UMAn Model =
Urban Metabolism Analyst Model

What
Extrapolation model for Material Flow Accounting at urban level

Advantages
Level of detail, Plug Ins

Where
Malmö, Stockholm, Gothenburg (Sweden) and Lisbon and Leiria (Portugal), Sabadell and Manresa (Spain), Albano Laziale, Pomezia, Cremona and Torino (Italy)

What for
Tool for Policy Makers e.g. Urban WINS
UMAn Role In Urban WINS

“Development and implementation of urban metabolism and material flow account approach for decision making processes”

- Italy
  Cremona, Torino, Albano Laziale and Pomezia
- Romania
  Bucharest
- Spain
  Manresa and Sabadell
- Portugal
  Leiria

- Basis for LCA
- Urban profiles
- Support to Strategic Planning
- Support to roadmaps
UMAn Model - Basics

MATERIAL FLOW ACCOUNTING

EXTRACTION

Kalmykova, Y., et al., Resource consumption drivers and pathways to reduction: economy, policy and lifestyle impact on material flows at the national and urban scale, Journal of Cleaner Production (2015), http://dx.doi.org/10.1016/j.jclepro.2015.02.027
UMAn Model - Basics

Transport & International Trade Statistics
Agricultural & Mining Statistics
Industrial Statistics
Statistics On Waste And Air Emissions

UNIT = TONS

Kalmykova, Y., et al., Resource consumption drivers and pathways to reduction: economy, policy and lifestyle impact on material flows at the national and urban scale, Journal of Cleaner Production (2015), http://dx.doi.org/10.1016/j.jclepro.2015.02.027

ROAD
RAIL
MARITIME
AIR
UMAn Model - Basics

UNIT = TONS

Transport & International Trade Statistics
Agricultural & Mining Statistics
Industrial Statistics
Statistics On Waste And Air Emissions

AGRICULTURE
FORESTRY
FISHING
MINING

Kalmykova, Y., et al., Resource consumption drivers and pathways to reduction: economy, policy and lifestyle impact on material flows at the national and urban scale, Journal of Cleaner Production (2015), http://dx.doi.org/10.1016/j.jclepro.2015.02.027
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EXTRACTIVE INDUSTRIES
MANUFACTURE
CONSTRUCTION INDUSTRY
SERVICE INDUSTRY
EMPLOYMENT DATA

Kalmykova, Y., et al., Resource consumption drivers and pathways to reduction: economy, policy and lifestyle impact on material flows at the national and urban scale, Journal of Cleaner Production (2015), http://dx.doi.org/10.1016/j.jclepro.2015.02.027
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MUNICIPAL WASTE
INDUSTRIAL WASTE
WASTEWATER
AIR EMISSIONS

Kalmykova, Y., et al., Resource consumption drivers and pathways to reduction: economy, policy and lifestyle impact on material flows at the national and urban scale, Journal of Cleaner Production (2015), http://dx.doi.org/10.1016/j.jclepro.2015.02.027
UMAn Model - Basics
Nomenclatures

- **Product Types**
  - CN – Combined Nomenclature
  - NST – Standard Goods Classification for Transport Statistics

- **Industrial Activity**
  - NACE – Statistical Classification of Economic Activities

- **Territory**
  - NUTS – Nomenclature of Territorial Units for Statistics
  - LAU – Local Administrative Unit
Statistics data - Challenges

Need detailed data
- 10000 products
- Inputs, Throughputs, Outputs

Available statistics
- High quality data at country level
- Standard EW-MFA method

Scarce data at urban level
- Downscale from country and regional level

Non-homogeneous sources
- Use multiple datasets
- Adapt from multiple spatial scales
- Different years available

Confidentiality
- Need to request micro-data
- Data protection
**UMAn model - Steps**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Products of agriculture, hunting, and forestry; fish and other fishing products</td>
</tr>
<tr>
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<td>Coal and lignite; crude petroleum and natural gas</td>
</tr>
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<td>03</td>
<td>Metal ores and other mining and quarrying products; peat; uranium and thorium</td>
</tr>
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<td>Food products, beverages and tobacco</td>
</tr>
<tr>
<td>05</td>
<td>Textiles and textile products; leather and leather products</td>
</tr>
<tr>
<td>06</td>
<td>Wood and products of wood and cork (except furniture); articles of straw and plaiting materials; pulp, paper and paper products; printed matter and recorded media</td>
</tr>
<tr>
<td>07</td>
<td>Coke and refined petroleum products</td>
</tr>
<tr>
<td>08</td>
<td>Chemicals, chemical products, and man-made fibers; rubber and plastic products; nuclear fuel</td>
</tr>
<tr>
<td>09</td>
<td>Other non metallic mineral products</td>
</tr>
</tbody>
</table>

- **Municipality Consumption**
  - Employees by NACE

- **Material Categories**
  - 20 material types *

- **Stock + Future Waste**
  - Product Lifetimes

Pictures: ec.europa.eu/eurostat/ramon
### UMAn model - Steps

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### Economic Activities

- **Raw vs. Final**
- **Municipality Consumption**
- **Employees by NACE**
- **Material Categories**
  - 20 material types *
- **Stock + Future Waste**
- **Product Lifetimes**

### Notes

- [ec.europa.eu/eurostat/ramon](ec.europa.eu/eurostat/ramon)
UMAn model - Steps

- Extrapolations
  - Time
  - Region
  - Product Category

- Material Consumption
  - NST to CN 8-digit

- Economic Activities Consumption
  - Raw vs. Final

- Municipality Consumption
  - Employees by NACE

- Material Categories
  - 28 material types

- Stock + Future Waste
  - Product Lifetimes
UMAn model - Steps

MatCat nomenclature

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fossil fuels</td>
<td>Low ash fuels, High ash fuels, Lubricants and oils and solvents, Plastics and rubbers</td>
</tr>
<tr>
<td>Metals</td>
<td>Iron, steel alloying metals, and ferrous metals, Light metals, Nonferrous heavy metals, Special metals, Nuclear fuels, Precious metals</td>
</tr>
<tr>
<td>Nonmetallic minerals</td>
<td>Sand, Cement, Clay, Stone, Other (fibers, salt, or inorganic parts of animals)</td>
</tr>
<tr>
<td>Biomass (forestry, crops, and animal products)</td>
<td>Agricultural biomass, Animal biomass, Textile biomass, Oils and fats, Sugars, Wood and fuels, Paper and board, Nonspecified biomass</td>
</tr>
<tr>
<td>Chemicals and fertilizers</td>
<td>Alcohols, Chemicals and pharmaceuticals, Fertilizers and pesticides</td>
</tr>
<tr>
<td>Others</td>
<td>Nonspecified, Liquids</td>
</tr>
</tbody>
</table>

Activities Consumption

- Raw vs. Final

Municipality Consumption

- Employees by NACE

Material Categories

- 28 material types *

Stock + Future Waste

- Product Lifetimes
UMAn model - Steps

MatCat nomenclature

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</tr>
<tr>
<td>Others</td>
<td>Nonspecified Liquids</td>
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### Table: Material Consumption

<table>
<thead>
<tr>
<th>Material Category</th>
<th>CN2007</th>
<th>Average Lifespan (years)</th>
<th>Weibull type k</th>
<th>Yearly throughput (%)</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Fossil fuels</td>
<td>82151030</td>
<td>5</td>
<td>10</td>
<td>0.0%</td>
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<tr>
<td></td>
<td>82151080</td>
<td>4</td>
<td>8</td>
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<td></td>
<td>82152010</td>
<td>4</td>
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<td>0.0%</td>
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<td>10</td>
<td>0.0%</td>
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<td>82159990</td>
<td>5</td>
<td>10</td>
<td>0.0%</td>
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<tr>
<td></td>
<td>83011000</td>
<td>3</td>
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<td>100.0%</td>
</tr>
<tr>
<td></td>
<td>83024200</td>
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<tr>
<td></td>
<td>83024200</td>
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<td>100.0%</td>
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<tr>
<td></td>
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<tr>
<td></td>
<td>83026000</td>
<td>1</td>
<td>10</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
Portugal Case

Data fit to the UMAn model

HIGH FIT

Primary Crops
Meat Production
Fishing
Forestry
Mineral Extraction
Air Emissions
Industrial Production
International Trade
Employment

Transport Statistics
Waste Economic Activities

LOW FIT

Vegetable Production

Municipal Waste
WEEE
Wastewater
Spain Case

Data fit to the UMAN model

HIGH FIT
- Fishing
- Forestry
- Industrial Production
- International Trade
- Wastewater

LOW FIT
- Vegetable Production
- Municipal Waste
- WEEE
- Transport Statistics
- Air Emissions
- Employment

Waste Economic Activities
- Mineral Extraction
- Meat Production
- Primary Crops
Italian Case

Data fit to the UMAN model

High Fit
- Employment
- Primary Crops
- Mineral Extraction
- Waste Economic Activities
  - Meat Production
  - Industrial Production
  - Forestry
  - International Trade
  - Municipal Waste
  - WEEE
  - Transport Statistics

Low Fit
- Vegetable Production
- Air Emissions
- Transport Statistics
- Wastewater
- Fishing
Romanian Case

Data fit to the UMAN model

- Mineral Extraction
- Wastewater
- Meat Production
- Waste Economic Activities
- Primary Crops
- Air Emissions
- Fishing
- Forestry
- Transport Statistics
- Municipal Waste
- WEEE
- Industrial Production
- International Trade
- Employment
UMAn model
Uncertainty in results
Input and Output – Results
Domestic extraction – Results

Mineral extraction about 80% and vegetable 10%
Around 116 kton correspond to stone and sand
Other materials include agricultural biomass, clay, and wood

<table>
<thead>
<tr>
<th>CN2008 Section</th>
<th>CN2008 Section Name</th>
<th>DE (ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>Mineral products</td>
<td>124 837,91</td>
</tr>
<tr>
<td>II</td>
<td>Vegetable products</td>
<td>13 445,05</td>
</tr>
<tr>
<td>IX</td>
<td>Wood and articles of wood; wood charcoal; cork and articles of cork; manufactures of straw, of esparto or of other plaiting materials; basketware and wickerwork</td>
<td>3 331,51</td>
</tr>
<tr>
<td>IV</td>
<td>Prepared foodstuffs; beverages, spirits and vinegar; tobacco and manufactured tobacco substitutes</td>
<td>0,02</td>
</tr>
</tbody>
</table>

MANRESA 2008
Product groups CN2 section
DOMESTIC EXTRACTION INDICATOR
Imports and exports – Results

PRODUCT AND MATERIAL CHARACTERISTICS
Minerals lead in imports and exports
Minerals imported include mostly construction materials and fuels
Prepared food and vegetable products represent also significant imports and exports

ORIGIN AND DESTINATION OF PRODUCTS
The top imported and exported sections come from national sources

PIEMONTE 2013
Product groups CN2 section
IMPORT AND EXPORT INDICATORS
**Industrial production – Results**

**PRODUCT AND MATERIAL CHARACTERISTICS**

10 sections most abundantly produced are groups 25 and 27 for the mineral section, iron and steel for the metals. Other abundant CN groups include 47 - pulp of wood and recovered paper or paperboard and 44 - wood.

<table>
<thead>
<tr>
<th>Section</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Products of the chemical or allied industries</td>
<td>90.86%</td>
</tr>
<tr>
<td>Base Metals and articles of base metal</td>
<td>70.78%</td>
</tr>
<tr>
<td>Mineral products</td>
<td>31.91%</td>
</tr>
<tr>
<td>Pulp of wood or of other fibrous cellulosic material; recovered (waste and scrap) paper or paperboard; paper and paperboard and articles thereof</td>
<td>24.49%</td>
</tr>
<tr>
<td>Prepared foodstuffs; beverages; spirits and vinegar; tobacco and manufactured tobacco substitutes</td>
<td>24.23%</td>
</tr>
<tr>
<td>Articles of stone, plaster, cement, asbestos, mica or similar materials; ceramic products; glass and glassware</td>
<td>20.47%</td>
</tr>
<tr>
<td>Wood and articles of wood; wood charcoal; cork and articles of cork; manufactures of straw, of esparto or of other plaiting materials; basketware and wickerwork</td>
<td>12.54%</td>
</tr>
<tr>
<td>Machinery and mechanical appliances; electrical equipment; parts thereof; sound recorders and reproducers, and parts and accessories of such articles</td>
<td>11.77%</td>
</tr>
<tr>
<td>Vegetable products</td>
<td>11.54%</td>
</tr>
<tr>
<td>Textiles and textile articles</td>
<td>8.61%</td>
</tr>
</tbody>
</table>

**INDUSTRIAL PRODUCTION INDICATOR**
Product Consumption – Results

Sections shown have overwhelming presence of one product group in comparison to the rest.
Cement in group 38 represents 2/3 of Section V and more than 90% of Section VI.

V - Mineral products
- 25 - Salt; sulphur; earths and stone; plastering materials, lime and cement
  6 282 893,34 ton
- 27 - Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes
  1 930 158,03 ton
- 26 - Ores, slag and ash
  68 846,54 ton

VI - Products of the chemical or allied industries
- 34 - Soap, washing and lubricating preparations, waxes, candles, modelling pastes
  123 840,62 ton
- 31 - Fertilisers
  68 206,26 ton
- 38 - Miscellaneous chemical products
  2 220 571,14 ton

II - Vegetable products
- 12 - Grains, seeds and fruits, industrial and medicinal plants, straw and fodder
  563 817,78 ton
- 10 - Cereals
  201 717,62 ton
- 7 - Edible vegetables, roots and tubers
  106 889,92 ton

TORINO 2013
Product groups CN2 section and CN4 groups
CONSUMPTION INDICATOR
Consumption of materials dominated by Non-metallic minerals
Fossil fuels and biomass also show significant consumption
Stone, sand and fuels are dominant, while agricultural biomass and clay follow next.
Chemical industry is responsible for almost 30% of all consumption
The residential sector is responsible for almost 20% of consumption
For the construction sector, the products most utilized are concrete ready to pour and bituminous mixtures

<table>
<thead>
<tr>
<th>NACE Code</th>
<th>NACE Label</th>
<th>Pomezia Consumption (ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>Manufacture of coke and oil refining products</td>
<td>231 321,24</td>
</tr>
<tr>
<td>POP</td>
<td>Total expense in final consumption</td>
<td>164 048,66</td>
</tr>
<tr>
<td>10-12</td>
<td>Manufacture of other food products and tobacco + Meat industries + Manufacture of dairy products + Manufacture of beverages</td>
<td>49 719,47</td>
</tr>
<tr>
<td>351-353</td>
<td>Production and distribution of electrical energy + Production and distribution of gas</td>
<td>47 176,89</td>
</tr>
<tr>
<td>41-43</td>
<td>Construction</td>
<td>45 524,37</td>
</tr>
</tbody>
</table>
Waste generation – Results

Construction and demolition waste represent around 50% of all waste generated.
Municipal and industrial waste represent similar amounts.
60% of all waste goes to landfill.
25% of all waste is recycled.
15% of municipal waste recycled while 70% of industrial waste recycled.

MANRESA 2008
Waste by type and destination
MUNICIPAL AND INDUSTRIAL INDICATORS
Future waste – Results

Throughput estimates based on lifetime

XVI - MACHINERY AND MECHANICAL APPLIANCES; ELECTRICAL EQUIPMENT; PARTS THEREOF; SOUND RECORDERS AND REPRODUCERS, TELEVISION IMAGE AND SOUND RECORDERS AND REPRODUCERS, AND PARTS AND ACCESSORIES OF SUCH ARTICLES 287,55

VI - PRODUCTS OF THE CHEMICAL OR ALLIED INDUSTRIES

XVII - VEHICLES, AIRCRAFT, VESSELS AND ASSOCIATED TRANSPORT EQUIPMENT

V - MINERAL PRODUCTS

FUTURE PLASTICS WASTE
Future waste – Results

CREMONA 2013
Throughput estimates based on lifetime
FUTURE HEAVY METALS WASTE

XVI - MACHINERY AND MECHANICAL APPLIANCES; ELECTRICAL EQUIPMENT; PARTS THEREOF; SOUND RECORDERS AND REPRODUCERS, AND PARTS AND ACCESSORIES OF SUCH ARTICLES
XV - BASE METALS AND ARTICLES OF BASE METAL
XVII - VEHICLES, AIRCRAFT, VESSELS AND ASSOCIATED TRANSPORT EQUIPMENT
XIII - ARTICLES OF STONE, PLASTER, CEMENT, ASBESTOS, MICA OR SIMILAR MATERIALS; CERAMIC PRODUCTS; GLASS AND GLASSWARE
### Future waste – Results

<table>
<thead>
<tr>
<th>Year</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<th>17</th>
<th>18</th>
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<tbody>
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</tr>
</tbody>
</table>

**MANRESA 2008**

Throughput estimates based on lifetime

**FUTURE TEXTILE FROM BIOMASS WASTE**

- **XI** - TEXTILES AND TEXTILE ARTICLES
- **XII** - FOOTWEAR, HEADGEAR, UMBRELLAS, SUN UMBRELLAS, WALKING STICKS, SEAT-STICKS, WHIPS, RIDING-CROPS AND PARTS THEREOF; PREPARED FEATHERS AND ARTICLES MADE THEREWITH; ARTIFICIAL FLOWERS; ARTICLES OF HUMAN HAIR
- **XVII** - VEHICLES, AIRCRAFT, VESSELS AND ASSOCIATED TRANSPORT EQUIPMENT
- **VIII** - RAW HIDES AND SKINS, LEATHER, FURSKINS AND ARTICLES THEREOF; SADDLERY AND HARNESS; TRAVEL GOODS, HANDBAGS AND SIMILAR CONTAINERS; ARTICLES OF ANIMAL GUT (OTHER THAN SILKWORM GUT)
- **VII** - PLASTICS AND ARTICLES THEREOF; RUBBER AND ARTICLES THEREOF
Material Benchmark – Results

### Material Benchmark

#### PILOT CITIES 2008/2013

#### Material types per capita

**DOMESTIC EXTRACTION INDICATOR**

<table>
<thead>
<tr>
<th>MATCAT_1 DIG</th>
<th>POMEZIA</th>
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<th>TORINO</th>
<th>CREMONA</th>
<th>SABADELL</th>
<th>MANRESA</th>
<th>LEIRIA</th>
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**CONSUMPTION INDICATOR**

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### Products Benchmark – Results

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<td>4,96</td>
<td>7,26</td>
<td>17,49</td>
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</table>

**PILOT CITIES 2008/2013**

Product types per capita

**CONSUMPTION INDICATOR**
Thank you very much!

Website: www.urbanwins.eu
E-mail us: rosado@chalmers.se
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