The Biospheric Project - Manchester International Festival 2013


Document Version:
Early version, also known as pre-print

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Food and the city

[the best way to predict the future is to design it!]

richard buckminster fuller

Prof Greg Keeffe
Director of Research [Architecture]
Queens University Belfast

Design team leader –[aquaponic systems] at the biospheric project.

g.keeffe@qub.ac.uk
How sustainable are we……?

Professor Greg Keeffe
ants

- More biomass than people
- Handle their waste and others
- Grow and harvest food
- Construct houses, farms, dumps cemeteries etc from recyclable materials
- Create disinfectants and medicines that are healthy, safe and biodegradable
London needs around 120 Londons to feed it.

The ecological footprint of Londoners is 293 times the size of London. The area of London and the UK are superimposed for a clearer comparison.
Ecological big hitters
In London

<table>
<thead>
<tr>
<th>Activity</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat eating</td>
<td>5800</td>
</tr>
<tr>
<td>Pet food</td>
<td>3100</td>
</tr>
<tr>
<td>Milk drinking</td>
<td>2500</td>
</tr>
<tr>
<td>Cars</td>
<td>2100</td>
</tr>
</tbody>
</table>

In ‘000’s of gha
Source City Limits
2005.
www.citylimits.org

Professor Greg Keeffe
Ration book city

<table>
<thead>
<tr>
<th>Item</th>
<th>Pounds</th>
<th>CO2/Lb</th>
<th>TOTAL CO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEEF</td>
<td>15</td>
<td>33 lb</td>
<td>33 lb</td>
</tr>
<tr>
<td>LAMB</td>
<td>16</td>
<td>32 lb</td>
<td>32 lb</td>
</tr>
<tr>
<td>PORK</td>
<td>9</td>
<td>9 lb</td>
<td>9 lb</td>
</tr>
<tr>
<td>CHICKEN</td>
<td>4.5</td>
<td>8 lb</td>
<td>8 lb</td>
</tr>
<tr>
<td>TUNA</td>
<td>3.8</td>
<td>8 lb</td>
<td>8 lb</td>
</tr>
<tr>
<td>SALMON</td>
<td>0.06</td>
<td>0 lb</td>
<td>0 lb</td>
</tr>
<tr>
<td>TOMATOES</td>
<td>0.6</td>
<td>0.06 lb</td>
<td>0.06 lb</td>
</tr>
<tr>
<td>POTATOES</td>
<td>0.4</td>
<td>0.24 lb</td>
<td>0.24 lb</td>
</tr>
<tr>
<td>MILK</td>
<td>4</td>
<td>0.8 lb</td>
<td>0.8 lb</td>
</tr>
<tr>
<td>BREAD</td>
<td>1.3</td>
<td>1.3 lb</td>
<td>1.3 lb</td>
</tr>
<tr>
<td>PASTA</td>
<td>1.2</td>
<td>2.4 lb</td>
<td>2.4 lb</td>
</tr>
<tr>
<td>APPLES</td>
<td>0.5</td>
<td>0.5 lb</td>
<td>0.5 lb</td>
</tr>
<tr>
<td>PEARS</td>
<td>0.5</td>
<td>1 lb</td>
<td>1 lb</td>
</tr>
<tr>
<td>CHEESE</td>
<td>6</td>
<td>6 lb</td>
<td>6 lb</td>
</tr>
<tr>
<td>TOTAL CO2 OF ORDER</td>
<td>103.2 lb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEEKLY CO2 RATION</td>
<td>43.1 lb</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The above table shows the dramatic differences between the amount of CO2 required to produce lamb compared to chicken for example. The average person has a food carbon footprint of around fifty four pounds of CO2 per week by cutting this to forty pounds a twenty percent reduction could be achieved. This could easily be achieved by choosing foods with lower CO2 levels and would not require people to reduce food intake.
McDONALDS UK: Food Miles

Professor Greg Keeffe

‘just how big is a shop?’
McDONALDS: The ‘Size’ of each restaurant

<table>
<thead>
<tr>
<th>Food Type</th>
<th>Conditions</th>
<th>No. of UK McDonalds Restaurants 1225</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No. of Kg per day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No. Kg required per restaurant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yield tonnes per acre</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Feed tonnes per year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Space required per animal (m²)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Space required for food (m²)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Space required (m²)</td>
</tr>
<tr>
<td>Beef</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Freedom Foods</td>
<td>33.000</td>
</tr>
<tr>
<td></td>
<td>Free Range</td>
<td>14.600</td>
</tr>
<tr>
<td></td>
<td>Organic</td>
<td>14.600</td>
</tr>
<tr>
<td>Eggs</td>
<td>Freedom Foods</td>
<td>81.000</td>
</tr>
<tr>
<td></td>
<td>Free Range</td>
<td>81.000</td>
</tr>
<tr>
<td>Pork</td>
<td>50% organic diet</td>
<td>4.600</td>
</tr>
<tr>
<td></td>
<td>100% Organic</td>
<td>4.600</td>
</tr>
<tr>
<td>Fish</td>
<td>Alaskan Pollock</td>
<td>Unknown</td>
</tr>
<tr>
<td></td>
<td>Hokis</td>
<td>Unknown</td>
</tr>
<tr>
<td>Fish Substitute</td>
<td>Trout</td>
<td>10 Kg</td>
</tr>
<tr>
<td>Wheat</td>
<td></td>
<td>13.700</td>
</tr>
<tr>
<td>Potatoes</td>
<td></td>
<td>176.000</td>
</tr>
<tr>
<td>Lettuce</td>
<td></td>
<td>18.000.000</td>
</tr>
<tr>
<td>Grünkern</td>
<td></td>
<td>15.6 Kg</td>
</tr>
<tr>
<td>Tomatoes</td>
<td></td>
<td>15 Kg</td>
</tr>
<tr>
<td>Onions</td>
<td></td>
<td>34 Kg</td>
</tr>
<tr>
<td>Carrots</td>
<td></td>
<td>180</td>
</tr>
<tr>
<td>Oil (Rapeseed)</td>
<td>4,000 metric</td>
<td>4.0 Kg</td>
</tr>
<tr>
<td>Cheese Slices</td>
<td>614,000,000</td>
<td>1373</td>
</tr>
<tr>
<td>Abattoirs</td>
<td></td>
<td>3,000</td>
</tr>
</tbody>
</table>

**McDONALDS FOOD CONSUMPTION:**

There are approximately 1225 McDonalds Restaurants up and down the UK. Each one has food deliveries 3-5 times a week. Nationwide McDonalds serve almost 2,000,000 people daily. Each person orders their food but is blissfully unaware of the amount of energy and resources that have gone into providing them with their meal. The last column in the table opposite shows how much space goes into providing food for 1 restaurant for a year. The figures for fish could not be calculated as they would require a small portion of the ocean.

The average size of a McDonalds in the UK is approximately 381m², however each restaurant actual size is almost 4 million m². Nationwide McDonalds uses 913 tonnes of food each day, which is approximately 743 Kg of food per restaurant per day.

On a global scale, McDonalds uses 23,033 tonnes of food per day, which equals 8,407,046 tonnes annually.

**THE SPACE REQUIRED:**

The boxes below represent the spaces required for each different food source.

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Professor Greg Keeffe
SELF SUFFICIENT McDonalds: Zero Food Miles

VERTICAL McDonalds:
The average size of a UK McDonalds Restaurant is 381m². Using this as a basic footprint guide, the diagram below indicates what a self sufficient McDonalds would look like.

**CHICKEN:**
To house all the broilers for chicken meat would require 376 levels at approximately 1.127 KM high.

**PORK:**
To house all the pigs would require 2483 levels at a total of 7.448 KM.

**BEEF:**
It would require approximately 6979 levels just for cows alone. This would account for 20.94 KM of the overall structure.

**A PASSENGER JET:**
To give an example of how high the structure is, a standard passenger plane flies at around 10.5 KM.

30.39KM HIGH!

ISLINGTON McDonalds:
The site in Islington is approximately 89,000m². If we use that as the footprint for our self sustained McDonalds restaurant we get different results.
The new building would be 43 stories tall, reaching 129 m high. The new ‘Mega-McDonalds’ would dominate the cityscape of Liverpool.

**CHICKEN:**
To house all the broilers for chicken meat would require 1.6 floors at approximately 4.8m high.

**PORK:**
To house all the pigs would require 10.6 floors at a total of 31.8m tall.

**BEEF:**
It would require approximately 29.9 floors just for cows alone. This would account for 89.7m of the overall height of the structure.

LIVERPOOL METROPOLITAN CATHEDRAL:
Possibly one of Liverpool’s most famous historic landmarks. Standing at approximately 85m tall, this building would be swamped by the new ‘Mega-restaurant’.

Professor Greg Keeffe
MacDonald’s drive thru true size - with goat meat saves 215 hectares

Professor Greg Keeffe
SELF SUFFICIENT McDonalds: Vegetarian

VERTICAL McDonalds:
The average size of a UK McDonalds Restaurant is 351m². Using this as a basic footprint guide, the diagram below indicates what a self-sufficient McDonalds would look like.

ISLINGTON McDonalds:
The site in Islington is approximately 89,000m². If we use that as the footprint for our self-sustained McDonalds restaurant, we get different results. The new building would be just 2 stories tall, reaching 6 m high. The new 'Mega-McDonalds' would fit nicely into the cityscape of Liverpool.

LIVERPOOL METROPOLITAN CATHEDRAL:
Possibly one of Liverpool's most famous historic landmarks. Standing at approximately 85m tall, this building would be swamped by the new 'Mega-restaurant'.

A PASSENGER JET:
To give an example of how high the structure is, a standard passenger plane flies at around 10.5 KM

VEGGIE:
The overall structure would be easier to manage. Natural light would be able to penetrate the centre of the building allowing the vegetables to grow. Other parts of the building could be lit with artificial lighting to control temperatures. With this control, the manager could almost trick the plants into thinking it is a different season than it actually is allowing year-round growing.

POTATOES:
For all the potatoes for hash browns and chips would require 136 levels of the McDonalds tower which is approximately 408m

LEGUMES, NUTS + SEEDS:
For all the meat alternatives it would require 112 levels of the McDonalds tower which is approximately 330m

Professor Greg Keeffe
Professor Greg Keeffe

**BRIEF**
the numbers

**per store...**

**Coffee Demand**  
57.2 kg coffee per day  
20.88 tonnes/year  
20.88 hectares

**Sugar Demand**  
17.16 kg sugar per day  
6.26 tonnes/year  
0.75 hectares

**Water Demand**  
42.4 litres per day  
160,000 litres/year  
= 200 m² surface area

**Milk Demand**  
42.4 litres per day  
160,000 litres/year  
9.2 hectares
Invisible terrace: autonomous living machine

Professor Greg Keeffe
Professor Greg Keeffe
Nutritionally Complete:

Biospheric
Urban Carpet

Citylab 2001
The Biospheric Project

Aquaponic food system
- Large-scale building system
- Closed cycle
- Biodiverse
- Permaculture
- Organic

- ‘The future will be born not made’
  Kevin Kelly

Professor Greg Keeffe
Extra structural support!!

Agreement on these 16 15x10cm pieces of steel took 6 months!

[they took a morning to fit!]

Professor Greg Keeffe
Fish!
Fish!
Three pumps needed.

Total power needed 960Watts
£3.60 per day
UV filtration x 3
To prevent Legionella build up

Professor Greg Keeffe
Miineralisation and filtration

84 containers
100Kg worms

Professor Greg Keeffe
Worm mineralisation detail.

Professor Greg Keeffe
Window systems

Professor Greg Keeffe
Professor Greg Keeffe
Prototype food producing façade: Building becomes cyborg

Hardware = technology
Software = biotic components
Interface = food management
Green genius façade with BDP, Siemens, QUB and Biospheric Foundation

Professor Greg Keeffe
Synergetic City: Bio-port free energy city Liverpool

Self assembly urbanism

Final form 10 glass factories Producing 250,000 tonnes pa

Professor Greg Keeffe
Free Energy city resource flows

Closing cycles – food, energy and materials in bio-port

Professor Greg Keeffe
Bio Port: Carbon neutral, self-assembly city

FREE ENERGY CITY

Professor Greg Keeffe

Citylab
with Kees Christiaanse and
MacCreanor Lavington, Rotterdam

A productive vision for Salford - Shortlisted

(we were told we were ‘trying to run the place down’)
Food and the city

[the best way to predict
the future is to design it!]

Thanks to
QUB Design team: Andy Jenkins
Tilly Hall

QUB Build team: Morgan Grennan
Josh Greenfield
and the students of
Queens University Belfast.
School of Architecture.

Prof Greg Keeffe
Director of Research [Architecture]
Queens University Belfast

g.keeffe@qub.ac.uk