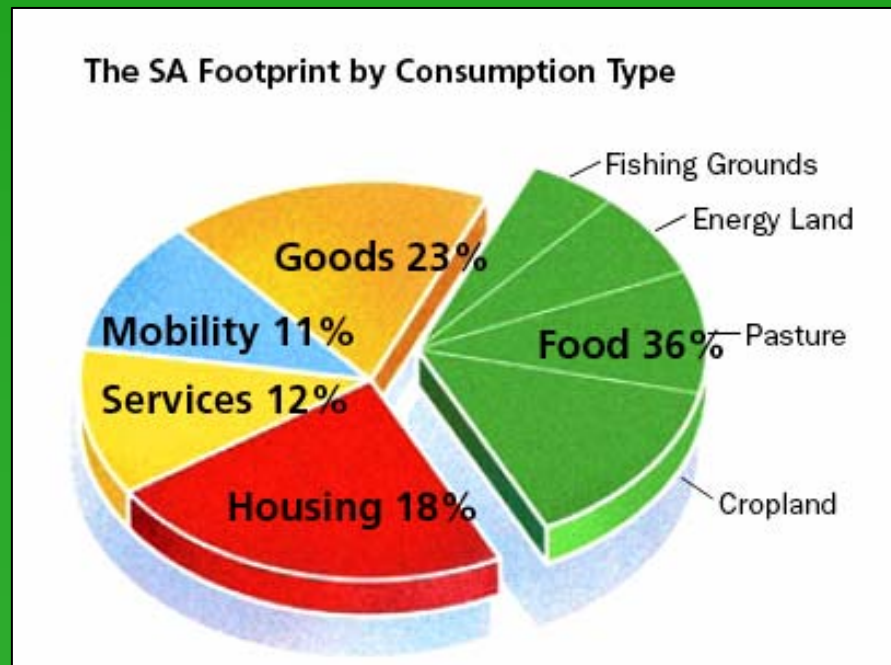
Footprint & South Australia

- GFN partner organisations include **Sustainability and Climate Change Division** of Dept Premier and Cabinet, and **Office of Zero Waste SA**
- Footprint accounts for SA developed by State government in association with **University of SA** in 2005, released in 2006

www.sustainableliving.sa.gov.au

Footprint & South Australia

Average South Australian's Footprint = **7 global hectares (gha)** per person, slightly less than the Australian average of 7.7 gha/cap



Footprint & South Australia

- South Australians use **3.9 times** what is available per person on the planet



- State Strategic Plan target of **30% reduction** in SA's Footprint by 2050

www.stateplan.sa.gov.au/plan_targets_obj3.php

Scales, Not Crystal Ball

- Footprint cannot tell us what to do, is an **indicator** of how much we 'weigh' on the planet at a certain point in time; can use to test scenarios
- role of **policy** to determine how to ensure quality of life for all within the means of nature



Footprint Information

- www.footprintnetwork.org
Global Footprint Network
- www.earthday.net/footprint/index.asp
Personal Footprint Calculator
- www.google.com
...and search on 'ecological footprint'!

if everyone lived like me...



...how many planets would we need?

