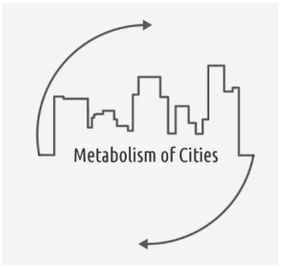
22 MAGGIO 2017
Festival dello Sviluppo Sostenibile

YOUTH 4 SDGs | Giovani per gli SDGs
Il ruolo dei giovani nello sviluppo sostenibile



Metabolism of Cities Website
Operationalizing urban metabolism in cities

Gabriela Fernandez

Ph.D. Candidate, Urban Planning, Design and Policy

Department of Architecture and Urban Studies

Politecnico di Milano, Milan, Italy

PARTNER

MAIN MEDIA PARTNER

MEDIA PARTNER

CON LA COLLABORAZIONE DI

CON IL CONTRIBUTO DEL MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE

Worldwide Climate Change Initiatives

GLOBAL COVENANT of MAYORS for CLIMATE & ENERGY

Covenant of Mayors

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UN CLIMATE CHANGE CONFERENCE
مؤتمر الأمم المتحدة لتغير المناخ

MAYORS ADAPT
THE COVENANT OF MAYORS INITIATIVE ON ADAPTATION TO CLIMATE CHANGE

PARIS2015
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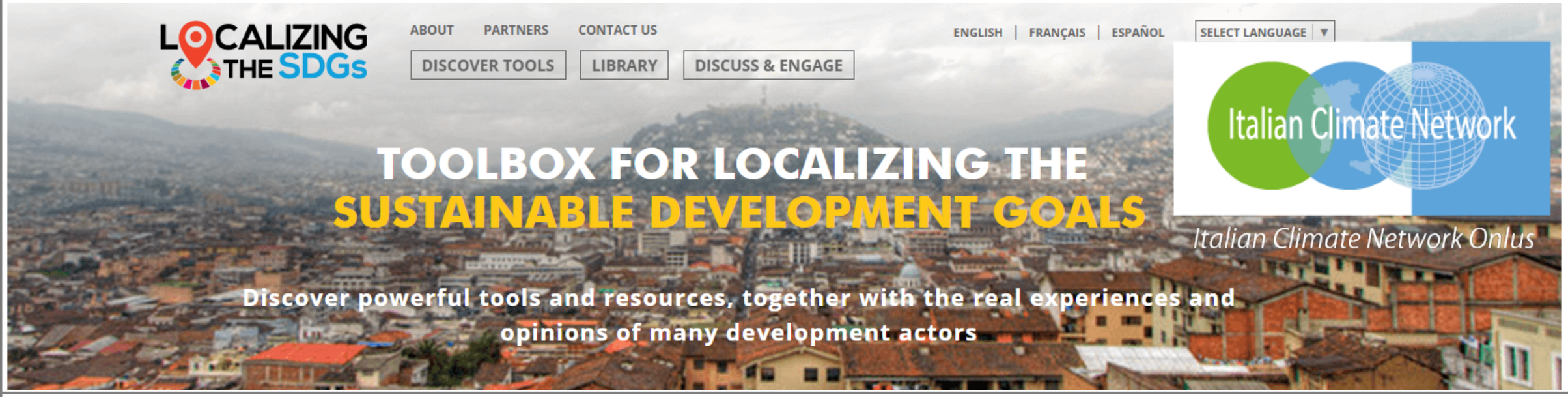
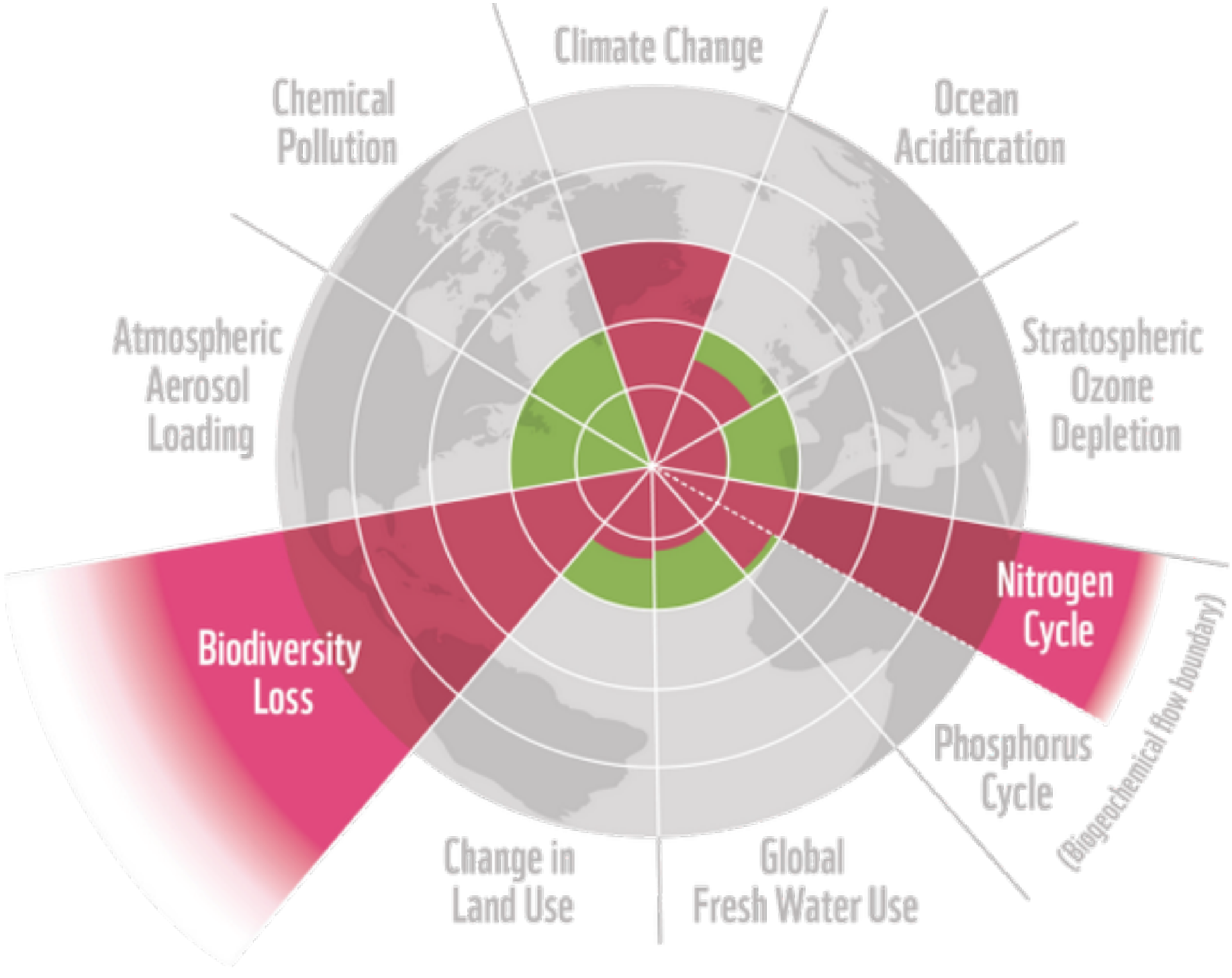
COP21·CMP11



Planetary Boundaries and Protecting the Stratospheric Ozone layer in the atmosphere!



Metabolism of Cities (www.metabolismofcities.org)

Metabolism of Cities | About | Current Research | OMAT | Publication Collections | Publication Database | Login

Map with urban metabolism studies

Select Language

Map created by metabolismofcities

This map shows urban metabolism studies that have been identified as part of our database with publication

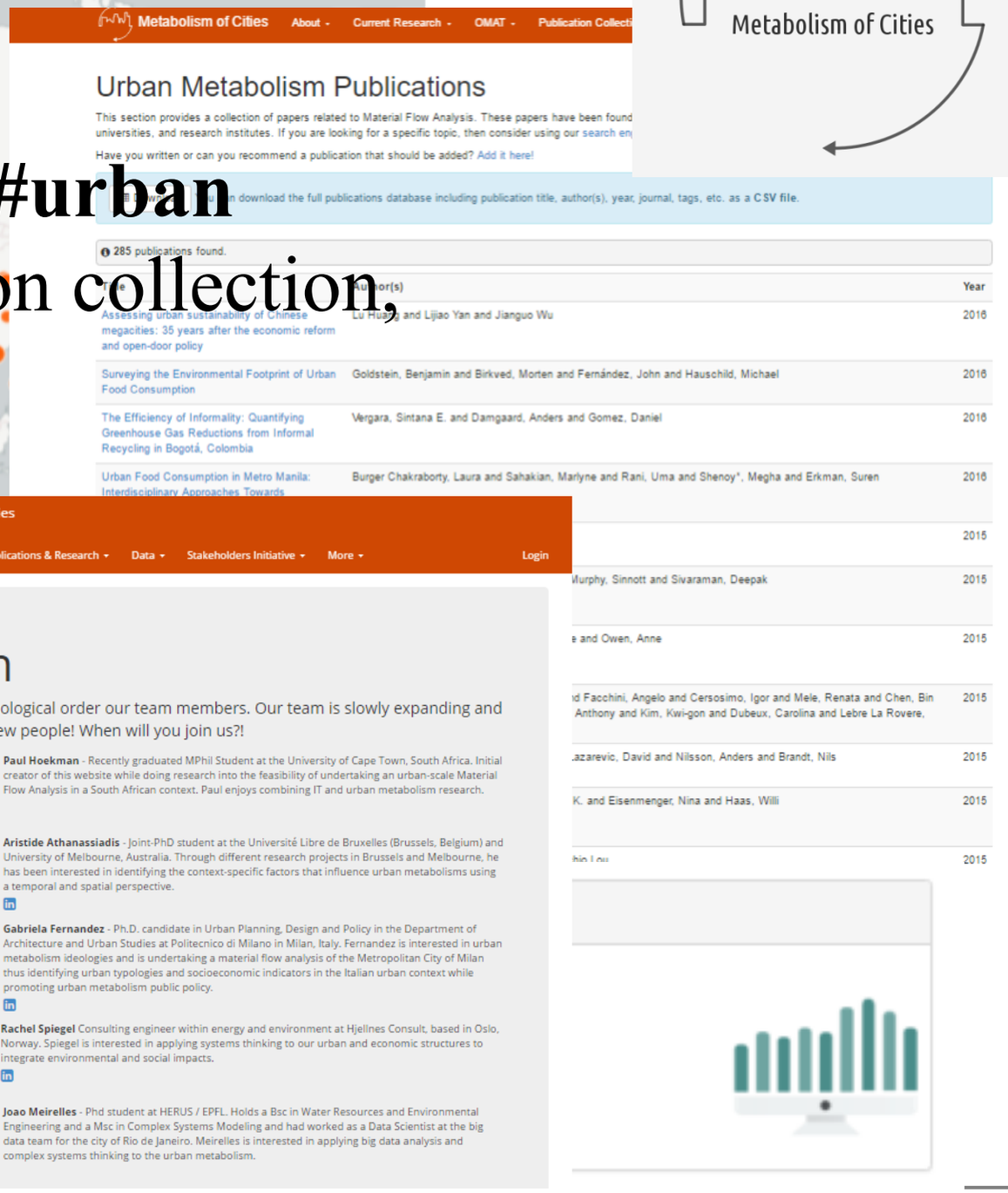
Download | You can download the underlying dataset as a CSV file. The full list with publications ca

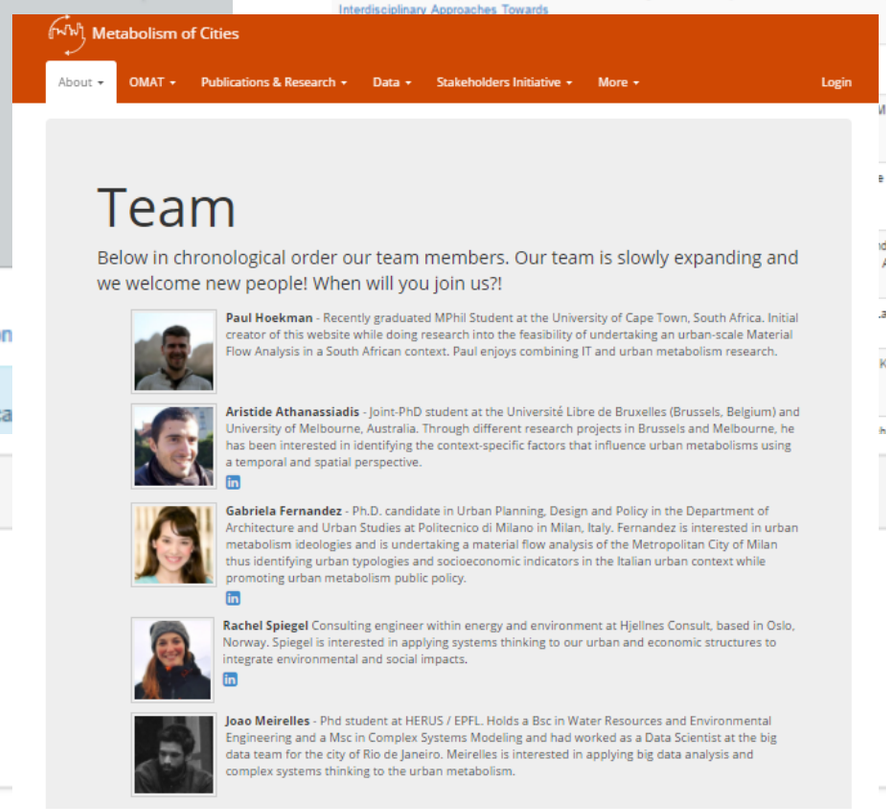
Quick Statistics

- 8 Research projects listed, see the current research list.
- 285 Papers and other publications listed in the database.
- 9 Publication collections.
- 223 Unique tags used for classifying publications.
- 1689 Tags used in total.

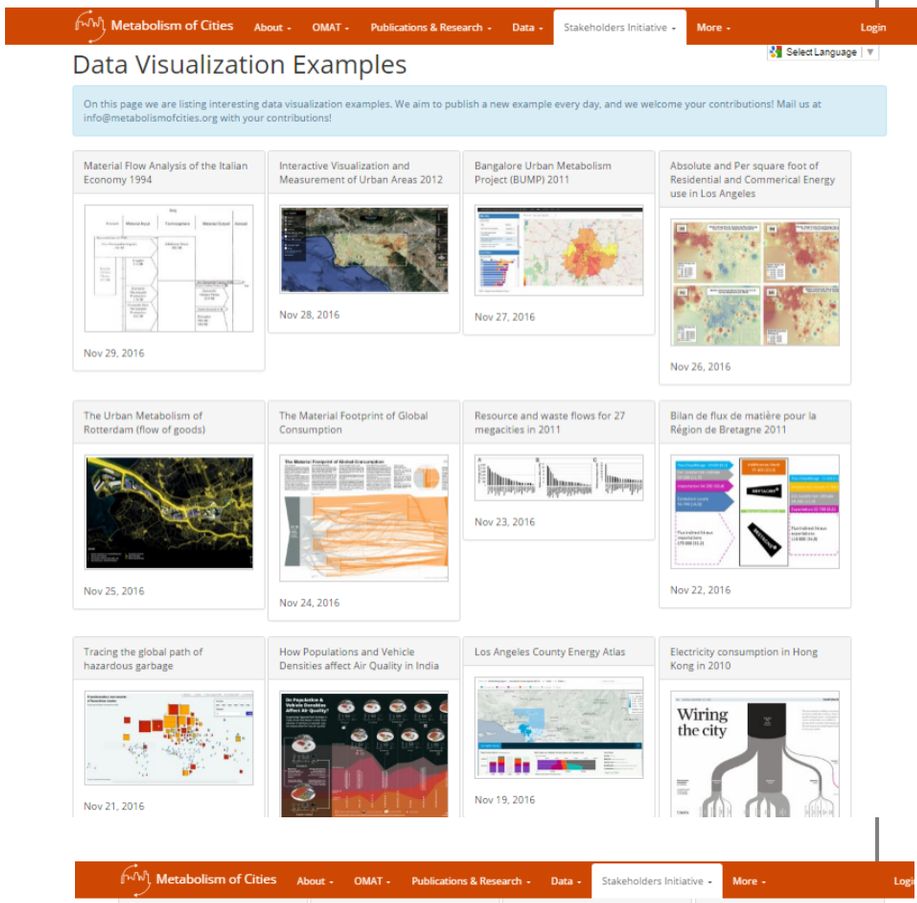
Open source online platform on **#urban metabolism.** Data and publication collection, free online tool, blog and more.

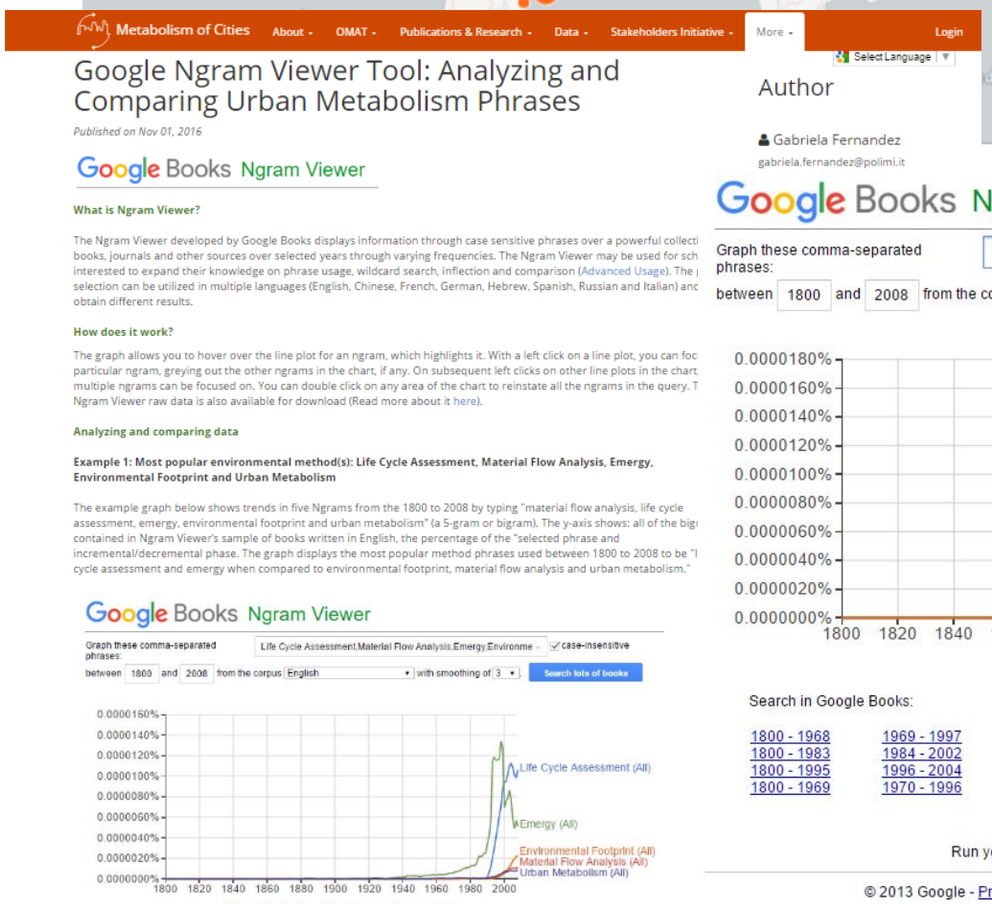
Founded by Paul, Aris and Gabriela

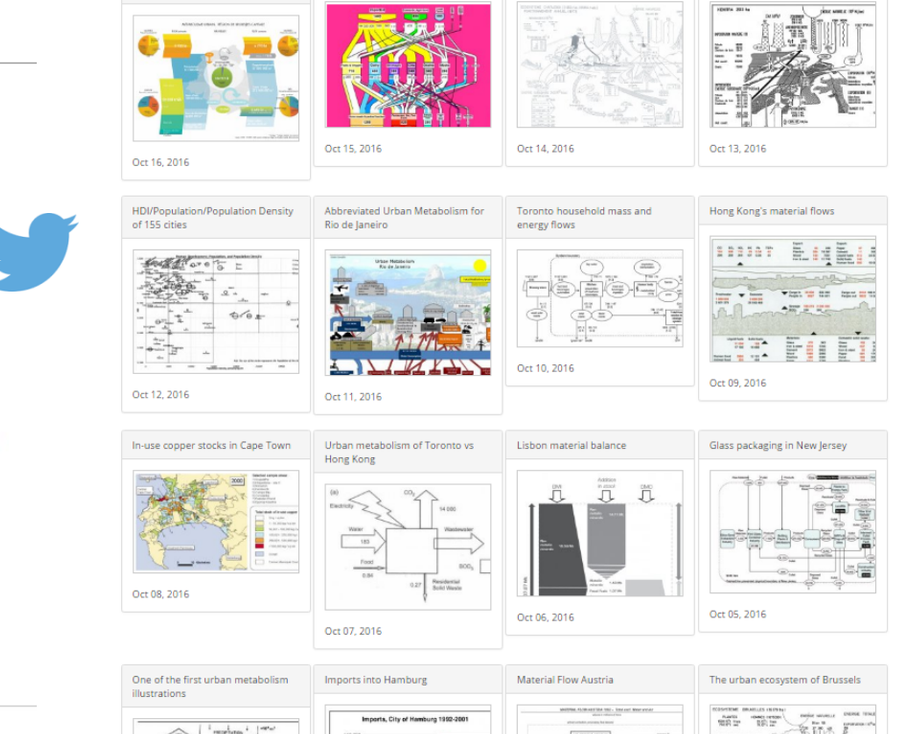




Metabolism of Cities (www.metabolismofcities.org)







Data Visualizations in Urban Metabolism Research

There are many ways to visualize your results in urban metabolism research. However, it is a challenge to design a map or diagram that is clear and appealing at the same time, and that captures the full extent of your dataset. Should you use sankey diagrams, maps, or other visual representations? What software to use? How to make it look professional without spending a lot of time on it? At the Metabolism of Cities website we want to enlist your help to answer those questions! We are setting up a Stakeholders Initiative and invite everyone to join the discussion. Data Visualizations will be our first topic of discussion, running from October-December 2016. In this period, we will publish blog posts (guest contributions are welcome), host online discussions, take stock of work in this field, and build or expand on open source software that can help develop data visualizations.

Introduction to Data Visualizations

Introduction post on our blog by Aristide Athanassiadis. This post discusses what type of visualizations to use, which software to use, and provides some examples of data visualizations.

Read more »

Data Visualizations Examples

In this section we will post a new data visualization every day! We will showcase great examples and also cases of 'what not to do'. Your contributions are welcome so if you have anything to share, please contact us.

Read more »

Call for Research Collaboration

Are you interested in participating in a data visualization research project? Then read more about this call for collaboration!

Read more »

Links

A collection of useful links related to data visualization.

Read more »

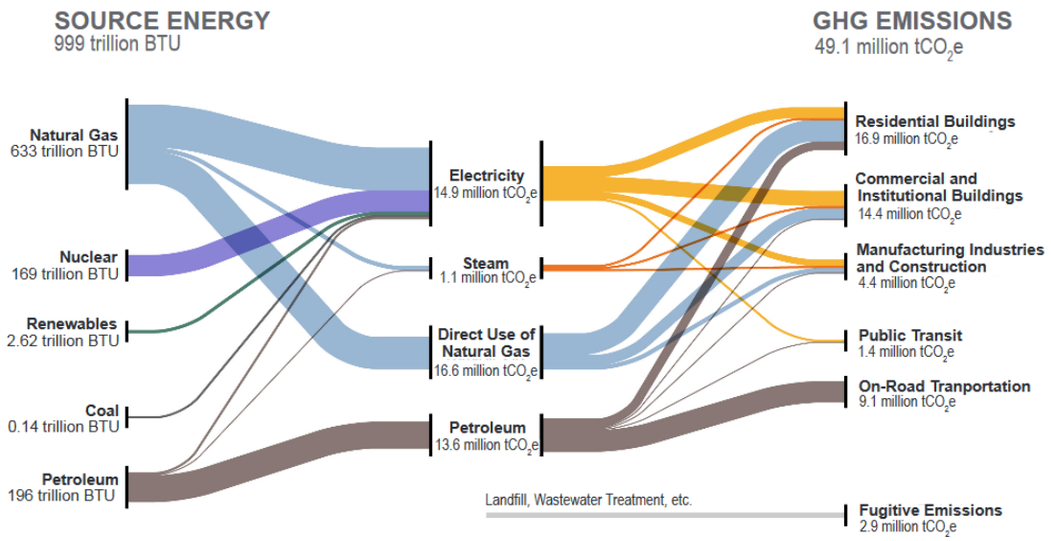
Participate!

Would you like to participate? Now is the right time to take action! Here is a list of how you can collaborate in this stakeholders initiative:

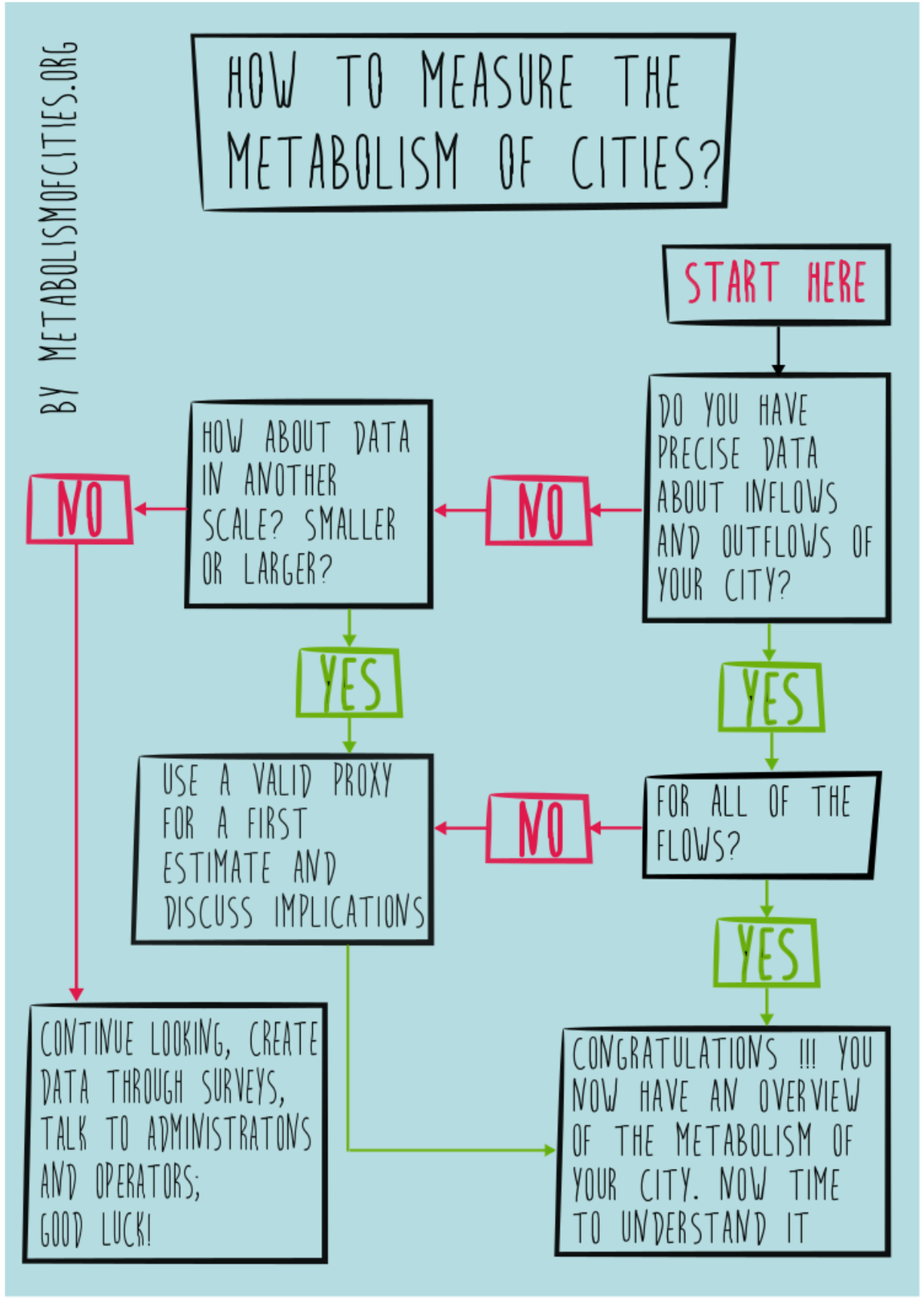
- **Contribute interesting data visualizations**
  We are posting a new data visualization every day, and we would love for you to contribute! Do you have a particularly good, bad, interesting or otherwise captivating data visualization to share? E-mail it to us at info@metabolismofcities.org!
- **Write a guest blog post**
  We welcome guest blog posts about any topic related to data visualization. It can be a personal story about how you dealt with data visualizations, or a study of data visualizations in some of the recent work done by authors you admire. Or anything else you feel contributes to this topic. Interested? Let us know and we can discuss this topic! Contributions are due any time before the year ends.
- **Collaborate in research**
  There is an open call to collaborate in a research project around data visualizations. Read more here and sign up if you are interested in collaborating!
- **Contribute your own idea**

Testo

Fig. 1: 2014 New York City Energy Consumption and Greenhouse Gas Emissions



Area	Domestic consumers GWh	Commercial and industrial consumers GWh	All consumers GWh
City of London	25.6	2,359.4	2,384.9
Barking and Dagenham	282.5	433.5	715.9
Barnet	645.0	549.4	1,194.4
Bexley	397.9	384.9	782.8
Brent	439.4	593.9	1,033.3
Bromley	584.8	449.8	1,034.6
Camden	363.5	1,401.5	1,765.0
Croydon	618.8	690.9	1,309.6
Ealing	497.6	880.9	1,378.5
Enfield	519.5	496.6	1,016.0
Greenwich	385.5	372.8	758.4
Hackney	354.6	471.0	825.6
Hammersmith and Fulham	291.1	732.5	1,023.6
Haringey	386.8	395.1	781.9
Harrow	368.0	255.3	623.3
Havering	425.0	400.5	825.5
Hillingdon	442.2	1,049.9	1,492.0
Hounslow	394.9	995.3	1,390.2
Islington	323.6	897.9	1,221.5
Kensington and Chelsea	384.3	1,271.7	1,656.0
Kingston upon Thames	279.5	324.1	603.7
Lambeth	455.5	679.7	1,135.2
Lewisham	429.4	334.5	763.9
Merton	326.8	468.7	795.5
Newham	386.1	973.4	1,359.5
Redbridge	423.0	280.8	703.8
Richmond upon Thames	353.7	345.7	699.4
Southwark	462.2	1,130.3	1,592.4



Metabolism of Cities Portal: Publications and Research

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Select Language

Urban Metabolism Publications

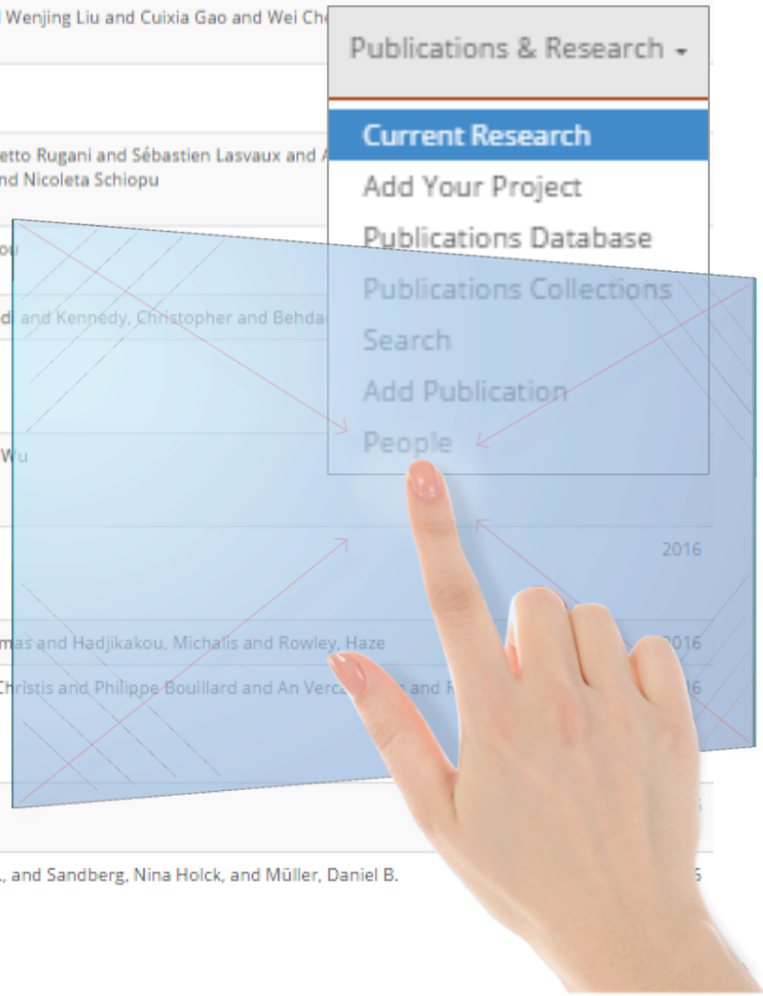
This section provides a collection of papers related to Material Flow Analysis. These papers have been found in a variety of journals, as well as in collections from EUROSTAT, universities, and research institutes. If you are looking for a specific topic, then consider using our search engine which allows you to quickly filter through the database.

Have you written or can you recommend a publication that should be added? Add it here!

Download You can download the full publications database including publication title, author(s), year, journal, tags, etc. as a **CSV file**.

388 publications found.

Title	Author(s)	Year
Connecting land-use and water planning: Prospects for an urban water metabolism approach	S. Serrao-Neumann and M. Renouf and S.J. Kenway and D. Low Choy	2017
A bibliometric review on natural resource accounting during 1995-2014	Shaozhuo Zhong and Yong Geng and Wenjing Liu and Cuixia Gao and Wei Ch	
A multi-year, multi-scale analysis of urban sustainability	Anat Dor and Meidad Kissinger	
A review of urban metabolism studies to identify key methodological choices for future harmonization and implementation	Didier Beloin-Saint-Pierre and Benedetto Rugani and Sébastien Lasvaux and A Galdric Sibiude and Enrico Benetto and Nicoleta Schiopu	
An evaluation of the urban metabolism of Macao from 2003 to 2013	Kampeng Lei and Lu Liu and Inchio Lo	
An Urban Approach to Planetary Boundaries	Hoornweg, Daniel and Hosseini, Mehd and Kennedy, Christopher and Behda	
An urban metabolism approach to the water supply of the Greater Accra Metropolitan Area (GAMA)	Stephen Passmore	
Assessing urban sustainability of Chinese megacities: 35 years after the economic reform and open-door policy	Lu Huang and Lijiao Yan and Jianguo Wu	
Between theory and quantification: An integrated analysis of metabolic patterns of informal urban settlements	Zora Kovacic and Mario Giampietro	2016
City Carbon Footprint Networks	Chen, Guangwu and Wiedmann, Thomas and Hadjikakou, Michalis and Rowley, Haze	2016
Comparing a territorial-based and a consumption-based approach to assess the local and global environmental performance of cities	Aristide Athanassiadis and Maarten Christis and Philippe Bouillard and An Verc and Ahmed Z. Khan	16
Contesting Urban Metabolism: Struggles Over Waste-to-Energy in Delhi, India	Demaria, F. and Schindler, S.	
Dynamic type-cohort-time approach for the	Vásquez, Felipe, and Løvik, Amund N., and Sandberg, Nina Holck, and Müller, Daniel B.	



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Publication Collections

This section provides an overview of the main classifications that have been used to group the different publications together.

Metabolism Studies

331 publications found. View All

- Ecological Footprint Analysis (9)
- Economy-Wide Material Flow Analysis (EW MFA) (121)
- Emergy analysis (1)
- Industrial Symbiosis (0)
- Life Cycle Assessment (LCA) (17)
- Material Intensity per Unit Service (MIPS) (1)
- Material Stock Analysis (27)
- Multi-region Input-Output Analysis (4)
- Physical input-output tables (PIOT) / Input-Output Assessment (IOA) (37)
- Political ecology (3)
- Social Metabolism (10)
- Substance Flow Analysis (SFA) (84)
- Urban Ecology (6)
- Urban Resilience (0)

Methodologies

68 publications found. View All

- Circular Economy (6)
- Energy/Emergy (16)
- EUROSTAT methodology (43)
- Urban Metabolism Analyst Model (3)

Publication Types

418 publications found. View All

- Book (11)
- Book Review (1)
- Book Section (2)
- Case Study (171)
- Commentary / Editorial (4)
- Comparison (19)
- Forum (1)
- Institutional Report (15)
- Methodology (81)
- PhD Thesis (2)
- Practical Guides and Handbooks (10)
- Research and Analysis (59)
- Review Paper (20)
- Thesis (12)

Countries

384 publications found. View All

- Antarctica (1)
- Argentina (6)
- Australia (9)
- Austria (8)
- Bangladesh (3)
- Belgium (8)
- Bhutan (1)
- Bolivia (2)
- Brazil (11)
- Canada (9)
- Chile (4)
- China (41)
- Colombia (6)
- Czech Republic (10)
- Denmark (2)
- Dominica (1)
- Ecuador (2)
- Egypt (5)
- Europe (14)
- Finland (5)
- France (11)
- Germany (5)
- Ghana (1)
- Greece (2)
- Hong Kong (3)
- Iceland (1)
- India (16)
- Indonesia (1)
- Iran (2)
- Ireland (2)
- Italy (7)
- Japan (15)
- Jordan (2)
- Laos (1)
- Latin America (2)
- Mexico (6)
- Morroco (1)
- Nepal (1)
- Nigeria (2)
- Norway (8)
- Pakistan (2)
- Peru (1)
- Philippines (7)
- Portugal (5)
- Russia (2)
- Schotland (1)
- Senegal (2)
- Singapore (5)
- Slovenia (1)
- South Africa (8)
- South Korea (5)
- Spain (5)
- Sri Lanka (1)
- Sweden (15)
- Switzerland (7)
- Taiwan (5)
- Thailand (5)
- The Netherlands (8)
- Trinidad and Tobago (1)
- Turkey (2)
- United Kingdom (16)
- United States (31)
- Venezuela (1)
- Vietnam (2)

Cities

280 publications found. View All

- Accra (1)
- Adelaide (2)
- Amman (2)
- Amsterdam (2)
- Athens (2)
- Austin (1)
- Bangalore (1)
- Bangkok (4)
- Barcelona (2)
- Beijing (12)
- Bogotá (2)
- Brisbane (2)
- Brittany (1)
- Brussels (5)
- Helsinki (1)
- Ho Chi Minh City (1)
- Hong Kong; City (3)
- Ile-de-France (1)
- Issaquah (0)
- Istanbul (2)
- Jakarta (2)
- Karachi (2)
- Kathmandu (1)
- Kawasaki (0)
- Kentra (1)
- Kolkata (2)
- Lagos (2)
- Le Mans (1)
- Norrköping (1)
- Osaka (2)
- Oslo (5)
- Paris (8)
- Perth (3)
- Poland (1)
- Portland (1)
- Porto (1)
- Prague (2)
- Quebec (1)
- Rennes (1)
- Rio de Janeiro (6)
- Rotterdam (2)
- Santiago de Chile (1)

Behind the Scenes of the Global Urban Metabolism Data Extraction Dataset

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Paper

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Paper	City	Area	subArea	Year	Year (end	Indicator	Value	Unit	Per capita	OBS		
2	Energy and material flows of megacities	London			2006		Total exports per capita	158.5	t	per capita			
3	Energy and material flows of megacities	London			2007		Total exports per capita	158.5	kt	total			
4													
5	Energy and material flows of megacities	London	Socioeconomic Definition	demography	2010		Brinkhoff population	12400000.00	habitants	total			
6	Energy and material flows of megacities	London	Socioeconomic Definition	demography	2001		Population	7322400.00	habitants	total			
7	Energy and material flows of megacities	London	Socioeconomic Definition	demography	2005		Population	7546600.00	habitants	total	This is the 2006 population figure, which w		
8	Energy and material flows of megacities	London	Socioeconomic Definition	demography	2006		Population	7546600.00	habitants	total			
9	Energy and material flows of megacities	London	Socioeconomic Definition	demography	2011		Population	8173941.00	habitants	total			
10	Energy and material flows of megacities	London	Socioeconomic Definition	demography	2001	2011	Population growth rate 2001-11	11.63	%	total	calculated		
11	Energy and material flows of megacities	London	Socioeconomic Definition	economy	2001		GDP	168410000000.00	GBD pou	total			
12	Energy and material flows of megacities	London	Socioeconomic Definition	economy	2006		GDP	225270000000.00	GBD pou	total			
13	Energy and material flows of megacities	London	Socioeconomic Definition	economy	2011		GDP	270830000000.00	GBD pou	total			
14	Energy and material flows of megacities	London	Socioeconomic Definition	economy	2001		GDP	280683333333.00	US dollar	total	(PPP adjusted US dollars)		
15	Energy and material flows of megacities	London	Socioeconomic Definition	economy	2006		GDP	375450000000.00	US dollar	total	(PPP adjusted US dollars)		
16	Energy and material flows of megacities	London	Socioeconomic Definition	economy	2011		GDP	386900000000.00	US dollar	total	(PPP adjusted US dollars)		
17	Energy and material flows of megacities	London	Socioeconomic Definition	economy	2001	2011	10-year growth rate in GDP 2001 to 2011	37.84	%	total	calculated		
18	Energy and material flows of megacities	London	Biophysical Characteristics	land use	2011		Land area	1594.70	km2	total			
19	Energy and material flows of megacities	London	Biophysical Characteristics	land use	2011		Urbanized area	560.10	km2	total			
20	Energy and material flows of megacities	London	Biophysical Characteristics	weather									
21	Energy and material flows of megacities	London	Biophysical Characteristics	weather									
22	Energy and material flows of megacities	London	Biophysical Characteristics	weather									
23	Energy and material flows of megacities	London	Biophysical Characteristics	weather									
24	Energy and material flows of megacities	London	Biophysical Characteristics	land use									
25	Energy and material flows of megacities	London	Biophysical Characteristics	land use									
26	Energy and material flows of megacities	London	Biophysical Characteristics	land use									
27	Energy and material flows of megacities	London	Energy	stationary									

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	A	B	C	D	E	F	G	H	I
1	rank	paper	authors	year	region	DUMPED			
2	1	Energy and material flows of megacities	Kennedy, Chris	2016	multiple				
3	2	Urban Metabolism of Six Asian Cities	Paulo Ferrao a	2014	multiple				
4	3	Cambio Climático y el Metabolismo Urbano de las Megaurbes Latinoamericanas	Delgado, Gian	2012	multiple				
5	4	Urban Metabolism of Paris and Its Region	Sabine Barles	2009	Paris				
6	5	Urbanization and Socioeconomic Metabolism in Taipei	Shu-Li Huang a	2009	Taipei				
7	6	Dynamic modeling of Singapore's urban resource flows: Historical trends and sustainable scenario developme	Abou-Abdo, T.	2011	Singapore				
8	7	Towards a Dynamic Approach to Urban Metabolism: Tracing the Temporal Evolution of Brussels' Urban Metab	Athanassiadis,	2016	Brussels				
9	8	Aspects of stocks and flows in the urban built environment of Cape Town	Gasson, Barrie	2007	Cape Town				
10	9	Material Flow Analysis of the City of Hamburg	Hammer, Mark	2003	Hamburg				
11	10	Material flow analysis: A tool to support environmental policy decision making. Case-studies on the city of Vien	Hendriks, Caro	2000	Vienna				
12	11	A material flow analysis and ecological footprint of York	Barrett, John a	2002	York				
13	12	The metabolism of a city: the case of Hong Kong	Newcombe, Ke	1978	Hong Kong				
14	13	Urban material flow analysis: An approach for Bogotá, Colombia	Alfonso Piña, Wi	2014	Bogotá				
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Explore

Energy and material flows of megacities
Urban Metabolism of Six Asian Cities
Cambio Climático y el Metabolismo Urbano de las Megaurbes Latinoameri
Urban Metabolism of Paris and Its Region
Urbanization and Socioeconomic Metabolism in Taipei
Dynamic modeling of Singapore's urban resource flows: Historical trends a
Towards a Dynamic Approach to Urban Metabolism: Tracing the Temporal
Aspects of stocks and flows in the urban built environment of Cape Town
Material Flow Analysis of the City of Hamburg
Material flow analysis: A tool to support environmental policy decision maki
A material flow analysis and ecological footprint of York
The metabolism of a city: the case of Hong Kong
Urban material flow analysis: An approach for Bogotá, Colombia

Global Urban Metabolism Literature Review Dataset

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Done

	A	B	C	E	
1	**Done**	**Region**	**Year**	**Paper**	**Authors**
2	Xica	Brussels	1977	L'écosystème URBS: L'écosystème urbain bruxellois	Duvigneaud, P. and Denayer-De Smet, S.
3	Joao	Hong Kong	1978	The metabolism of a city: the case of Hong Kong	Newcombe, Ken and Kalma, Jetse D and Aston, Alan R
4	Xica	Materials accou	1998	Materials accounting as a tool for decision making in environmental policy (MAc TEmPo)	Brunner, P.H. and Laner, T. and Lohm, U. and de Haes, U. and Desitler, M. and Baccini, P
5	Joao	Swiss lowlands	2000	Material flow analysis: A tool to support environmental policy decision making. Case-studies on the city	Hendriks, Carolyn and Obernosterer, Richard and Müller, Daniel and Kytzia, Susanne and B
6	Joao	Vienna	2000	Material flow analysis: A tool to support environmental policy decision making. Case-studies on the city	Hendriks, Carolyn and Obernosterer, Richard and Müller, Daniel and Kytzia, Susanne and B
7	Xica	Hong Kong	2001	Escalating trends in the urban metabolism of Hong Kong: 1971-1997	Warren-Rhodes, Kimberley and Koenig, Albert
8	Xica	Hong Kong	2001	Escalating trends in the urban metabolism of Hong Kong: 1971-1997	Warren-Rhodes, Kimberley and Koenig, Albert
9	Joao	York	2002	A material flow analysis and ecological footprint of York	Barrett, John and Vallack, Harry and Jones, Andrew and Haq, Gary
10	Xica	Hamburg	2003	Material Flow Analysis of the City of Hamburg	Hammer, Mark and Giljum, Stefan and Hinterberger, Friedrich
11	Joao	Linköping	2006	Food Consumption and Nutrient Flows: Nitrogen in Sweden Since the 1870s	Schmid Neset, Tina-Simone
12	Xica	Cape Town	2007	Aspects of stocks and flows in the urban built environment of Cape Town	
13	Joao	Paris	2007	Mesurer la performance écologique des villes et des territoires: le métabo	
14	Xica	Beijing	2009	Evaluation of urban metabolism based on emergy synthesis: A case study	
15	Joao	Ile-de-France	2009	Urban Metabolism of Paris and Its Region	
16	Xica	Oslo	2009	Combined	
17	Joao	Paris	2009	Urban Me	
18	Xica	Paris and its su	2009	Urban Me	
19	Joao	Taipei	2009	Urbanizati	
20	Xica	Methodology a	2011	Methodolo	
21	Joao	Singapore	2011	Dynamic r	
22	Xica	Suzhou	2011	Data Acqu	
23	Joao	Suzhou	2011	Urban Me	
24	Xica	Buenos Aires	2012	Cambio C	
25	Joao	Gothenburg	2012	Pathways	
26	Xica	Metabolism of t	2012	Metabolis	

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Regional Material Flow Analysis

Paper L'écosystème URBS: L'écosystème urbain bruxellois
Author(s) Duvigneaud, P. and Denayer-De Smet, S.
City/Region Brussels

We soon plan to provide per-capita material flow data from this paper here. Stay tuned!

Delete this as a regional case study

Manage meta information

Air pollution
Data source comments
Indicators
Local characteristics
Material flows
Material Stock
Solid waste
Total energy use
Wastewater
Water

Admin

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Urban Metabolism of Paris and Its Region

Title Urban Metabolism of Paris and Its Region

Author(s) Sabine Barles

Re-classify authors

Year 2009

Source Journal of Industrial Ecology, Volume 13, Issue 6, Pages 898-913

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Abstract The article presents the results of a research project aimed at (1) examining the feasibili urban scale in France, (2) selecting the most appropriate method, (3) identifying the availabl specific case. Using the Eurostat method, the study was conducted for the year 2003 and fo the entire region. Applying the method on a local scale required two local indicators to be d exported wastes on MFA: LEPO, local and exported flows to nature, and DMCconr, a modifie exported wastes (and imported ones if necessary). As the region extracts, produces whole, its direct material input (DMI) is lower than the national DMI. In all the areas, LEPO e multiscale approach reveals that urban metabolism is strongly impacted by density and the exports all of its wastes to the other parts of the region and concentrates food consumption consumes high levels of construction materials and fuel. This supports the use of MFA on ar management and dematerialization strategies and clearly reveals the important interaction development, and material flows.

More Information http://doi.wiley.com/10.1111/j.1530-9290.2009.00169.x

Tags

Publication Types

Book | Book Review | Book Section | **Case Study** | Commentary / Editorial | Comparison | Forum | Practical Guides and Handbooks | Research and Analysis | Review Paper | Thesis

Metabolism Studies

Ecological Footprint Analysis | **Economy-Wide Material Flow Analysis (EW MFA)** | Emergy analysis | Material Intensity per Unit Service (MIPS) | Material Stock Analysis | Multi-region Input-Output Analysis | Physical input-output tables (PIOT) / Input-Output Assessment (IOA) | Political ecology | Social Metabolism | Substance Flow Analysis (SFA) | Urban Ecology | Urban Resilience

Countries

Antarctica | Argentina | Australia | Austria | Bangladesh | Belgium | Bhutan | Bolivia | Brazil | Canada | Chile | China | Colombia | Czech Republic | Denmark | Dominica | Ecuador | Egypt | Europe | Finland | **France** | Germany | Ghana | Greece | Hong Kong | Iceland | India | Indonesia | Iran | Ireland | Italy | Japan | Jordan | Laos | Latin America | Mexico | Morroco | Nepal | Nigeria | Norway | Pakistan | Peru | Philippines | Portugal | Russia | Schotland | Senegal | Singapore | Slovenia | South Africa | South Korea | Spain | Sri Lanka | Sweden | Switzerland | Taiwan | Thailand | The Netherlands | Trinidad and Tobago | Turkey | United Kingdom | United States | Venezuela

Admin

UM Stakeholder Initiative Data Visualization Project

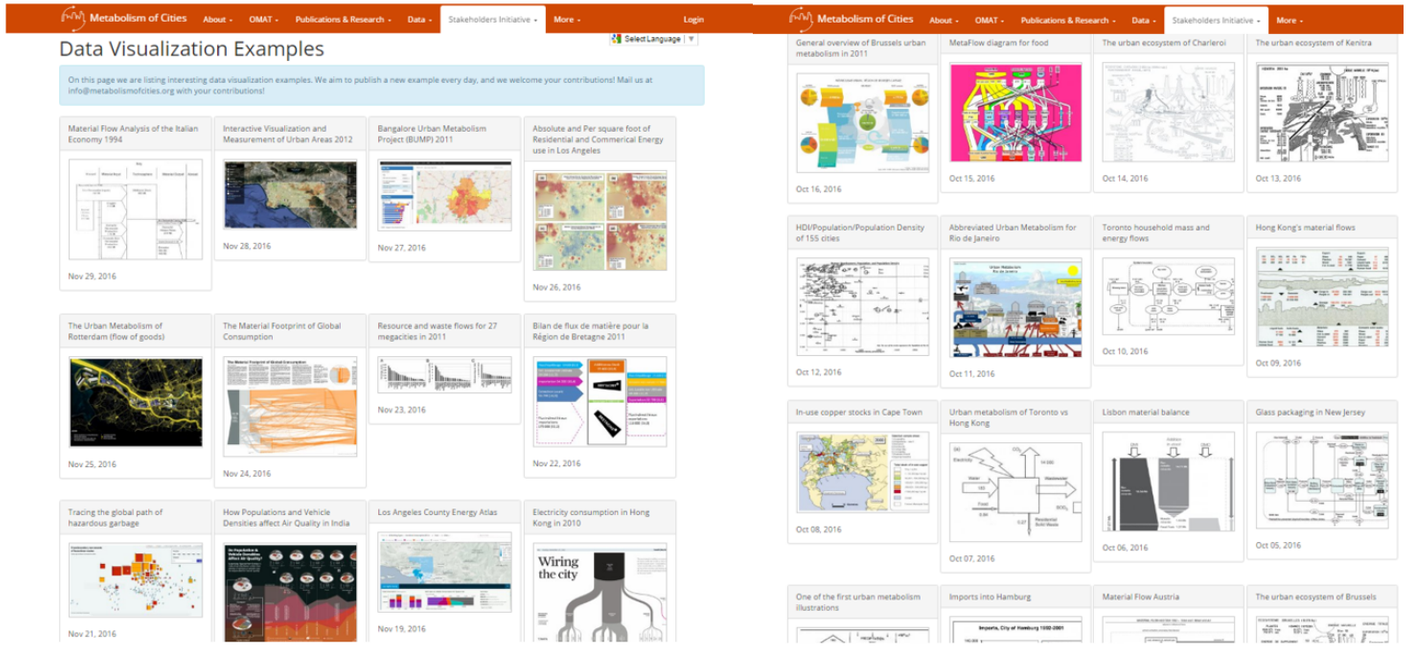


Figure 1. Metabolism of Cities Visualization Project

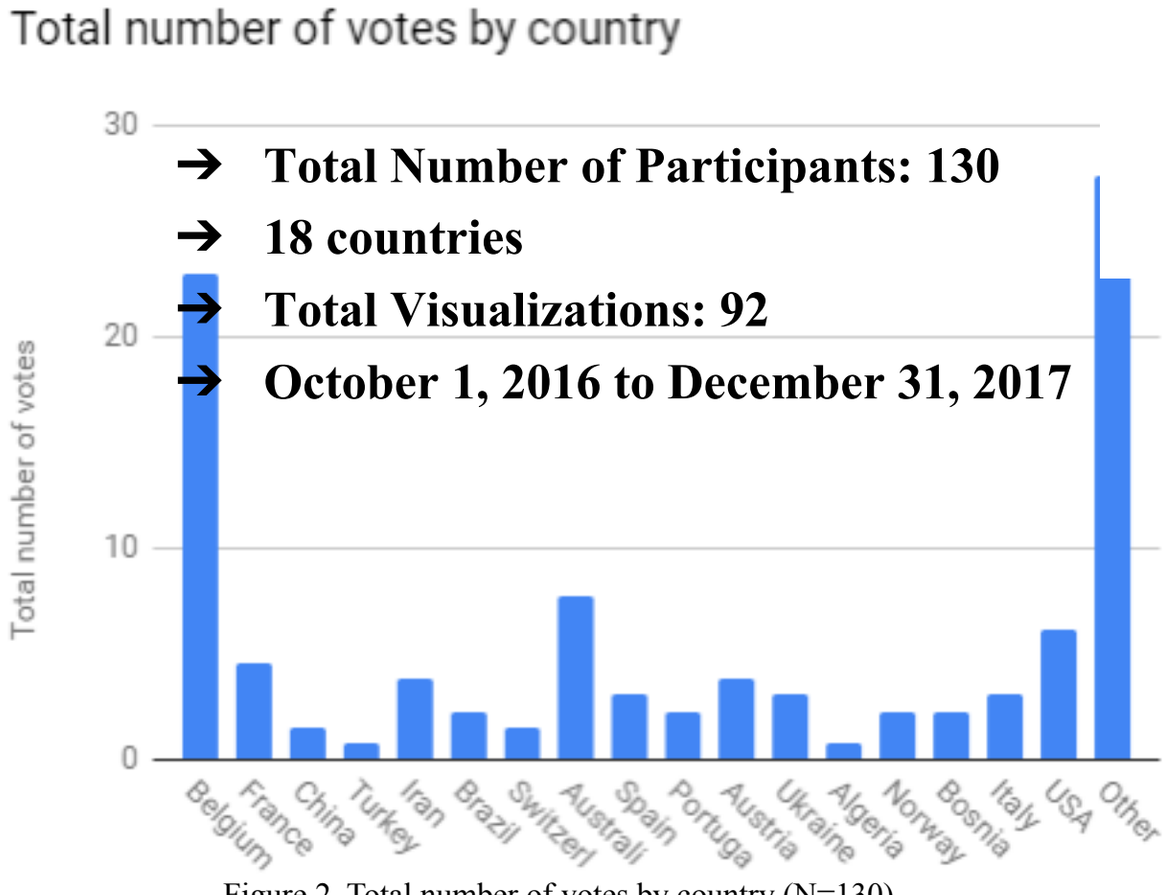


Figure 2. Total number of votes by country (N=130)

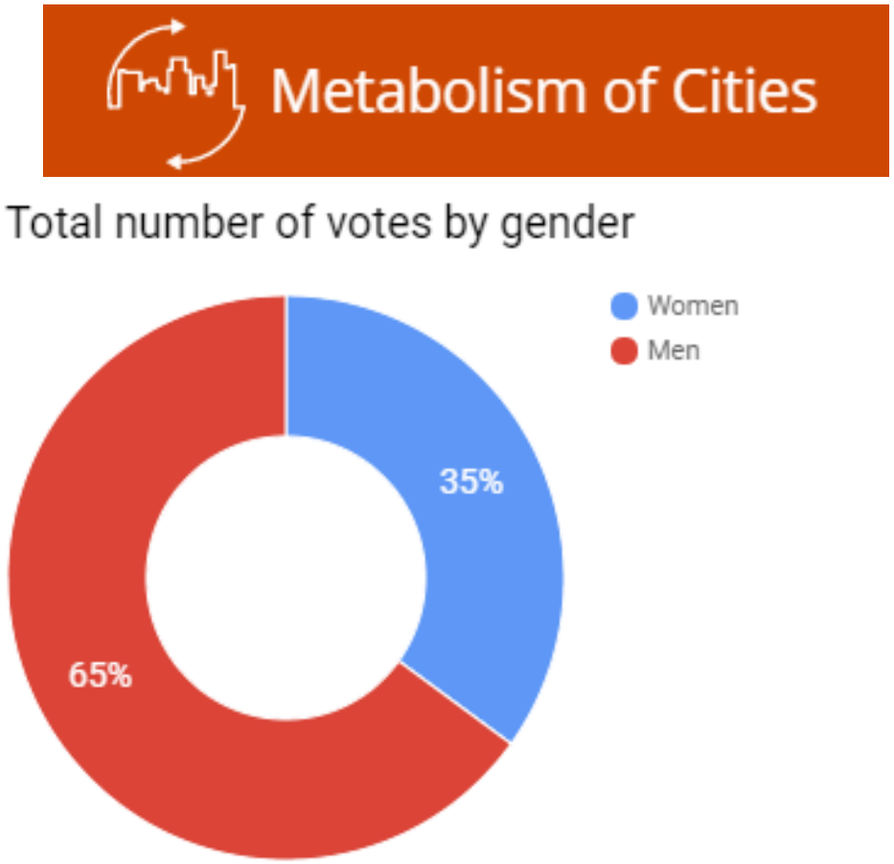


Figure 3. Total number of votes by gender

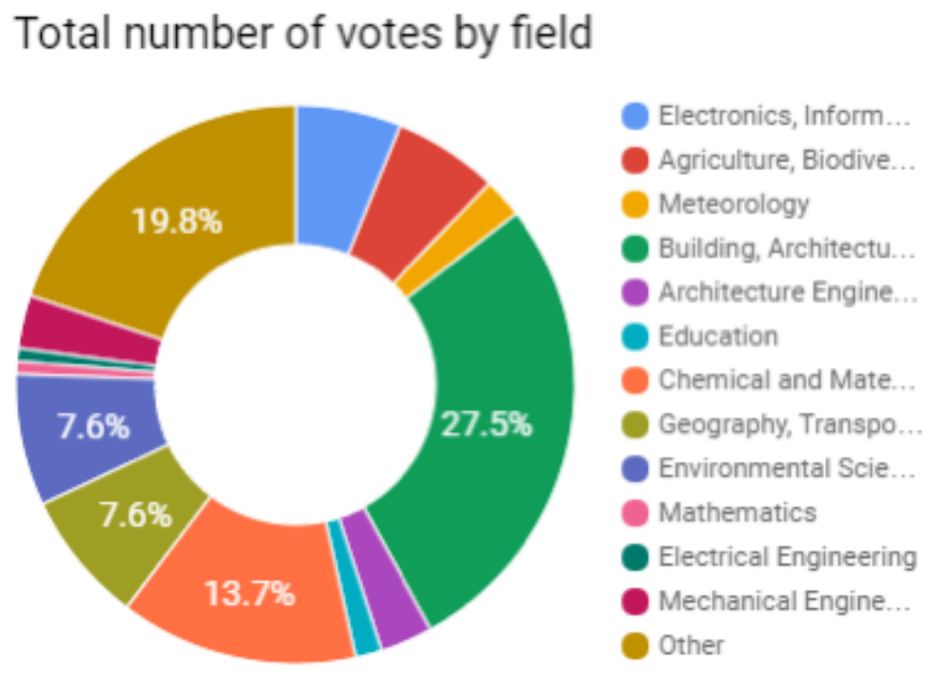


Figure 4. Total number of votes by interdisciplinary field

Metabolism of Cities

Spreading urban metabolism research, education and awareness Initiative:
What is next?

- International Society for Industrial Ecology Conference 2017
- **Global Urban Metabolism MOC Publication**
- **Urban Metabolism International Survey**
- **Defining the direction of urban metabolism!**

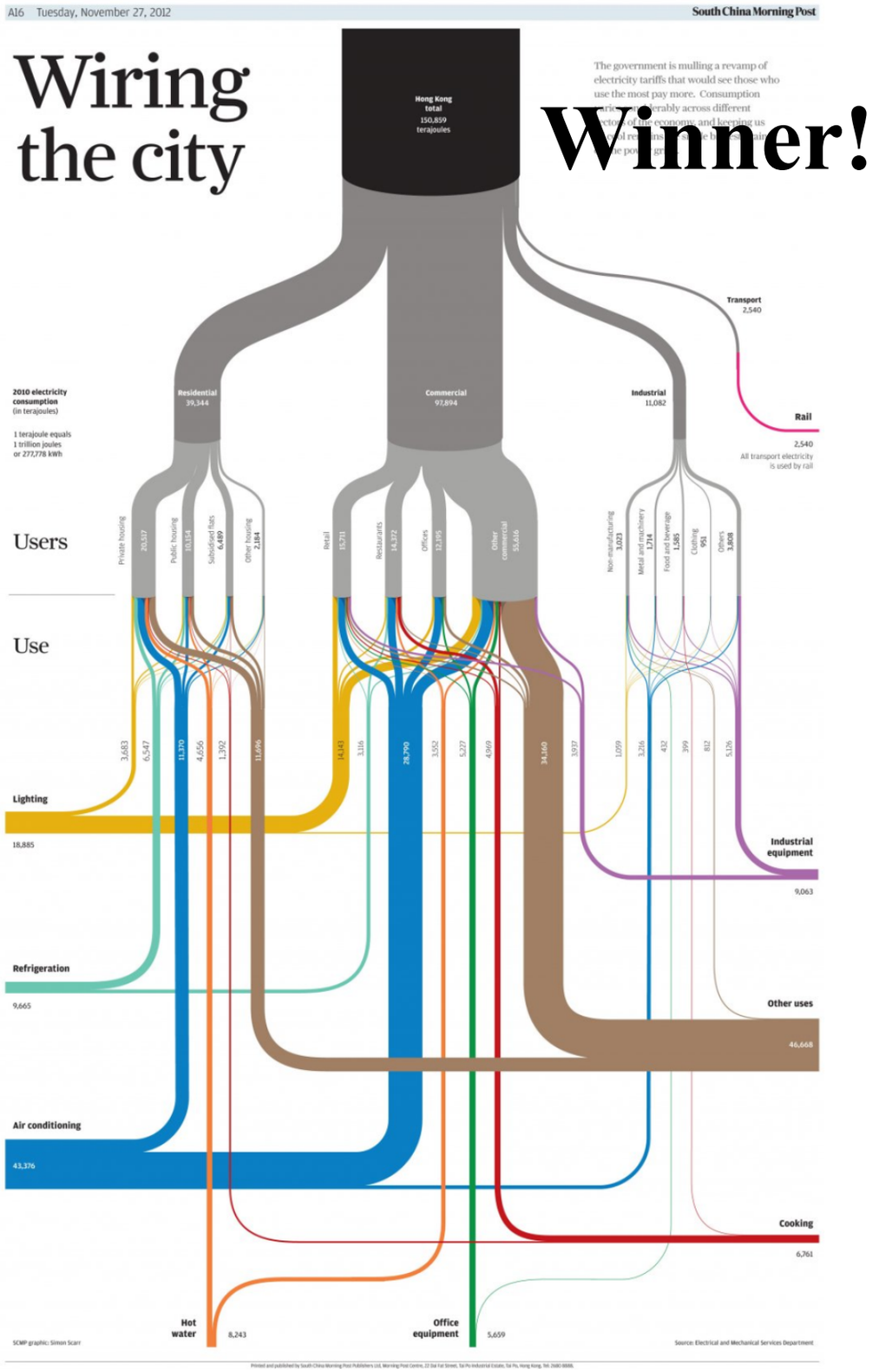
MOC Partnership Network:

GLOBAL INITIATIVE FOR RESOURCE EFFICIENT CITIES

GI-REC
Operationalizing Urban Metabolism at the City Level

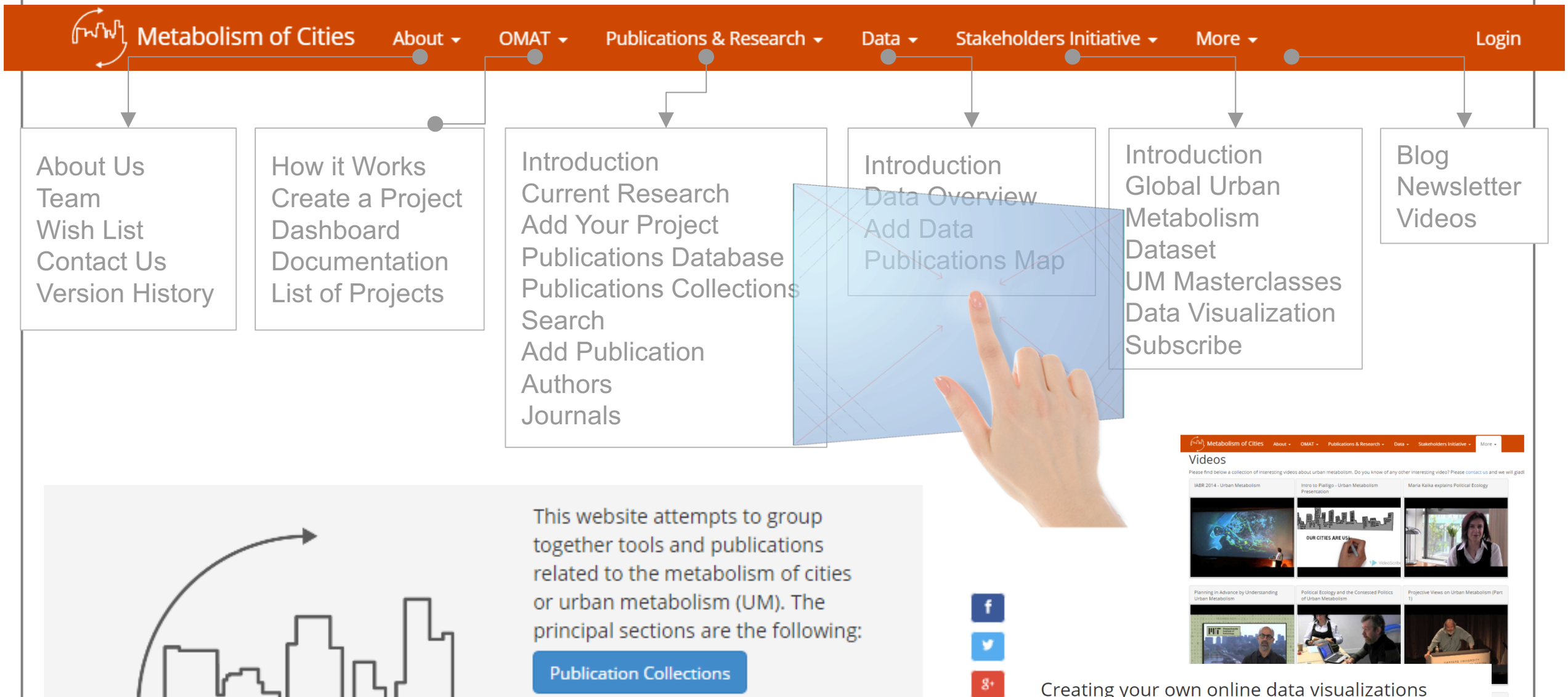
SUSTAINABILITY INSTITUTE

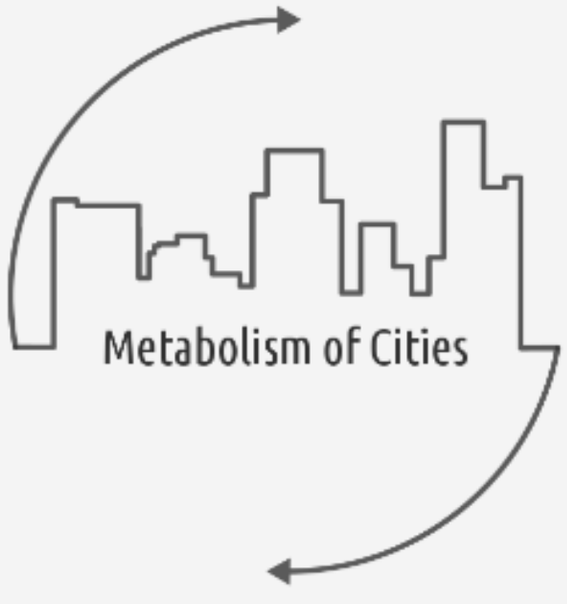
UN environment



Winner!

Metabolism of Cities (www.metabolismofcities.org)





This website attempts to group together tools and publications related to the metabolism of cities or urban metabolism (UM). The principal sections are the following:

- Publication Collections
- Publication Database
- Current Research
- Stakeholders Initiative
- Data
- Online MFA Tool (OMAT)

Creating your own online data visualizations

Published on Dec 09, 2016

Many researchers are familiar with the regular computer tools and desktop programs that are used for everyday tasks: word processors (like Microsoft Word or LibreOffice Writer) and spreadsheet programs (like Microsoft Excel or LibreOffice Calc) are frequently used to produce documents and reports. However, the use of online software can be very helpful when it comes to preparing data visualizations of urban metabolism research. But unlike office tools, the use of specialist online software is rarely taught in schools and it takes some effort to learn how to use them. The good news is that with a little bit of practice and by using the right tools, any urban metabolism researcher can start producing their own online data visualizations. In this blog post, we will introduce three tools and demonstrate how they work and how they can be used.

We selected three different tools: SankeyMATIC, Online Material Flow Analysis Tool (OMAT) and CartoDB. These were chosen because they provide different kinds of data visualization options but they are all highly relevant to urban metabolism research. They can furthermore all be used free of charge, and are easy to learn. For each of them we will describe what they should be used for, what kind of final can be generated from them, and we include a step-by-step tutorial for each of the tools to show you how to get started with them.

SankeyMATIC

What is it?

SankeyMATIC is an online sankey diagram builder. A sankey diagram is a diagram that shows the origin and destination(s) of flows by drawing a set of connected arrows, representing the quantities by varying the width of each line. This kind of diagram is very useful to visually represent the flow of energy through a system or to display the results of a material or substance flows study. This benefit of using such a diagram is that it can convey lots of information in an easy-to-understand format which requires little explanation. If this data is represented in a tabular format, it is often much more difficult to grasp proportions of flows and the relationship between the different flows. These kinds of diagrams may be easy to understand, but they are difficult to design without the right software. With SankeyMATIC it is possible to develop Sankey diagrams in a matter of minutes and with very little

UN environment

GI-REC
Operationalizing Urban Metabolism at the City Level

Systems approaches to make cities resource efficient

Local governments are tasked with maintaining and improving overall quality of life for their cities of which economic development, environment, and health are critical aspects. Long seen as a dichotomy, we now have proven and cost efficient solutions that allow us to combine both economic development and health of places and people. A resource efficient approach generates innovation and combines greater productivity with lower operating costs and reduced environmental impacts, while opening up consumer choices for sustainable lifestyles. Resource efficiency reduces overall city consumption while improving quality of life.

It is however, difficult to achieve resource efficiency if city management is compartmentalized. How many cities are there where the water providers do not talk to energy providers? Urban metabolism is one systems approach to city planning, which makes integrated, inter-sectoral, planning possible. Defined as a way of looking at cities and all the resources that flow within their complex networks ("material flows") of interlocked social and physical infrastructure, urban metabolism conceptualizes the city as a living super-organism in which there are continuous flows of inputs and outputs helps in the study of the patterns of movements of matter and energy. It encourages city planners to consider how cities source, process, and use resources in their spatial and socio-economic planning. Through resource flow analysis cities can:

- **Develop policies based on quantitative and qualitative knowledge of the flow of key resources (water, waste, energy, materials) taking into consideration its potential impact on food systems and land**
- **Consider city resource vulnerabilities beyond city boundaries and over time, making a city more resilient**
- **Use an integrated analysis to identify sectors where costs/waste can be cut down and 'close the loop' towards circular economy.**
- **Ensure equitable sourcing and distribution of, and access to resources using a resource map layered with socio-economic data**

Cities occupy **3%** of land surface

Cities produce **50%** of global waste

Cities account for **60- 80%** of global GHG emissions

Cities consume **75%** of natural resources

Cities produce **80%** of global GDP

High potential for savings through Resource Efficiency

30%

Water savings globally through minor investment and behavioral change

30% to 50%

Energy savings potential in existing buildings through behavioral change and application of readily available and low-cost technologies.

USD 41 TRILLIONS IN SAVINGS

Investment required for urban infrastructure in the next 20 years: Greater resource efficiency - in water, waste, transport and energy- could generate significant savings by reducing infrastructure needs and operating costs.

What is the Global Initiative for Resource Efficient Cities?

The Global Initiative for Resource Efficient Cities (GI-REC) is a cooperation platform offered by UN Environment to connect many different institutions that are using systems approaches (specifically urban metabolism and morphology approaches) towards building low-carbon, resilient, and resource efficient cities. Using UN Environment's convening ability, the Initiative distinguishes itself from other city sustainability activities by (a) building on existing city networks, and (b) having a sustainable consumption and production entry point to assist cities with realizing the economic, social and environmental benefits of resource efficiency.

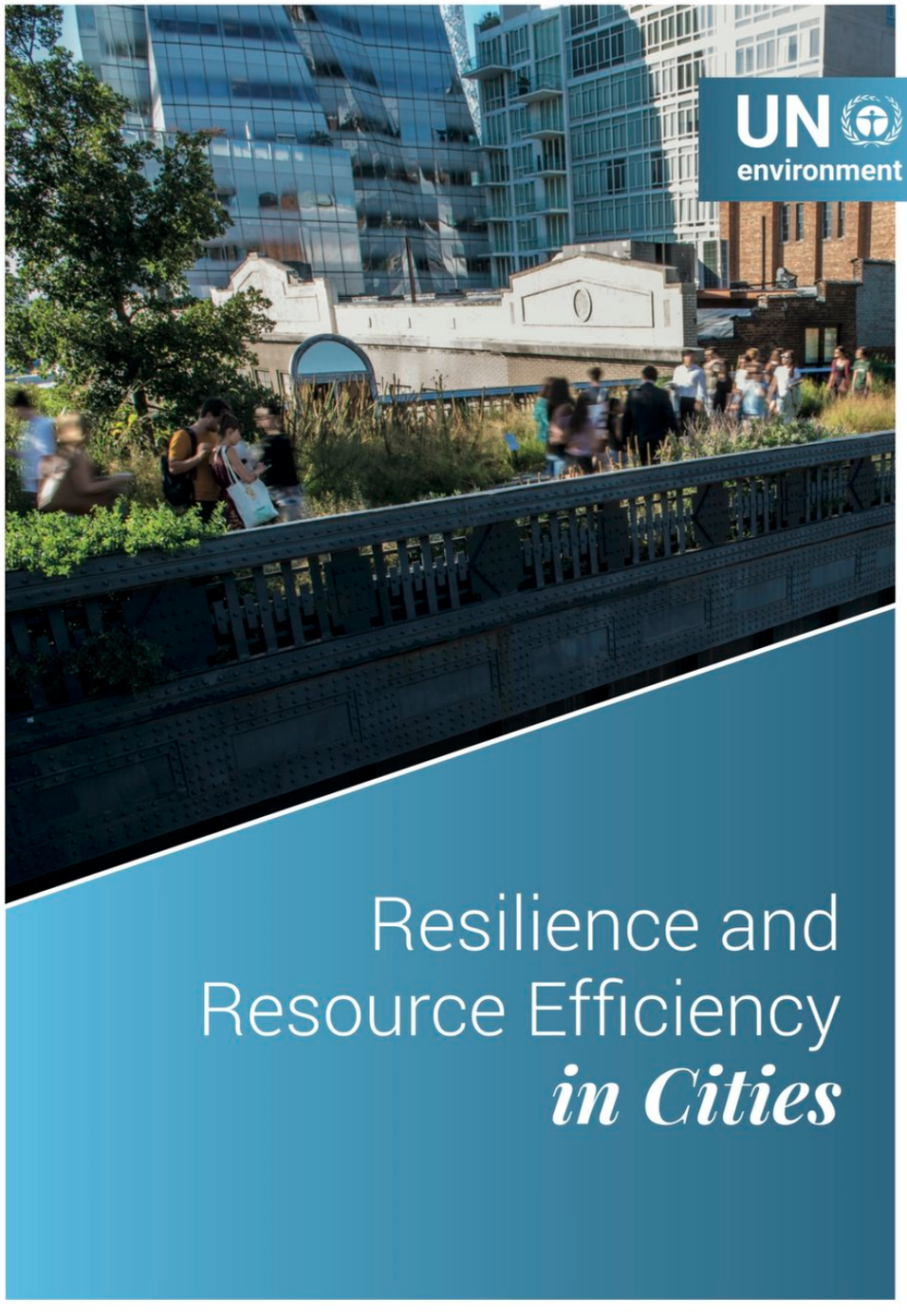
Tools and Support Mechanisms

Creating Knowledge
(developing tools and research products)
In various fields related to resource efficiency and SCP as well as to increase access, processing and use of resources through supply chain and life cycle management, to facilitate decision-making in creating solutions to improve efficiency of processes and use of resources within and across value chains, taking a Life-Cycle approach.

Piloting
To help cities apply the Urban Metabolism approach:
a. Access to methodology and technical expertise.
b. Intra-city decision-making processes based on science, translating theory into practice.

Network Platform
It provides a mechanism for decision makers to exchange experiences, share best practices, and establish a peer-review process across cities for further improving access to resources and their efficient use.

PARTNERS

CONTACT INFORMATION | Global Initiative for Resource Efficient Cities UN Environment, Economy Division | 1 Rue Miollis, Building VII, 75015 Paris www.resourceefficientcities.org

Resilient Cities Congress, Bonn, Germany (May 4, 2017)