Greensettle

GREEN CITIES AND SETTLEMENTS

UNIVERSITY of OULU
OULUN YLIOPISTO

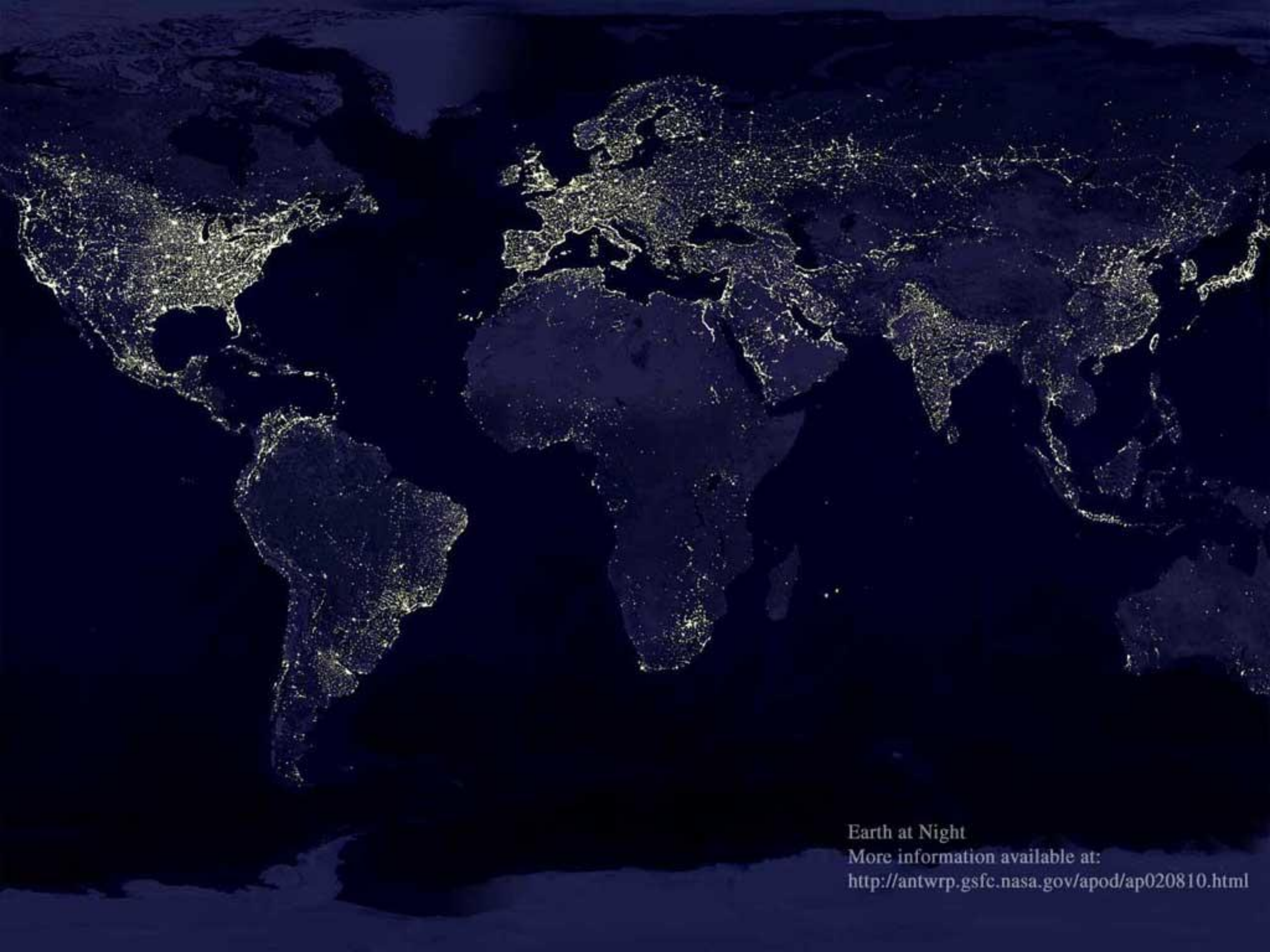
Resource efficiency in an urban context

Eva Pongrácz

University of Oulu, Thule Institute, NorTech Oulu

Welcome to the Anthropocene!

- We have entered a period that climate researchers call the Anthropocene – the geological age when humans have a significant global impact on the Earth's ecosystems
- A fundamental physical characteristic property of a planetary body is its characteristic radiation emission spectrum, determined by the planet's heat content, composition and atmospheric physics and chemistry
- The Earth's spectrum however is no longer just a matter of reflections from clouds, emitted infrared radiation and the like
- Rather it includes television and radio broadcasts and leakage from all sorts of technologies


Earth at Night
More information available at:
http://antwrp.gsfc.nasa.gov/apod/ap020810.html

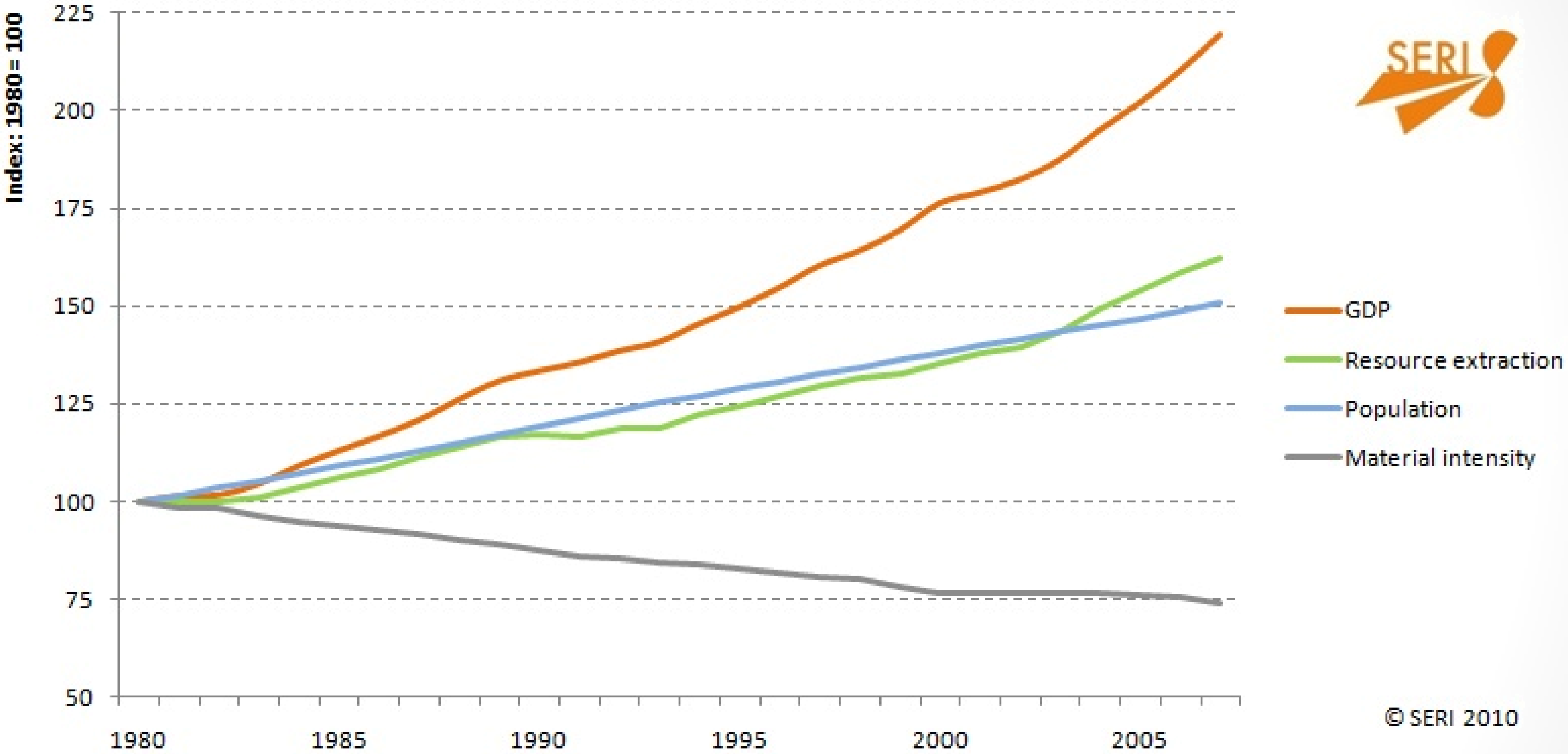
Humans – planet shapers…

- As a result of a rapid economic and technological growth, human settlements and, especially cities in the industrialized world have substantially changed their face and the way they interact with their inhabitants and the natural environment
- The challenges of urbanization, urban sprawl, non-renewable resource use are sizeable contributors to environmental degradation as well as deteriorated public health
- To this end, actions towards sustainability need to be implemented, in order to improve resource efficiency in the framework of eco-municipalities
- The pattern of raw material consumption in building the physical environment and providing materials goods and services is currently unsustainable

Resource efficiency

- Resource efficiency is the flagship initiative of EU and one of the thematic areas of UNEP
- Resource efficiency means using the Earth's limited resources in a sustainable manner.
- The key element of resource efficiency is decoupling resource use intensity from providing economic growth and human wellbeing.
- Resource decoupling as breaking the link between environmental "bads" and economic goods

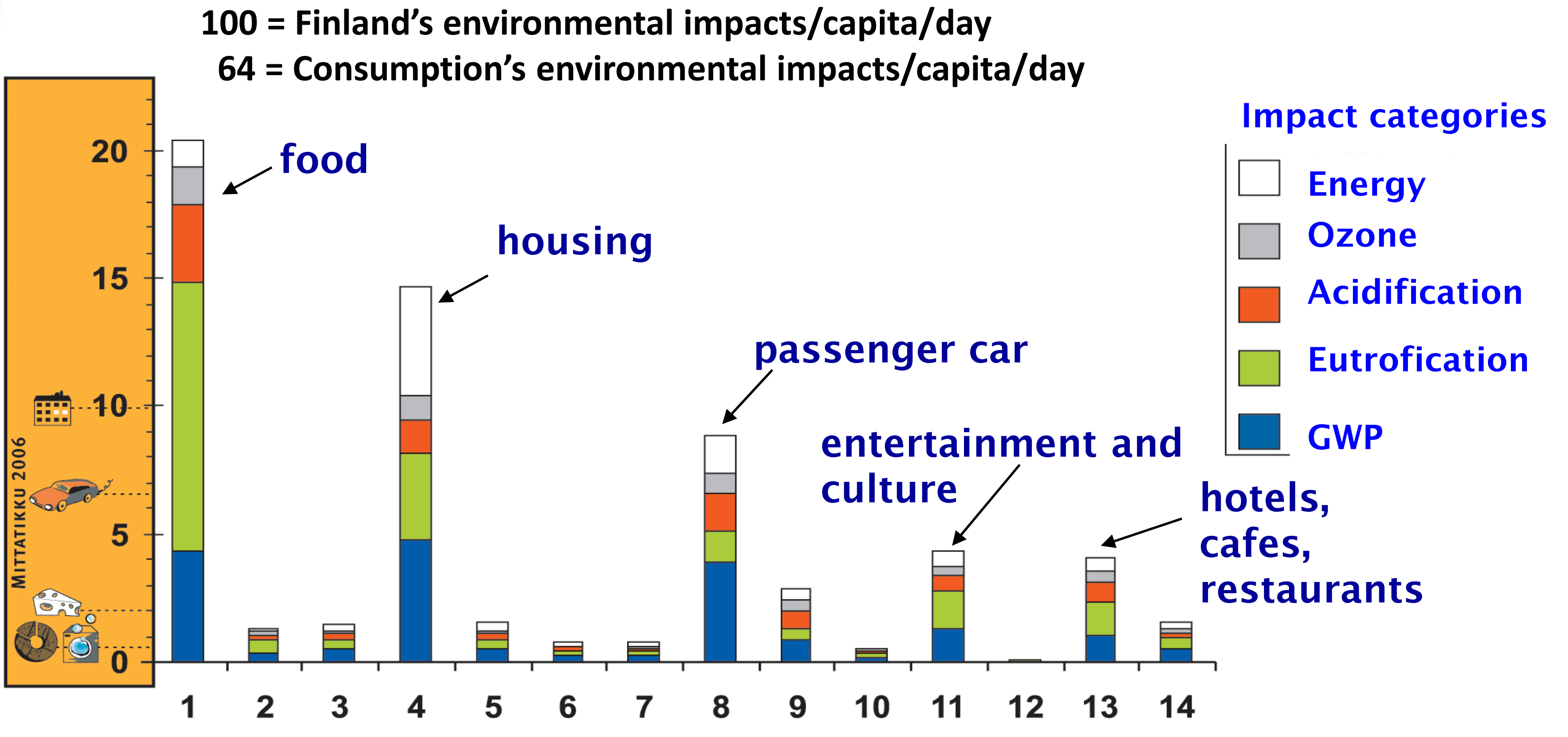
Trends in global resource extraction, GDP and material intensity



The urban context

- Cities are the places for the exchange of goods, ideas and money
- At their best, they bring the best that a community has to offer
- At their worst, cities bring lower quality of life for their occupants
- In our throughput society, cities are important nodes of material flow
- Humans spend 80-90% of their life indoors
- Energy, water and food among others are the most important resources needed in human settlements networks
- Commercial and residential buildings use 25% of total world energy consumption and generate 20% of CO_2 emissions
- At the same time, solid wastes, air pollution and wastewater are generated in abundance
- The challenge is to find a balance between resource efficiency and comfort

Environmental impact of Finnish consumption habits

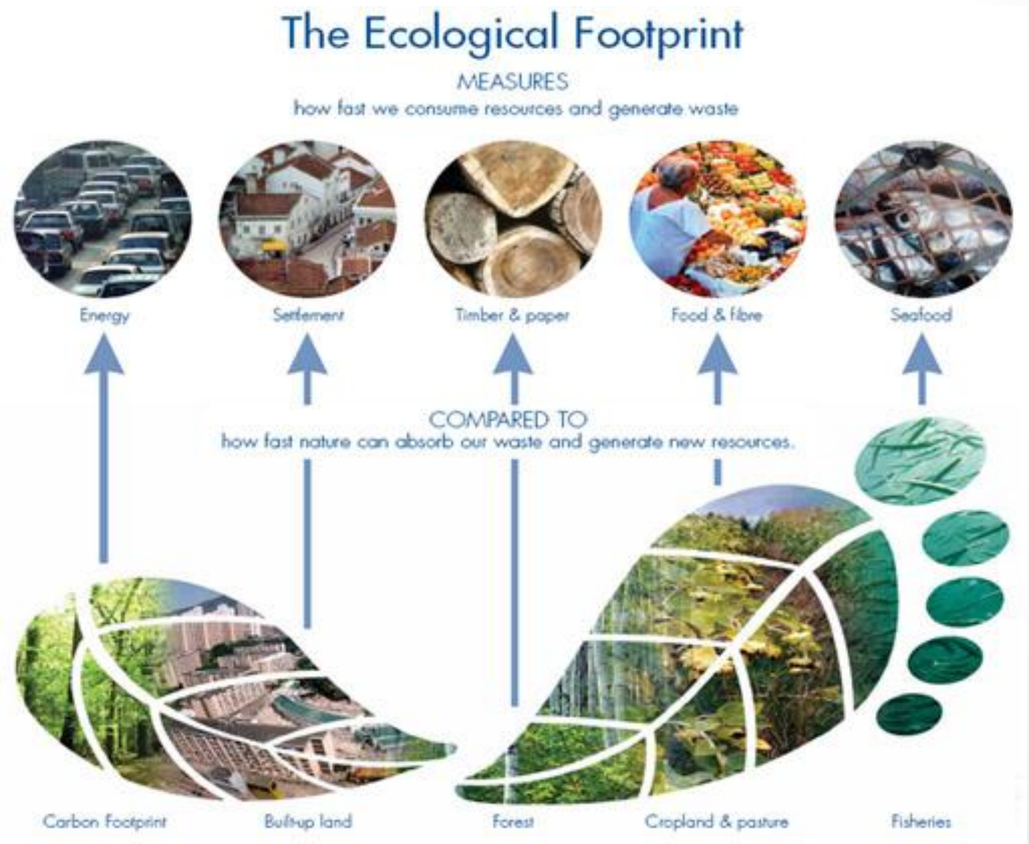


NISSINEN, A., GRÖNROOS, J., HEISKANEN, E., HONKANEN, A., KATAJAJUURI, J.-M., KURPPA, S., MÄKINEN, T., MÄENPÄÄ, I., SEPPÄLÄ, J. TIMONEN, P., USVA, K., VIRTANEN, Y. 2007. Developing benchmarks for consumer-oriented life cycle assessment-based environmental information on products, services and consumption patterns. Journal of Cleaner Production 15, 6/2007: 538-549.

Greensettle

Ecological footprint

- The amount of land needed to supply national population sustainably with resources and absorb their wastes.
- Humanity's total ecological footprint increased to 13.2 billion global hectares, growing by 147 million global hectares a year



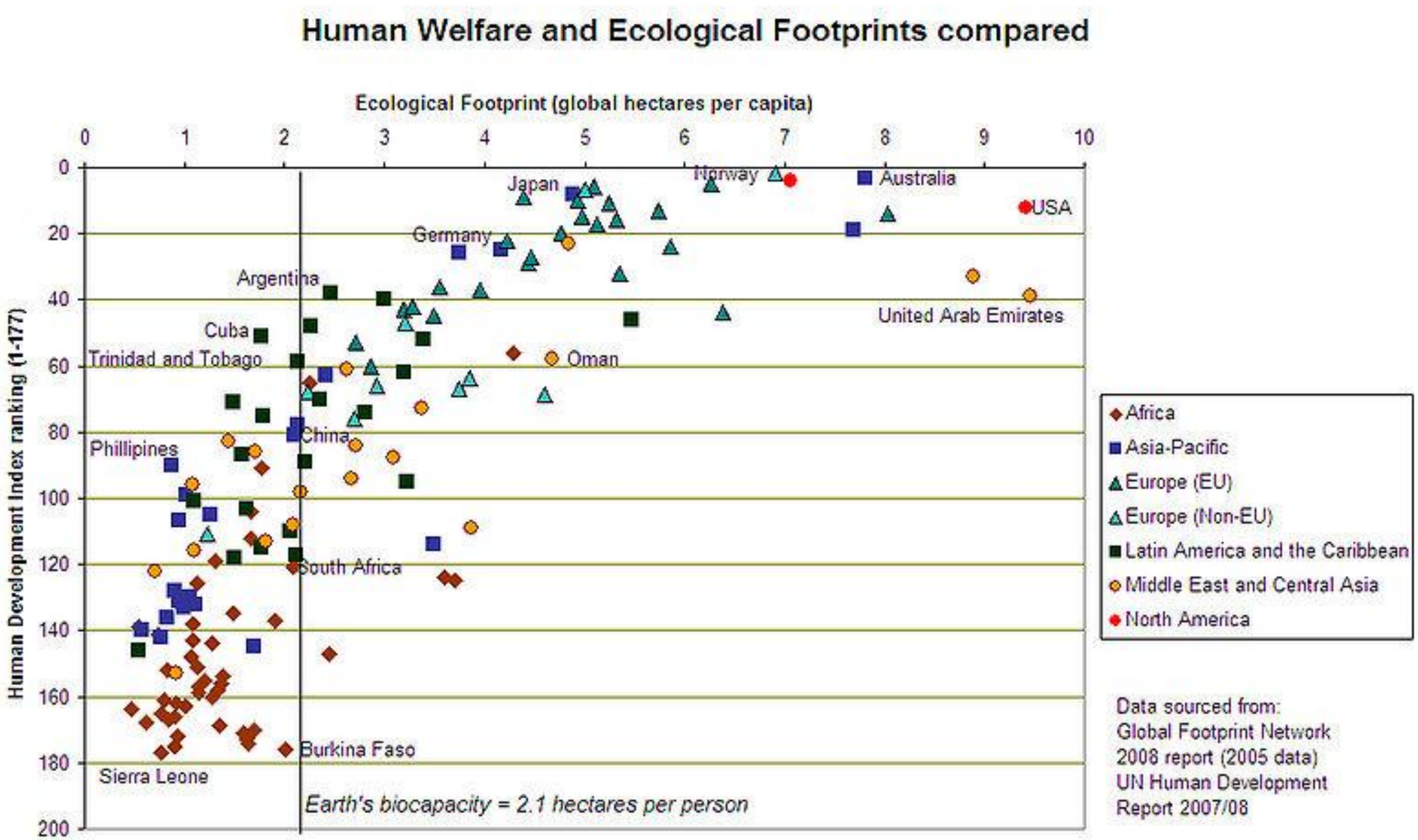
Ref.: http://www.footprintnetwork.org/

Ecological bigfoot

- The United States has the world's largest footprint at 9.57 hectares per person
- A sustainable footprint would be around 2 hectares
- Bangladesh and Mozambique: 0.53 hectares per capita
  - barely 1/20th of the US footprint.
- If the world consumed on the level of Americans, we could need 4 planets to sustain us!

… as if we had *four* planets

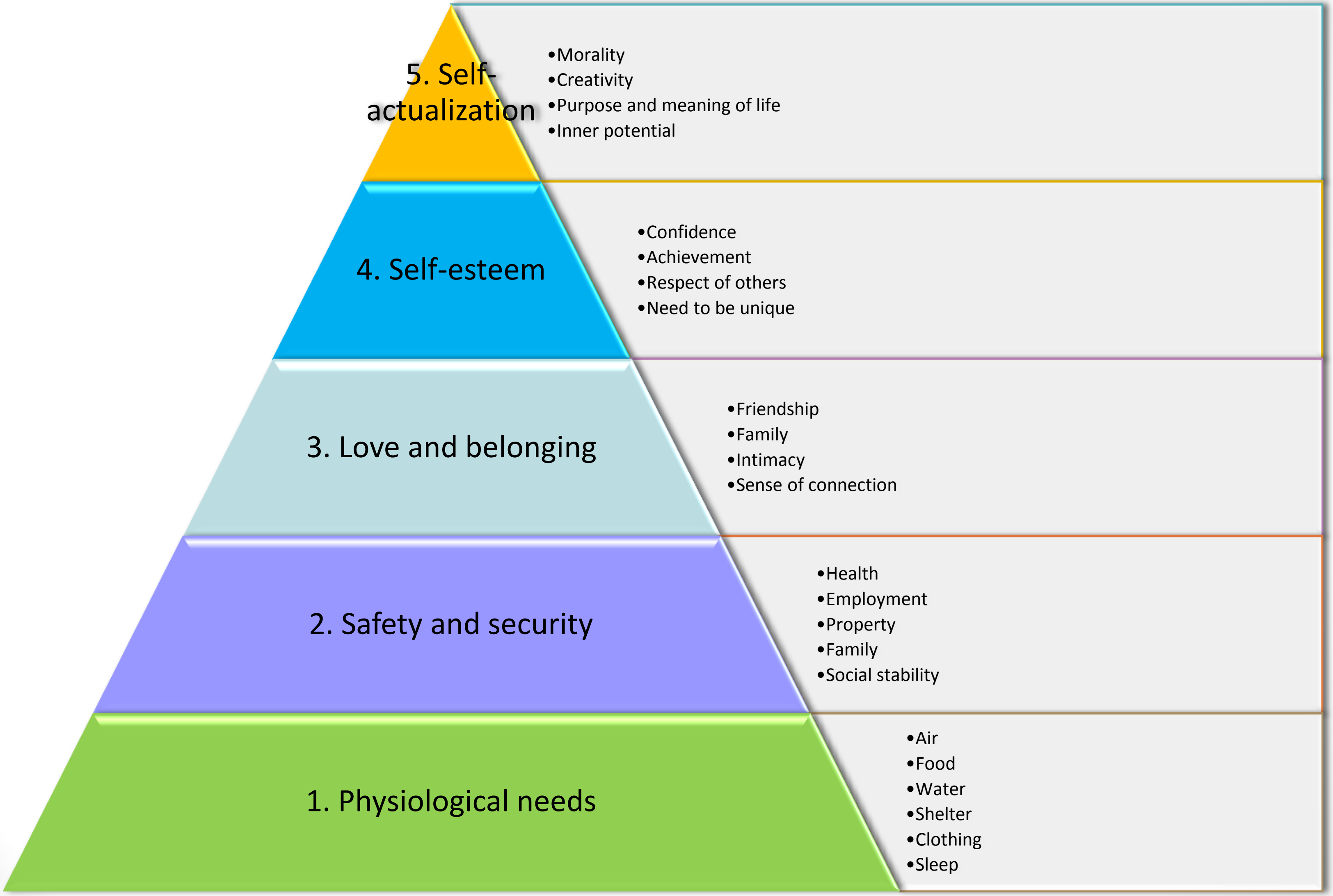
Human Development vs. Ecological Footprint



Material use intensity

- 3,200 kg of waste for every 100 kg of product
- 94 % of the materials extracted for use in manufacturing becomes waste before the product is even made.
- 80 % of what's left becomes waste within six weeks of use.
- modern industrial system is 1% efficient when all material and energy inputs are considered
- 20% of world population in industrial countries uses 80-85 % of the world's resources
- Only approximately 10% of economic activity provides us with goods and services that are necessary for biological survival.
- The rest satisfies our desire for *things* we want but do not really need.

Maslow hierarchy of needs



Greensettle

Visions of sustainable resource use

1. Resource-efficiency and recycling-based industry

2. Steady stocks society

3. Solarized technosphere

4. Balanced bio-economy

Ref.: Bringezu & Bleischwitz: Sustainable Resource Management. Greenleaf Publishing, 2009

Vision 1: Resource-efficiency and recycling-based industry (1/2)

- Recycling flows of materials on various scales will be the physical basis of a industry
- Materials, such as metals, will remain an important element of tomorrow's socio-industrial metabolism and sustainable economics
- The use of operational functions as in electronic goods will increase
- Technological change will be driven by attempts to increase resource productivity and to decrease cost for manufacturing materials
- End-user-oriented companies will provide product service systems, which will primarily focus on delivering desired functions to consumers
  - Service orientation will continuously trigger innovation

Ref.: Bringezu & Bleischwitz: Sustainable Resource Management. Greenleaf Publishing, 2009

Vision 1: Resource-efficiency and recycling-based industry (2/2)

- Cost of materials will motivate search for dematerialized solutions
  - New technologies and product design will be needed to improve the possibilities for recycling, at least for those essential elements which cannot be easily substituted
  - New services and new products to go hand-in-hand with resource efficiency technology development
- Functional diversity on the level of complex materials based on common element matrix - after use, worn-out compounds would degrade to a limited number of basic compounds
  - Organic materials will probably play a much more important role
- Mining the technosphere will be supported by infrastructure design
  - Houses, roads, sewage systems will optimize the chance of for material recycling after use
- In the human resources side, the demand for well-trained and educated craftsman, engineers and scientists will increase

Ref.: Bringezu & Bleischwitz: Sustainable Resource Management. Greenleaf Publishing, 2009

Vision 2: Steady stocks society (1/2)

- A dynamic equilibrium reached between construction and deconstruction
  - The network of buildings and infrastructures will come to completion
- Further development proceeds without physical growth
- The total amount of materials stocked in the built environment will be in steady state
  - Supplied by a sustainable material recycling and cascading system
  - Maturation of the socio-industrial metabolism will go hand-in-hand with the aging society and saturation of material wealth
  - Steady stocks will be reached first by richer countries with stable populations
  - Transition and developing countries will follow when stabilizing populations and able to provide good living, working and mobility
- Transport infrastructures will be completed at a level fulfilling mobility demands and multi-functional land-use
  - From expansion of road networks to optimization of existing infrastructures

Ref.: Bringezu & Bleischwitz: Sustainable Resource Management. Greenleaf Publishing, 2009

Vision 2: Steady stocks society (2/2)

- Central sewage systems will be increasingly substituted by decentralized systems
- Resource-light buildings will lower the addition to stock and the final stock volume
  - Private homes to be renovated to reduce energy costs for heating and cooling - insulation & solarization will be boosted
  - Dynamic equilibrium between construction and deconstruction
  - Renovation, modernization, refurbishment, exchange of constructions will be a main goal for building industry
  - This will give rise to the development of real estate resource management services
    - Planning a house will demand knowledge of technology and management options of material, energy and water issues
    - More role for consultancy for reducing costs through resource-efficiency

Ref.: Bringezu & Bleischwitz: Sustainable Resource Management. Greenleaf Publishing, 2009

Vision 3: Solarized technosphere (1/2)

- Surface of buildings and infrastructures will include the absorption and transformation of solar energy into useful power and heat, with surplus radiation reflected
  - Energy provided through roofs, facades
  - Solar energy absorption and storage infrastructure esp. in terrestrial and solar regions of high solar input
  - Phasing out fossil fuels, and drastically increase energy-efficiency – this will require material and land resources
- Key question: climate change mitigation to be combined with sustainable resource use
  - Use of renewable energy wit increased resource efficiency – e.g. to supply a future global car fleet with fuel cell technology, PGM use material efficiency will have to increase with a factor 10
- New business development in materials and energy efficiency, basic design will have to include life-cycle-wide resource use considerations

Ref.: Bringezu & Bleischwitz: Sustainable Resource Management. Greenleaf Publishing, 2009

Vision 3: Solarized technosphere (2/2)

- Technological systems will be developed with industrial photosynthesis, applying carbon capture and re-use
  - Towards a photoautotrophic system, that supplies itself with solar energy
  - Will require policy incentives and investments
  - Key technologies; gasification, pyrolysis, synthesis technologies
- A trade-off between renewable energy technologies and minerals need & resulting mining waste
  - Solution: technology integration – solar energy integrated into the "skin" of the technosphere
- Key technologies: solarized multifunction roofs, thin-layer technologies , insulation, humidity control, static functions – derivation of rainwater,
- Will need cooperation of engineers and scientist of different disciplines: material science, physics, civil engineering, microtechnologies, industrial ecology

Ref.: Bringezu & Bleischwitz: Sustainable Resource Management. Greenleaf Publishing, 2009

Vision 4: Balanced bio-economy (1/2)

- Biomass will become the major primary material resource, as a result of a relative increase in relation to mineral resource extraction
- The challenge is to improve the quality of these material flows, while halting expansion of arable land on the expense of natural ecosystems
- Physical economy to be based on biomass resources – biomaterials rather than biofuels!
- Food and non-food biomass to be used in cascades to complement material utility with energy provision
- Bionic economy – adopting biological principles in the form of carbon recycling and industrial photosynthesis
  - Non-food biomass harvest to be replaced by synthetic organic materials derived from recycled organic waste
  - Dry organic waste to be used as a feedstock of new synthetic compounds

Ref.: Bringezu & Bleischwitz: Sustainable Resource Management. Greenleaf Publishing, 2009

Vision 4: Balanced bio-economy (2/2)

- The use of GMOs is an open field, safer the use in white biotechnology, in green biotech the use is risky
- Crucial factors:
  - Maintaining groundwater quality - reduce nitrite load, avoid eutrophication of aquatic ecosystems
  - Resulting food price increase and its impact on the world's poor
- Factors limiting biomass production productivity
  - Overuse of fertilisers, there will always be losses
  - Open field conditions subject to droughts vs. rainfalls
- Key technologies:
  - Cascading use of carbon and other nutrients
  - Improving the technical and economical feasibility of industrial photosynthesis – recycling and re-use of carbon from end-of-life products
  - Carbon capture from exhaust for material feedstock supply

Ref.: Bringezu & Bleischwitz: Sustainable Resource Management. Greenleaf Publishing, 2009

Key elements of resource efficiency in urban systems

- Delivering desired functions to consumers
- Service orientation triggering innovation
- Mining the technosphere
- Development without physical growth
- Sustainable material recycling and cascading use of biomass
- Decentralized systems
- Solar energy absorption and storage infrastructure
- Improve the quality of biomaterial flows
- **Environmentally aware, ethical citizens!**

Summary:
How can technology contribute to urban resource efficiency?

- Better technology
  - In energy generation and use
  - In recycling technologies
  - In water treatment
- Quality instead of quantity
  - Cradle-to-cradle
  - Cascade systems
  - Well-being, not business as usual
- Changes needed:
  - Structure of societies
  - Attitude of people…

Centre for Economic Development, Transport and the Environment

THULE INSTITUTE

Kainuu

Thank you!

KAEEC Karelia Energy Efficiency Centre

This project is co-funded by the European Union, the Russian Federation and the Republic of Finland

Greensettle