URBAN AND RURAL LIVING IN THE CONTEXT OF THE SUSTAINABILITY CHALLENGE

Geoffrey P. Hammond

Professor of Mechanical Engineering and Founder Director of I•SEE,
University of Bath, Bath. BA2 7AY. UK
[Email: ensgph@bath.ac.uk]
Sustainable Development versus Sustainability
Sustainability Appraisal Methods – The Three Pillars
Cities and Sustainability
Environmental Footprinting - The Basics
The Environmental Footprint of Bath
⇒ Sustainable Cities?
Rural versus Urban Development - Swindon and Wiltshire
Concluding Remarks
⇒ Cities and Sustainability
⇒ Thinking Globally, Acting Locally
⇒ The Wider Horizon
In contemporary society, cities house some 50% of humanity across the globe; out of a total population of a little over 6 billion (bn) in 2000. This represents an almost ‘exponential’ growth in the 20th Century, which opened with only 15% of humans living in urban areas and a total population of about 1.65 bn.

There are now 35 cities across the world with over 5 million people, and literally hundreds having more than one million. This contrasts with 1800 AD when only London and Peking (renamed Beijing) had urban populations of one million.

- All cities provide access to community amenities and cultural events, but bring with them a range of social and environmental problems.
- The disadvantaged and minority groups tend to be concentrated in deprived inner city areas.
- Modern transportation systems, dependent as they are on internal combustion engines, result in pollutant emissions and poor air quality, as well as the inevitable traffic congestion that bedevil major cities.
Balancing economic and social development with environmental protection

→ “people, planet, prosperity”

Meeting the needs of the present without compromising the ability of future generations to meet their own needs
[Brundtland Report (1987)]

Sustainable Development versus ‘Sustainability’

Process or journey

destination

After Jonathan Porritt (2000)
THE SUSTAINABILITY VENN DIAGRAM

Ecology and thermodynamics

Society

Economics and technology

Area of sustainability
UK SUSTAINABLE DEVELOPMENT PRINCIPLES

- Achieving a sustainable economy
- Ensuring a strong, healthy and just society
- Living within environmental limits
  ⇒ the ‘Three Pillars’ of Sustainable Development
- Promoting good governance
- Using sound science responsibly

SUSTAINABILITY APPRAISAL METHODS

● THE ENVIRONMENTAL PILLAR
  ▪ Quantitative - Energy and environmental performance evaluation; typically on a life-cycle or ‘full fuel cycle’ basis. Typical uncertainty ± 20%.

● THE ECONOMIC PILLAR
  ▪ Quantitative - Environmental cost-benefit analysis [but with a large uncertainty band (orders of magnitude), depending on the monetary valuation technique adopted]; investment appraisal.

● THE SOCIAL PILLAR
  ▪ Qualitative – Analytic and deliberative processes (e.g., stakeholder engagement); mapping the socio-technical system; customer surveys [response to new technologies (such as smart meters) and business models]; ethical reflection on energy system impacts and futures.

TU/e
A NEW ERA IN LOCAL GOVERNMENT IN THE UK

- SUSTAINABLE COMMUNITY STRATEGIES
  - Shift in emphasis: “a revolution in local government”
  - Local Area Agreements (LAAs) as the delivery mechanism: targets with money attached
  - Principles/examples of good practice established by Government Departments

- EVIDENCE-BASED APPROACHES

- THE NEED FOR ‘SUSTAINABILITY PROOFING’ OF POLICIES AND PRACTICES
  - Checklist approach
  - ‘Ecological’ or environmental footprinting
  - Sustainability maps or ‘tortilla’ diagrams
  - Sustainability appraisal framework (Forum for the Future/Swindon Borough Council)
ENVIRONMENTAL FOOTPRINTING: THE BASICS - 1

- Footprint Units: GLOBAL HECTARES (gha)
  - Common unit used to standardize footprints worldwide

- Equivalence Factors
  - Convert land types into global hectares, so that they account for differences in ‘bioproducivities’

- Biocapacity
  - Available bioproductive land
  - Measured again in global hectares

- Functional Unit: the individual (i.e., Per Capita)
THE ENVIRONMENTAL FOOTPRINT, AND ITS LAND TYPES

The method of calculating the ecological or environmental footprints -

- Estimate resources used and wastes produced within the defined boundary (here various communities and their local government areas)
- Snapshot approach – one year, one footprint
- Consumption converted into equivalent land area
  \[ \text{Area} = \frac{\text{Resource Consumption (unit)}}{\text{Average Yield (unit/ha)}} \]
- Land areas into global hectares (gha)
  \[ \text{Footprint} = \text{Area} \times \text{Equivalence Factor} \]
- Sum components and normalise (per capita)
THE COMPONENT-BASED APPROACH TO ENVIRONMENTAL FOOTPRINT ANALYSIS

Source: Eaton et al. (Landscape and Urban Planning, 2007).
The Latin root of the word ‘civilization’ is *cives* – citizen – and so cities are clearly at the heart of human development.

It is currently fashionable to find material in the literature on ‘sustainable cities’. However, this notion harks back to the 1970s’ idea of autonomy or self-sufficiency in the built environment, when it became popular to strive for “autarkic” buildings or settlements.

Nevertheless, clusters of buildings and an integrated human-scale transport infrastructure can enhance energy conservation and reduce environmental impact. Even what have often been termed ‘compact cities’ are not in themselves sustainable.

They survive only because they are inextricably linked by human, material and communications networks to their hinterlands or ‘bioregions’. This outlying support structure extends from the regional to national and even global scale.
THE ‘AUTARKIC HOUSE’
– CAMBRIDGE, circa 1975

Source: bdonline.co.uk
‘HUMANOPOLIS’ – SUSTAINABLE HUMANS = SUSTAINABLE CITIES

Source: http://www.goldmercury.org/media-room/2014/03/gold-mercury-future-vision-projects-q2-2014/
THE (JUST) UNITED KINGDOM
THE UNESCO WORLD HERITAGE CITY OF BATH, circa 1825

Source: Doughty & Hammond (Buildings and Environment, 2004).
PRESENT DAY BATH – AN AERIAL VIEW OF PART OF THE CITY

Source: erinflewwthecoop.wordpress.com
THE ‘LINEAR’ MATERIAL FLOW THROUGH CITIES

(a) 'Linear metabolism' cities (consume and pollute at a high rate)

Source: Doughty & Hammond (Buildings and Environment, 2004).
Consumption patterns in most western lifestyles, such as those in Europe and North America, result in footprints which are far greater than the amount of geographically available land.

- **Overshoot factors for cities** –
  - 20 for Bath, 125 for London, 16 for Santiago de Chile, 200 for Vancouver

- ‘**Sustainable cities**’? Cities only survive because of human, material, and communications networks with their hinterlands or bioregions.

*Sources: Doughty & Hammond (Buildings and Environment, 2004), Wackernagel & Rees (1996)*
THE ENVIRONMENTAL FOOTPRINT OF BATH

Source: Doughty & Hammond (Buildings and Environment, 2004).

TU/e
AN EXAMPLE OF URBAN AND RURAL LIVING

- Wiltshire – mainly rural
  - County area of Wiltshire
  - Including the four districts of Salisbury, Kennet, North and West Wiltshire

- Swindon – mainly urban
  - The unitary authority of the Borough of Swindon

Source: Eaton et al. (Landscape and Urban Planning, 2007).
URBAN SWINDON AND RURAL WILTSHIRE
**ENVIRONMENTAL FOOTPRINT BALANCES BY LAND TYPE**

- **Wiltshire Footprint**
  - Crop: 11%
  - Pasture: 4%
  - Forest: 9%
  - Energy: 7%
  - Built Land: 7%
  - Bioproductive Sea: 7%
  - Total: 62%

- **Swindon Footprint**
  - Crop: 7%
  - Pasture: 4%
  - Forest: 10%
  - Energy: 7%
  - Built Land: 7%
  - Bioproductive Sea: 7%
  - Total: 65%
FOOTPRINT ANALYSIS OF SWINDON AND WILTSHIRE

- Wiltshire – mainly rural
  - 2,594,000 global hectares.
  - 5.94 global hectares per Wiltshire resident.
  - This amounts to an overshoot ration of 2.01:1
  - If the world’s population reflected this consumption, then we would need the equivalent biocapacity of 2.3 extra Earths:

- Swindon – mainly urban
  - 1,024,000 global hectares.
  - 5.65 global hectares per Swindon resident.
  - This amounts to an overshoot ration of 10.35:1
  - If the world’s population reflected this consumption, then we would need the equivalent biocapacity of 2.0 extra Earths:
FOOTPRINT-BIOCAPACITY COMPARISON: URBAN SWINDON

Crop
Pasture
Energy
Built Land
Sea
Total Area

Land Type

Footprint Biocapacity

Area (ha/cap)

0 1 2 3 4 5 6

Crop Pasture Energy Built Land Sea Total Area

Swindon Footprint
FOOTPRINT-BIOCAPACITY COMPARISON: RURAL WILTSHIRE

![Footprint-Biocapacity comparison graph for Rural Wiltshire](image-url)

- **Crop** Footprint: 0.5 gha/cap
- **Pasture** Footprint: 0.3 gha/cap
- **Energy** Footprint: 3.0 gha/cap
- **Built Land** Footprint: 1.0 gha/cap
- **Sea** Footprint: 0.1 gha/cap
- **Total Area** Footprint: 6.0 gha/cap

**Biocapacity Comparison for Rural Wiltshire:**

- **Crop** Biocapacity: 1.5 gha/cap
- **Pasture** Biocapacity: 1.3 gha/cap
- **Energy** Biocapacity: 2.5 gha/cap
- **Built Land** Biocapacity: 1.5 gha/cap
- **Sea** Biocapacity: 0.1 gha/cap
- **Total Area** Biocapacity: 5.0 gha/cap

**Wiltshire Footprint**
- Encourage sustainable lifestyles
- Use less energy
- Use renewable energy to provide energy services
- Supply energy efficiently e.g., use combined heat and power (CHP) and community heating
- Offset residual carbon dioxide emissions that cannot be avoided by other means

Source: ESD, Corsham
Towards a ‘Circular Economy’ for Cities

(b) 'Circular metabolism' cities (minimise new inputs and maximise recycling)

Source: Doughty & Hammond (Buildings and Environment, 2004).
THE ROLE OF FOOTPRINT ANALYSIS

- **Planning**
  - Model alternative scenarios – but a simple measure are rarely adequate tools for predicting the future, particularly the consequences of technological innovation.
  - Prioritise actions to address adverse impacts.

- **Monitoring**
  - Determine trends in resource use and ecological impacts over time.
  - Evaluate local strategies to combat climate change.

- **Education and Awareness Raising**
  - Simple to understand. They show how much natural capital we use in relation to how much we have.
  - Promote behavioural changes.

- **Conflicts with Market Mechanisms**
  - Some economists argue that over time prices correct for resource depletion and externalities.
  - Others argue that the footprint concept mitigates against free trade.
CONCLUDING REMARKS 1: CITIES AND SUSTAINABILITY

- Notwithstanding the above critique of the idea of ‘sustainable cities’, urban design of compact and convivial cities can obviously contribute to a more sustainable way of life, particularly in industrialised societies.

- This can be done by encouraging the development over time of integrated mixed-use urban communities in much the same way that has been advocated by a diverse range of architectural critics and urban planners. Such cohesive and convivial human settlements could provide diverse, yet socially balanced, communities in an attractive setting.

- This requires a conscious effort to reverse the trends in urban planning evident during most of the 20th Century.

- Sustainability assessment techniques need to be employed across the urban-rural interface in an extended process. Environmental footprint analysis could form an important part of that assessment as an integral part of 'systems thinking' more generally.

- A key element in this type of development is to focus on greatly improving the efficiency of resource use within cities, and thereby reducing their environmental footprint.
CONCLUDING REMARKS 2: BIOREGIONAL THINKING

- Consumption and pollutant emission patterns in both rural and urban communities are shown to be unsustainable, and well above the ‘Earthshare’ of 1.80 global hectares.

- The overshoot ratios for Swindon and Wiltshire were found to be 10.35:1 and only 2.01:1 respectively. This suggests that the largely rural community of Wiltshire has the greater potential to live within its own biocapacity.

- The environmental burdens caused by urban and rural living in developed countries feedback onto each other:–
  - Cities and towns require resources from beyond their geographic boundaries.
  - But rural communities also take advantage of the modern infrastructure and services typically provided in an urban setting. These include economic, educational and employment opportunities, as well as health care, and leisure facilities typically provided in an urban setting.
Footprint Analysis

- Shows that there is growing pressure on global ecosystems due to humanity activities
- This is leading to the destruction of natural capital rather than to global sustainability
- It also results in global inequity in resource consumption
- Footprint analysis highlights the challenge of achieving ‘One Planet Living’

We must think globally, but act locally - both to reduce our individual footprints and as an example to others
Sustainable development must be viewed in a global context.

The task facing the nearly 80% of the world population that live in developing countries is daunting, but environmental problems will feed back to industrial countries.

Environmental sustainability would be aided by the transfer of best practice, or "leapfrog", low carbon technologies from the richer to poorer regions.
The work presented here has been supported by the UK Research Councils’ Energy Programme (RCEP):

- the ‘Realising Transition Pathways’ (RTP) Consortium [under Grant EP/K005316/1];
- the UK Energy Research Centre Phase II [under Grant NE/G007748/1];
- the ‘UK INDEMAND’ End-Use Energy Demand Centre [under Grant EP/K011774/1];
- and their predecessor grants.

THANK YOU
“DON’T TAKE ANYTHING BUT PHOTOGRAPHS, DON’T LEAVE ANYTHING BUT FOOTPRINTS”

Signpost seen by the speaker, Sinharaja Rainforest Reserve, Sri Lanka (June 2001)