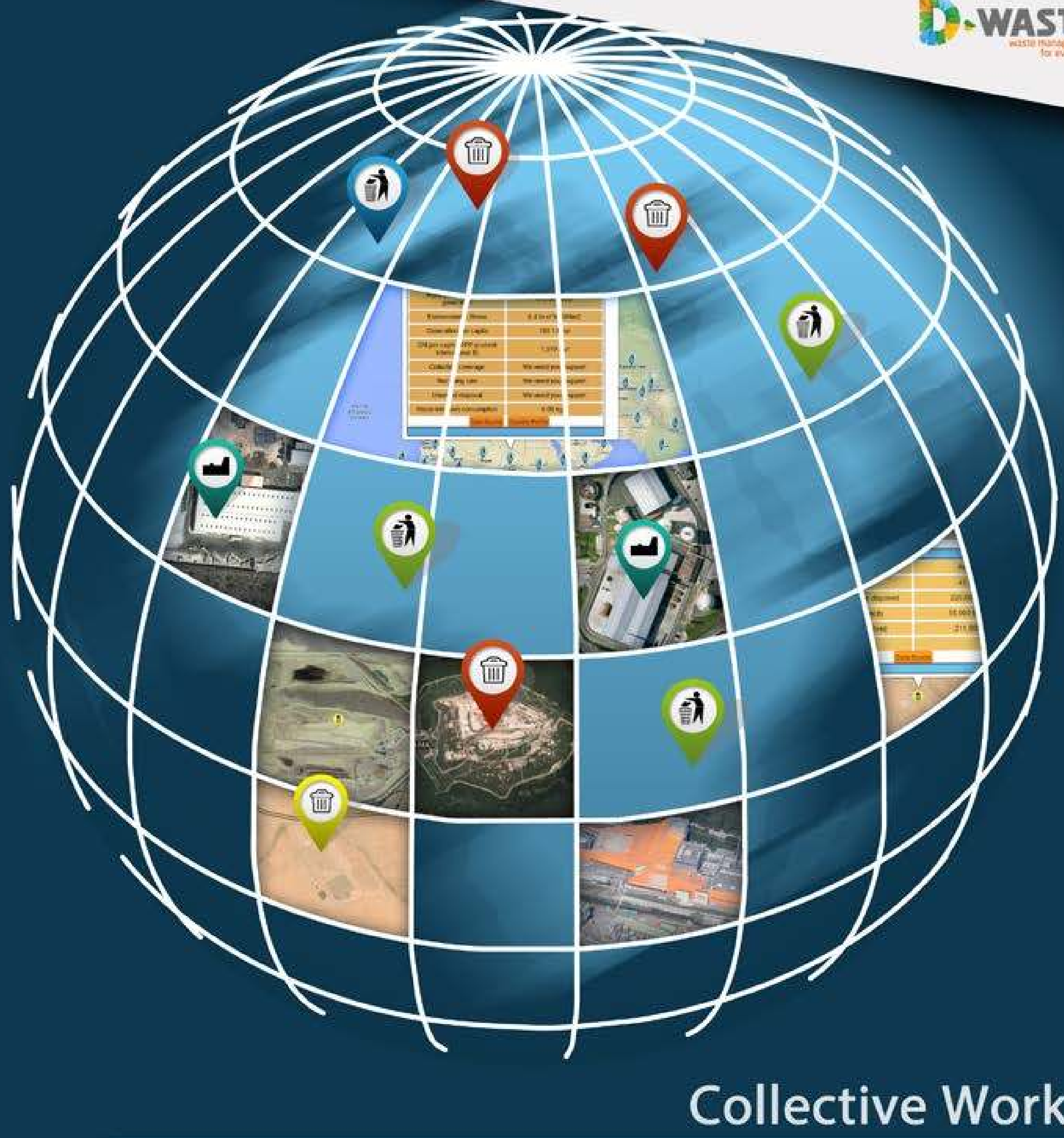
Waste Atlas
2013 Report

Powered by D-WASTE waste management for everyone



Collective Work

Welcome to the 1st Annual Report of Waste Atlas. Here we introduce the concept of Waste Atlas and its main features. The free access, crowdsourcing and non-commercial characteristics of Waste Atlas are presented, along with key data highlights.

ISWA International Solid Waste Association   WTERT   SWEEPNET   UNIVERSITY OF LEEDS   SWAPI

STEERING COMMITTEE

Hermann Koller – Managing Director of ISWA
Markus Luecke – GIZ, SWEEP-Net Teamleader
Antonis Mavropoulos – CEO and founder of D-Waste
Surendra Shrestha – Director of International Environmental Technology Center, UNEP
Masuro Tanaka – SWAPI coordinator, Tokyo University
Nickolas J. Themelis – Professor of Chemical Metallurgy, Department of Earth and Environmental Engineering, Columbia University, US

SCIENTIFIC COMMITTEE

Jose Fernando Juca – Professor at UFPE, Recife Area, Brazil;
Stratos Kalogirou – President of WTERT Greece and also a member of the Board in WTERT/USA in Earth Engineering Center of Columbia University;
Agamuthu Pariatamby – Editor-in-Chief of WM&R, University of Malaya, Kuala Lumpur, Malaysia;
Mario Russo – Coordinator Professor at Polytechnic Institute of Viana do Castelo, Portugal;
Costas Velis – Lecturer in Resource Efficiency Systems, University of Leeds, UK;
Goran Vujic – Assistant Professor at the University of Novi Sad, Serbia.

WASTE ATLAS TEAM

Waste Atlas has been developed through coordinated efforts and contributions by almost a thousand people. However, most of the work regarding the web interface and the data acquisition has been done by the permanent Waste Atlas Team, namely:

Ilianna Koukosia – GIS Expert
Ioannis Makris – Waste Atlas Developer
Alexandros Mavropoulos – Waste Atlas Project Manager
Antonis Mavropoulos – D-Waste Founder & CEO
Niki Mavropoulou – Data Analyst
Anthi Psalida – Data Analyst
Maria Tsakona – D-Waste Product Manager

CONTRIBUTORS

We would like to thank all the contributors for the data they provided. We would like to thank especially the following people for their excellent contributions: Ranjith Annepu (India), Timothy Byrne (United Kingdom), Magda Correal (Colombia),Natālija Cudečka-Puriņa (Latvia), Makoto Fujita (Japan), Joy Jadam (Lebanon), Ana Loureiro (Portugal), Liubov Melnikova (Russia), Ralf Müller (Germany), Juan Antonio Munizaga (Chile), Iris Odenthal (Germany), Michiko Ota (Japan),Eva Ridick (Mongolia), Ricardo Rollandi (Argentina), Atilio Savino (Argentina), Nickolas Themelis (USA), Jenny Westin (Sweden), Filipa Vaz (Portugal), Christos Venetis (Greece), Claudio Vieira (Brazil).

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Waste Atlas Partnership

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LEGAL NOTICE

PREFACE

The Waste Atlas started as a simple, yet powerful idea. There is so much data about waste management 'hidden' in the web: reports and scientific publications. How about having it organised in a user-friendly, well-structured and clearly presented way, able to provide meaningful information to those who need it? A simple way would be to organize the gigabytes of data and the hundreds of thousand documents around a map. Even better, extract the most reliable data, give it a uniform shape format and upload it on a web map, so that everyone always could access it. And why not provide free access to it and ask everyone to contribute, because this is the only way to obtain unreported information and to serve the need for continuous validation and updating.

The idea was simple, but the implementation was much more complex. It took thousands of man-hours to develop the right software tools capable of managing the data complexity, make it user-friendly, screen files and search for the most reliable values, and identify the exact location of thousands of facilities. Despite these challenges, the Waste Atlas is here, and with this report we celebrate its first birthday.

During this first year, the Waste Atlas became a collaborative product of six organizations (ISWA, WtERT, SWEEP-Net, SWAPI, University of Leeds, and D-Waste) and of nearly one thousand individuals. Despite their different backgrounds, all of them share the same view of a sustainable waste management in need to be understood on a global scale. There is agreement in that integrated waste management efforts currently lack in data sets and benchmarking tools required to fast improve things on the ground. There is consensus on the urgent need to develop modern web and mobile applications that will serve the waste management and recycling community.

Waste Atlas is already a unique information tool that aims to fill the aforementioned gaps and become a global reference for waste management experts, decisions makers, municipalities, companies, students, researchers and the general public.

In less than a year, Waste Atlas has been shaped with data from 59,000 files and documents. Currently (August, 2013), Waste Atlas hosts data for 162 countries, 1773 cities, 840 sanitary landfills, 697 waste to energy (WtE) plants, 100 mechanical-biological treatment (MBT) facilities, 74 biological treatment facilities, and 46 of the world's biggest dumpsites. The supporting software has been advanced to include a suite of novel customised graphs, visualizations and data-reporting modes. Waste Atlas among else provides unique global graphs that hint towards potential correlations of economic and social variables with key waste management indicators.

This document is the '2013 Waste Atlas report' and aims at presenting the first year's progress and the Waste Atlas database outputs regarding the profiles of 162 countries. The most significant difficulties faced are described, as well as, the next steps to be taken.

Waste Atlas has just started on its long way. Already widely recognized as a very useful tool, it will need much more work and improvements to become more scientific, more representative and more interactive. We will keep working hard on these three aspects, in close collaboration with our global partners and thousands of contributing individuals. As we keep uploading and managing data, we do not forget to mark the new emerging questions that will bring forward new data demands, in a perpetual cycle.

We do hope you will find this report useful and look forward to your comments and contributions.

Antonis Mavropoulos
D-Waste Founder & CEO

KEY MESSAGES

STEERING COMMITTEE

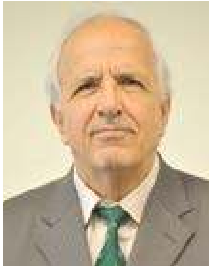
Markus Luecke, GIZ/SWEEP-Net Teamleader: SWEEP-Net as a regional network for integrated solid waste management in the Middle East and Northern African region highly welcomes and supports Waste Atlas, since it provides essential and important information for all planners, decision makers, potential investors and other stakeholders concerned with solid waste management and the efficient management of natural resources. The information provided is clear and – most important - free accessible. This makes Waste Atlas attractive especially for our partners in developing and emerging countries. Waste Atlas allows for benchmarking and provides a platform where countries can present their state and pace of development in this important sector. SWEEP-Net therefore is ready to contribute in making Waste Atlas a success.

David Newman, President of ISWA: ISWA is proud to be a partner of the Waste Atlas and will contribute to its diffusion, the information contained within it and its use as a tool for waste planning. I think the essential point about the Waste Atlas is this: it is a phenomenal tool for city planners facing challenges in implementing waste systems, so this goes for about half the world's population today. But more than this, the Waste Atlas provides a clear and easily consultable tool to understand where, how and which waste is treated (or not) and in what form. It gives a quick insight into the state of development of many nations and from this we can understand what an important factor waste is today in ensuring sustainable development. The Waste Atlas changes the game in terms of the quality of information available in one source, and for this its developers and we, as partners, should all be proud to offer this source, free, to the world.

KEY MESSAGES

STEERING COMMITTEE

Surendra Shrestha, Director of IETC/UNEP: In 2012, the Rio+20 conference underscored that broad public participation and access to information is essential to promoting sustainable development. The Waste Atlas is an initiative that provides access to information on waste management around the world, supporting UNEP's efforts to strengthen the science-policy interface and to promote integrated solid waste management globally. Waste Atlas takes data from multiple sources and organizes and structures it in a meaningful way. It is accessible to everyone, everywhere, and even encourages people to contribute information through crowdsourcing, thus empowering the public to monitor developments in their environment. As waste and its impacts is one of the most daunting environmental challenges in the 21st century, the Waste Atlas is an important step towards a concrete contribution to sustainable development.



Nickolas J. Themelis, Professor at Columbia University and founder of Global WTERT Council: The Waste Atlas is an ambitious undertaking to manage the oceans of waste management data generated in different parts of the world. After only one year of intensive effort, this project is on its way to accomplish this goal. The Global WTERT Council wishes our colleague Antonis Mavropoulos, full success!

KEY MESSAGES

SCIENTIFIC COMMITTEE

Agamuthu Pariatamby, Editor-in-Chief of WM&R, University of Malaya: The Report looks great and exhibits data that is clear. The organization of the data is good and will appeal to professionals as well as waste managers. The approach of disseminating the solid waste data in simple but colorful figures will definitely capture the audience. I am delighted to be a part of this important report which will form another very important source of information.

Mário Russo, Coordinator Professor at Polytechnic Institute of Viana do Castelo: The Waste Atlas is an interactive tool that was lacking in the waste sector in any country, since it lets us easily and for free to access several important data for planners, designers, managers, politicians and citizens interested in the issue of waste. It has the merit of providing a collection of standardized data in a single source. For millions of people it is the only source with data that allow planning and design in many countries, especially in Africa, Latin America and Asia. I must stress that it is an interesting tool for engineering students for their research and academic works. All the "Waste Family" must collaborate with Waste Atlas in order to improve the data about waste sector in their countries.

KEY MESSAGES

SCIENTIFIC COMMITTEE

Costas Velis, Lecturer at University of Leeds: a world-leading institution delivering research and education of global impact, is delighted to actively support the creation, operation and dissemination of Waste Atlas. We will contribute to the scientific robustness of this ground-breaking initiative, and ensure that the wider academic community and its beneficiaries, from students to policy and decision makers will receive maximum benefits. Introducing a practical tool such as Waste Atlas is the result of 'big think' and has huge disruptive potential: for the very first time, it enables all stakeholders to obtain an overview of key solid waste and resource management facts, in a freely accessible, rapid, succinct, comprehensive and user-friendly way. Flexible in scale, it goes from local to global. Its crowdsourcing feature empowers people in sharing much needed information, making available otherwise unobtainable, lay expertise, such as the location of obscure dumpsites. Data quality is of paramount importance and considerable effort is dedicated to cross-check, validate and overcome any discrepancies. Its potential as a source of previously unavailable critical data, combined with completeness of coverage, provides already a unique overview and benchmarking opportunities. As a database, it opens new important opportunities in developing novel insights, not least on the fundamental interdependencies between technologies, governance, and socioeconomic factors, which lie at the heart of effective waste and resources management. As the solid waste management practitioners and other stakeholders get their hands around Waste Atlas a new unprecedented level of awareness could be soon achieved. As everything radically new, teething issues will inevitably be present. We invite you to join us and focus on the big picture, heralding the arrival of Waste Atlas, a major leap forward for the waste and resources community, an absolutely timely and significant achievement.

Goran Vujic, Assistant Professor at the University of Novi Sad: Waste Atlas is a very fast, reliable and comprehensive visual tool for students who need to understand complexity of Global, but also Local-Regional Solid Waste Management. Using the big variety of data presented in Waste Atlas students can understand the impacts that culture, GDP, social, demography and other aspects have on Waste management. In future, academics and experts will have a great opportunity to work together on predicting waste quantities and composition, with Waste Atlas to provide a good starting point. Waste prediction analysis is one of the examples that can display how important and useful tool Waste Atlas can be for everyone, from students and professors to engineers, decision makers and authorities.

CONTENTS

INTRODUCTION

AN OCEAN OF DATA

Our era is characterized by an explosive growth in the amount of data available. Rapid technological evolution and development has led to increased exchange of information. According to IBM [1], around 2.5 quintillion bytes (2.5 x $10^{(18)}$ bytes) of data are generated daily (2012), embedded in the physical world in devices such as computers and mobile phones, in the course of creating and communicating data.

This tremendous rate of data generation results in vast amounts of data remaining unstructured on the web, making necessary the use of search engines seeking for meaningful information. Around 80% of the data generated is in the unstructured and form of presentation files, emails, audio and video files.

In the waste management sector there is also a great amount of data on the web that remains mostly unstructured. To illustrate, Figure 1-1 presents the results that the Google search engine generated for several key words related to waste management, on April 4, 2013. The magnitude of the results in Figure 1-1, demonstrates the massive amount of waste management data available on the internet.

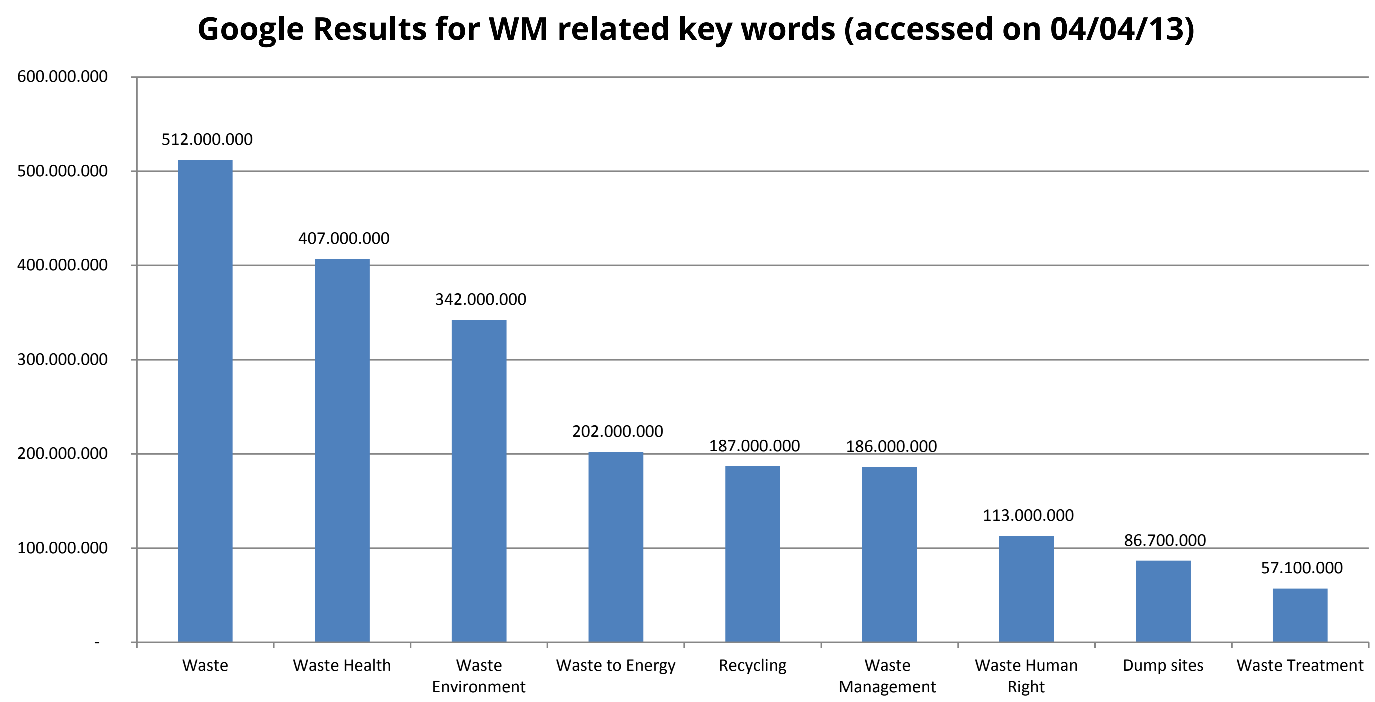


Figure 1-1: Google results for WM related key words

[1] IBM (2012), “Understanding Big Data”. Available at:
http://www-01.ibm.com/software/data/bigdata/
[2] BASEX (2008), “Information Overload: Now $900 Billion – What is Your Organization’s Exposure?”. Available at:
http://www.basexblog.com/2008/12/19/information-overload-now-900-billion-what-is-your-organizations-exposure/

There is a vital need for meaningful filtering, interpreting and guiding through this information 'chaos'. Currently, the Google search engine receives more than two million queries per minute [(2)], from users who seek useful and meaningful information. At the same time, according to research by Basex [(2)], information overload costs the U.S. economy a minimum of $900 billion per year in decreased employee productivity and innovation.

To those who use search engines for professional purposes and look for easily accessible yet reliable information, it becomes obvious that there is a need for better, more selective and more efficient search engines. This need can be safely anticipated to significantly grow in the future.

The challenge is both quantitative and qualitative. In quantitative terms, the challenge is to identify the most suitable results amongst hundreds of thousands to hundreds of millions of available data, without spending disproportionately much time. In qualitative terms, the ranking of the 'search' results is usually based on the popularity of the web pages and their relevance with the 'search' terms. Nevertheless, neither popularity nor relevance is directly (if at all) linked to the reliability required for professional and scientific purposes.

Another important limiting factor is the human capability to process and understand data. According to the economist Herbert Simon, "A wealth of information creates a poverty of attention and a need to allocate that attention efficiently among the overabundance of information sources that might consume it." To overcome this apparent or actual limit, several ways are available to process, visualise and synthesise meaningful information from this unstructured initial data population. Data management techniques are one of these ways, creating significant value by transforming data to information patterns.
Regarding the waste management and recycling sector, there is a growing recognition of the need for data sets of worldwide coverage, which will allow all interested parties to benchmark and justify local decisions and policies in a more informed and relationally justified manner. Waste Atlas aims to gather all such useful data in one place and provide tools for transforming data into meaningful information, most helpful in decision making processes. To this, Waste Atlas combines advanced data visualisation technologies with crowd-sourcing and experts reviews.

WASTE ATLAS

WASTE ATLAS CONCEPT

Waste Atlas is a crowd-sourcing, non commercial, free access map that visualises municipal solid waste management data across the world for comparison and benchmarking purposes. The platform can be easily accessed through the web portal www.atlas.d-waste.com and aims to transform the vast amount of data available into meaningful information and make it available to everyone interested in waste and resource management.

Data collection and uploading is based on the contribution of global partners and numerous scientists, consultants, academics, students and practitioners, from many countries and organizations. Data uploaded on Waste Atlas is cross-validated in the first place with other data sets available from multiple sources to ensure its reliability and consistency. What is finally published is what is considered as the most accurate. Specifically, each quantitative piece of information published is accompanied with reference to its published source. However, even data with published sources may not be as accurate, reliable and up to date as required; hence, all data is comprehensively evaluated before uploading. To this, the validity and publication date of the accompanied source is also taken into account. The methodology used to produce the data is evaluated as well. Multiple or comparable sources are actively sought and where available cross-checking is performed, e.g. taking time evolution or regional (/country/city) features into account. Verified outliers or data of questionable quality are exempted from uploading. However, all documents are kept in our database for future re-evaluation.

Net, the Global WTERT (Waste to Energy and Technology) Council, GIZ/SWEEP-NET, SWAPI and the University of Leeds. Each partner has its unique role in this alliance:

D-Waste (www.d-waste.com) is responsible to organize the project; to provide, develop, update, optimize and support technically the Waste Atlas web tool; to receive, elaborate, examine and correct (if necessary) the data provided; to implement, demonstrate and visualize the data provided; to bear the costs of data collection, acquisition and management and the expenses of website management and hosting and its equivalent application; to promote the Waste Atlas web tool.

ISWA (http://www.iswa.org/) a global, independent and non-profit making association, working in the public interest to fulfil its declared mission which is "To Promote and Develop Sustainable and Professional Waste Management Worldwide" provides waste management data already available from its long established working groups and conferences' proceedings and its unique Knowledge Base project.

Global WTERT Council (www.wtert.org) is an academic-industry organization consisting of fourteen national groups; it brings together engineers, scientists, and managers from universities, industry, and government with the objective of advancing sustainable waste management worldwide.

GIZ/SWEEP-NET (http://www.sweep-net.org/) is a regional network which works on institutionally anchoring the principles of sustainable and integrated solid waste management in Middle East - North Africa region countries and beyond, supports Waste Atlas by providing waste management data on regional, city, or country level utilizing the network's scientific and professional resources.

SWAPI, the Society of Solid Waste Management Experts in Asia and Pacific Islands is an organization which is rapidly developed at the Asian Pacific Region, where more than half of the global population is situated, promotes Waste Atlas at the Asian Pacific and encourages its members to provide local waste management data.

University of Leeds (www.leeds.ac.uk), a world-leading institution, delivering research and education of global impact, actively supports the creation, operation and dissemination of Waste Atlas. Waste and resource management expertise within the School of Civil Engineering, focusing on cross-disciplinary innovation for closing the materials loop and renewable energy generation, will contribute to data provision, analysis and overall scientific robustness of Waste Atlas. University of Leeds will ensure that the wider academic and research community and its beneficiaries, from students to policy- and decision-makers, will feed into Waste Atlas and receive maximum benefits from it.

During the 1st Waste Atlas Workshop held on April 24, 2013, representatives from all the entities participating in the Waste Atlas partnership declared the establishment of a steering and of a scientific committee. More specifically, it was decided that role of the steering committee will be to coordinate - prioritize the activities related to Waste Atlas partnership and to indicate future steps and targets for further development, whereas role of the scientific committee will be to ensure the scientific and technical integrity and consistency of the project, its proper documentation and scientific support and its linkages with research and academic institutes.

INPUT TO, ARCHITECTURE AND USE OF WASTE ATLAS

So far, more than 5,000 unique users have used Waste Atlas from 122 different countries, almost 1,000 people use its demo mobile app and more than 1,000 people have contributed with data. Currently, the database supporting Waste Atlas includes more than 59,000 files and it is increasing day by day and at a fast pace.

Waste Atlas software is based on the MVC (Model-View-Controller) architecture and is written using several programming languages, including PHP, Html5, JavaScript and CSS3. The front-end (View) utilizes Google Maps JavaScript API v3 for the presentation and projection of geographically-enabled data and Google Chart Tools for data visualization and chart rendering. It also uses the JavaScript library, JQuery, for the user interface and layout of the application. The back-end (Model and Controller) utilizes a powerful MySQL database for storing, organizing and retrieving data.

Waste Atlas design and layout aim at providing to its users a handy and easily-navigated web application. The functionality provided by Waste Atlas includes:

- Searching, retrieving and displaying the available data on the map
- Geocoding, that is searching for addresses (such as "1600 Amphitheatre Parkway, Mountain View, CA") or places and display them on the map
- Distance Calculation between two or more items on the map
- Easy change of map type. Available types are RoadMap, Satellite, Hybrid and Terrain
- Street View ability where applicable
- Map Overview on the bottom right of the map to easily identify current position in high scales
- Automaticaly generated, up-to-date and print-ready Country Waste Profile for all available countries

Users can benefit from Waste Atlas functions by:

- Creating Customized Charts for comparison purposes
- Viewing unique Global Correlation Charts (see Section 2.3)
- Accessing global visualizations of specific waste management indicators (See Section 2.3)
- Obtaining information regarding the amount of data already uploaded on Waste Atlas
- Accessing data regarding current global waste management situation
- Submiting waste management data

More detailed information about Waste Atlas can be accessed through the Help tab of the application at www.atlas.d-waste.com

Waste Atlas is also available as a mobile application available in **Android** and **iOS markets**. Use the QR to download it from the App Store.

FUNCTIONALITY ALREADY AVAILABLE ON WASTE ATLAS

Waste Atlas focuses on municipal solid waste and provides data for countries, cities and waste management facilities. As municipal waste is defined the waste mainly produced by households, including also similar waste generated from sources such as commerce, offices and public institutions. The amount of municipal waste generated consists of waste collected by or on behalf of municipal authorities and disposed of through the waste management system[3] . The waste composition adopted in Waste Atlas includes the following streams: organic, paper/cardboard, metal, plastic, glass and others. In all cases, data on Waste Atlas is presented in a way to facilitate users to compare conditions and situations.

DATA FOR COUNTRIES

The data uploaded on Waste Atlas aims to provide the users with a better understanding of a country's waste and resource management in the context of its wider situation. Therefore, in addition to waste management data, the Waste Atlas also provides economic, social, population and development indicators.

[3]European Environment Agency, 2013, 'Managing municipal solid waste — a review of achievements in 32 European countries'. Available at: http://www.eea.europa.eu/publications/managing-municipal-solid-waste

The users can find information about waste generation per capita, municipal waste generation, environmental stress, waste intensive consumption, collection coverage, recycling rate, unsound disposal and waste composition (See Annex II for definitions). Other indicators available are: GNI per capita (PPP); access to improved sanitation facilities; access to improved water source; population; population density; the percentage of urban population; and the Human Development Index (HDI). Although many countries have data that is available and up to date, for several cases it was difficult to find an accurate and up to date waste synthesis. Typical data quality challenges are:

a) In many scientific reports and articles writers adopt as waste composition of the country the waste composition of the country's capital, which is not always accurate. The same inaccurate extrapolation is done for waste generation per capita rates too.

b) The different components of municipal waste (organics, paper, plastics, etc.) are not uniformly defined, creating consistency problems.

c) The definition of municipal waste is not the same and it differs significantly in between countries. A very often phenomenon was the integration of the C&D stream into the municipal one.

For challenge a), cross-checking with Waste Atlas database data from multiple sources was used as a means to adjust apparent mistakes. For the challenges b) and c), besides cross-checking with data from similar conditions, basic statistical analysis was used to identify data inconsistencies.

So far, data sets for 162 countries are uploaded, covering 97% of global population. Based on these datasets, country profiles have been created and are available. An example of a country profile is given in **Figure 2-1**.

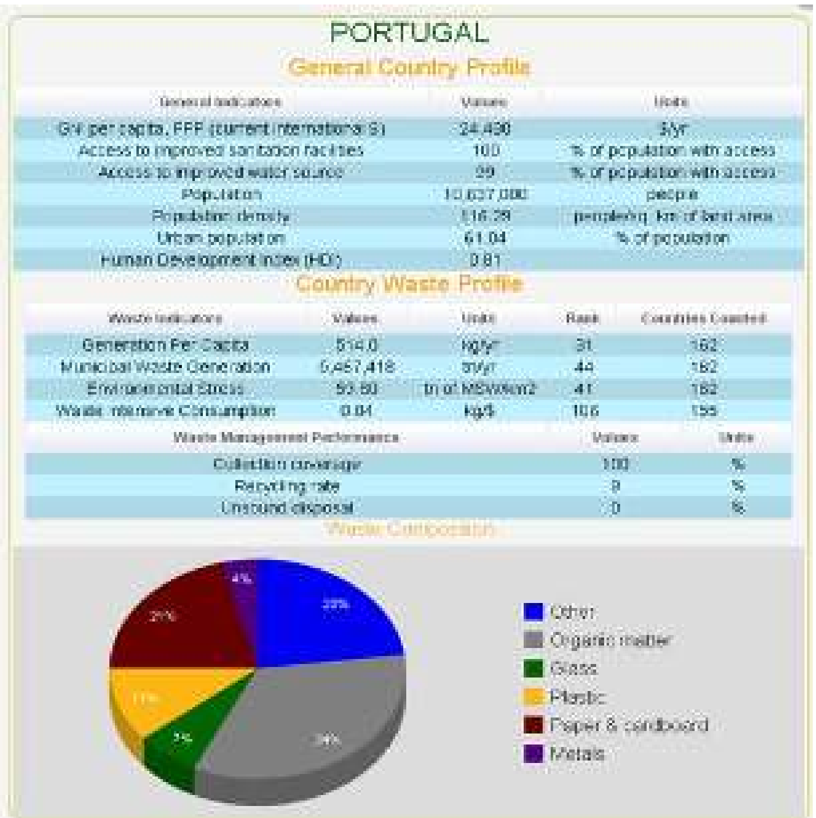


Figure 2-1: Portugal country profile on Waste Atlas

DATA FOR CITIES

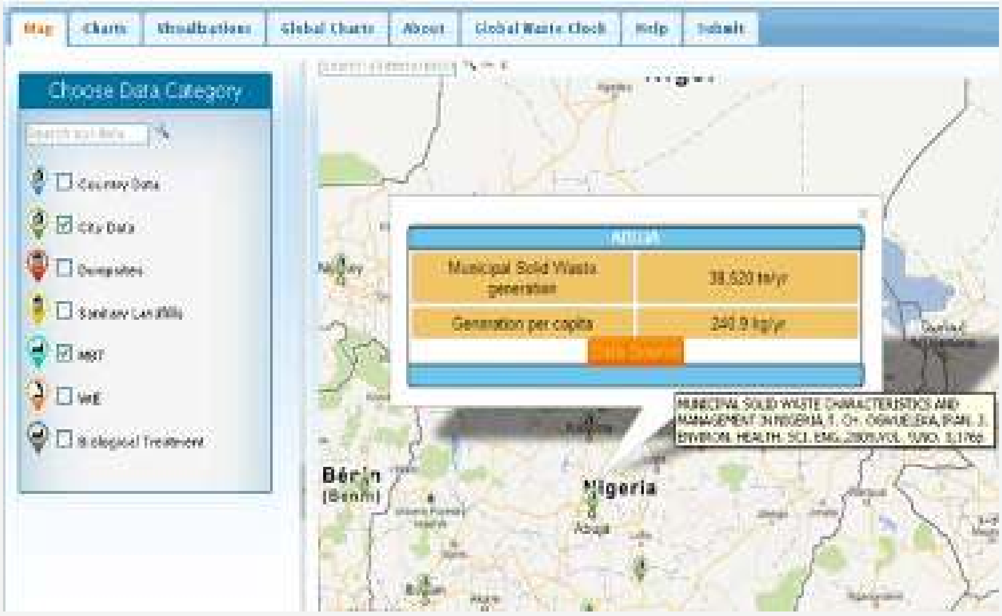
This layer includes data for 1773 cities from all over the world and more specifically information about overall municipal solid waste generation and municipal solid waste generation per capita. For these two categories of data are provided to the users it should be highlighted that an important inconsistency was made apparent while researching for data.

In many papers, referring to the same cities for similar periods, different waste generation per capita rates, different overall waste generation and finally different populations were provided. In some cases, the three parameters did not match at all as it was proven with elementary maths.

The problem is probably more generic and it is due to three factors.

a) The definition of a city is not always clear, especially when multiple municipalities and metropolitan areas are the subjects of the analysis. Thus different populations may be associated with different waste quantities and resulting in often biased or mutually inconsistent data points.

b) In many cases waste generation is assessed based on the waste collected or disposed of, leading to underestimation of the involved metrics since they do not include (often informal) recycled quantities.



c) Different authors use different municipal waste definitions, resulting in different waste generation profiles.

An important challenge is the lack of concrete socioeconomic datasets at the city level that would have allowed the investigation of potentially useful correlations between waste profiles and socioeconomic indicators.
Data for cities derives from the latest reliable source available in Waste Atlas database. Moreover, in some cases the city data provided considers regional and metropolitan areas. Such problems will be dealt with Waste Atlas next steps.

DATA FOR FACILITIES

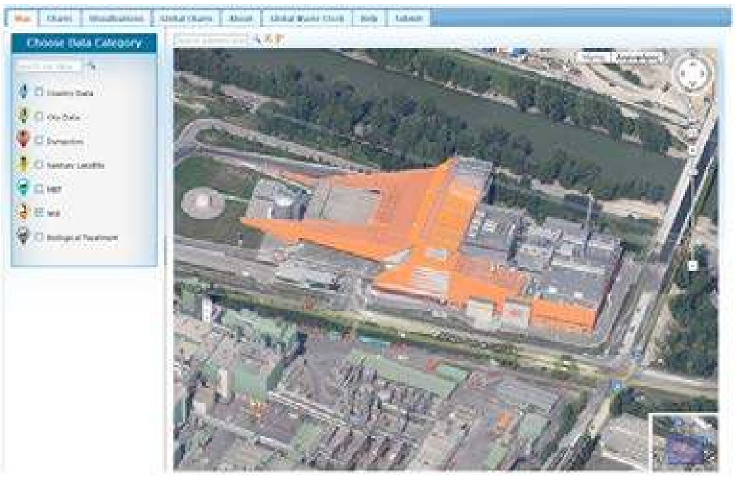
This group of data aims to provide to Waste Atlas' users useful information about a range of solid waste treatment facilities. More specifically, Waste Atlas hosts layers about sanitary landfills, waste to energy plants (WtE), mechanical and biological treatment facilities (MBTs), biological treatment facilities (BTs) (See Annex II for definition) and dumpsites. It is mentioned that the data is uploaded randomly, following the contributions received and the utilization of the multiple resources.

It should be noted that:

- The layer of Sanitary Landfills includes all the sites that fulfill certain environmental standards in order to be characterized as sanitary landfills. However, there is a number of sites, which were proved not to fulfill the minimum requirements of a sanitary landfill and for this reason they were not uploaded on Waste Atlas. In addition, limited number of controlled landfills is uploaded on Waste Atlas, especially for developing countries, aiming to "assist" and highlight their efforts to upgrade their uncontrolled dumpsites to sanitary landfills and generally to start applying safer forms of waste management. In every case, these sites are indicated with a comment. On Waste Atlas, users can find data about the status of a landfill, namely if it is active or not, the area it occupies, the amount of waste already disposed of in it, its annual capacity as well as information about the population it serves.

- In the layer of Waste to Energy (WtE) only facilities that treat thermally the incoming waste and generate energy are included. Although this categorization may be conflicting with others that include facilities of Anaerobic Digestion as WtE, Waste Atlas adopted a categorization of facilities based on the type of treatment implemented. By applying the WtE layer, users can access information regarding the type of the plant, namely if the technology applied is incineration, pyrolysis or gasification, its start up year and its annual capacity.

- The MBT layer includes information about the type of the facility, its start up year and its annual capacity. Three major types of MBT facilities have been identified so far; MBT-Compost; MBT-AD and MBT-RDF/SRF facilities, differentiatled on the basis of the main biological reactor and the related main product of the plant.



- The BT layer includes facilities that receive only feedstock or source segregated organic waste. In this type of facilities only biological treatment takes place, namely Composting and Anaerobic Digestion. The information provided in this layer is the same type of information as in MBT facilities.

- Even though dumpsites may not considered waste facilities, given the existing situation in most places of the developing world and the waste management practices followed in most of these countries, it was considered important to include dumpsites in the waste facilities group, in order to have a better perception of the current situation. Users can find useful information about the status of the dumpsite, the estimated amount of the waste included in them, the waste concentration of them, namely how many tons are included per hectare, and the estimated number of informal waste pickers that work in them.

So far, users can find data for:

- 840 sanitary landfills (SLs)
- 697 waste to energy facilities (WtE)
- 100 mechanical-biological treatment facilities (MBTs)
- 74 biological treatment facilities (BTs?)
- 46 of the world biggest dumpsites.

The most important problems faced during the mapping of facilities were the following.

a) The exact location was very difficult to be found for most of the facilities and it became possible only after extensive research and specific contributions of organizations and local scientists.

b) The facilities' categorization was not always easy to be implemented and maybe there is a need for a different one.

c) Although the data available for dump sites is much more than is uploaded, there is a huge lack of reliable information about them.

At this point and in order to avoid any confusion, it should be highlighted that the facilities data already uploaded on Waste Atlas are not complete for each reported country; however, this is a primary effort to outline the waste management systems in each of them. Even though in most countries of the developing world dumping is still the main practice of solid waste management, scarce data exists even for the few good practices available. On the contrary, in rich and developed countries, not only information was available, but in certain cases it was grouped and categorized as well. For this reason, it can be observed that most of the operating WtE facilities in Europe and the United States have been uploaded on Waste Atlas, whereas there is lack of information about facilities in Asia (excluding Japan) and in Africa.

CORRELATED GLOBAL CHARTS & GLOBAL WM MAPS

This part aims to present 9 global correlation charts and 8 global waste management maps (visualizations) that have been created using the data already available on Waste Atlas. The graphs provided are outputs of the Waste Atlas database.

The innovative characteristic of the Global Graphs is that they correlate for the first time waste management indicators (such as collection coverage or rate of unsound disposal) with other indicators, such as HDI and GNI per capita, for so many countries.

Moreover, visualizations make more obvious and highlight the differences existing over the world in many aspects of waste management, suggesting the areas where research and studies should be conducted and funds should be allocated to ameliorate current situation.

It should be noted that the global correlation charts present all the data found, including outliers. Even though a comment of the trends outlined in these graphs would be constructive, all data collected needs further elaboration in order to come up with safe conclusions. For this reason the scientific committee of Waste Atlas will take all the necessary actions required so as to elaborate this data and to conclude to any outcomes. As for the global waste management maps, all data was uploaded. Global waste management maps make more obvious the lack of data for certain areas of the world, such as the developing countries of Asia, Africa and Latin America.

GLOBAL CORRELATION CHARTS

COUNTRY LEGEND

1–Albania
2–Algeria
3–Angola
4–Antigua and Barbuda
5–Argentina
6–Armenia
7–Australia
8–Austria
9–Azerbaijan
10–Bahrain
11–Bangladesh
12–Barbados
13–Belarus
14–Belgium
15–Belize
16–Benin
17–Bhutan
18–Bolivia
19–Bosnia and Herzegovina
20–Botswana
21–Brazil
22–Brunei Darussalam
23–Bulgaria
24–Burkina Faso
25–Burundi
26–Cameroon
27–Canada
28–Cape Verde
29–Central African Republic
30–Chad
31–Chile
32–China
33–Colombia
34–Comoros
35–Congo, Dem. Rep.
36–Congo, Rep.
37–Costa Rica
38–Cote d'Ivoire
39–Croatia
40–Cuba
41–Cyprus
42–Czech Republic
43–Denmark
44–Dominica
45–Dominican Republic
46–Ecuador
47–Egypt, Arab Rep.
48–El Salvador
49–Eritrea
50–Estonia
51–Ethiopia
52–Fiji
53–Finland
54–France
55–Gabon
56–Gambia, The
57–Georgia
58–Germany
59–Ghana
60–Greece
61–Grenada
62–Guatemala
63–Guyana
64–Haiti
65–Honduras
66–Hong Kong SAR, China
67–Hungary
68–Iceland
69–India
70–Indonesia
71–Iran, Islamic Rep.
72–Ireland
73–Israel
74–Italy
75–Jamaica
76–Japan
77–Jordan
78–Kazakhstan
79–Kenya
80–Korea, Rep.
81–Kuwait
82–Kyrgyz Republic
83–Lao PDR
84–Latvia
85–Lebanon
86–Lesotho
87–Lithuania
88–Luxembourg
89–Macao SAR, China
90–Macedonia, FYR
91–Madagascar
92–Malawi
93–Malaysia
94–Maldives
95–Mali
96–Malta
97–Mauritania
98–Mauritius
99–Mexico
100–Moldova
101–Mongolia
102–Morocco
103–Mozambique
104–Myanmar
105–Namibia
106–Nepal
107–Netherlands
108–Nicaragua
109–Niger
110–Nigeria
111–Norway
112–Oman
113–Pakistan
114–Panama
115–Paraguay
116–Peru
117–Philippines
118–Poland
119–Portugal
120–Qatar
121–Romania
122–Russian Federation
123–Rwanda
124–Sao Tome and Principe
125–Saudi Arabia
126–Senegal
127–Serbia
128–Sierra Leone
129–Singapore
130–Slovak Republic
131–Slovenia
132–South Africa
133–Spain
134–Sri Lanka
135–St. Lucia
136–Sudan
137–Suriname
138–Swaziland
139–Sweden
140–Switzerland
141–Syrian Arab Republic
142–Tajikistan
143–Tanzania
144–Thailand
145–Togo
146–Trinidad and Tobago
147–Tunisia
148–Turkey
149-Turkmenistan
150–Uganda
151–Ukraine
152–United Arab Emirates
153–United Kingdom
154–United States
155–Uruguay
156–Uzbekistan
157–Venezuela, RB
158–Vietnam
159–West Bank and Gaza
160–Yemen, Rep.
161–Zimbabwe

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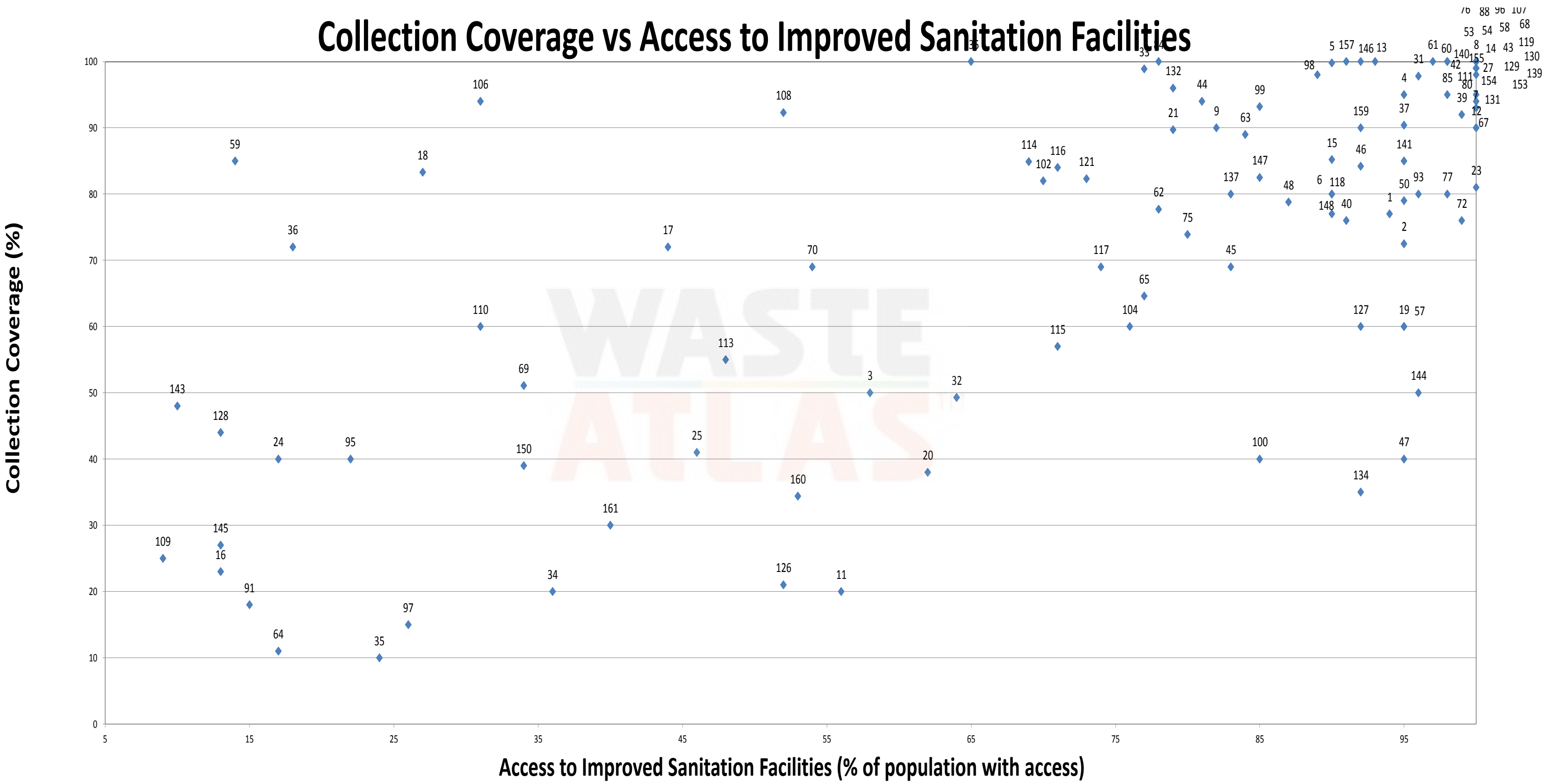

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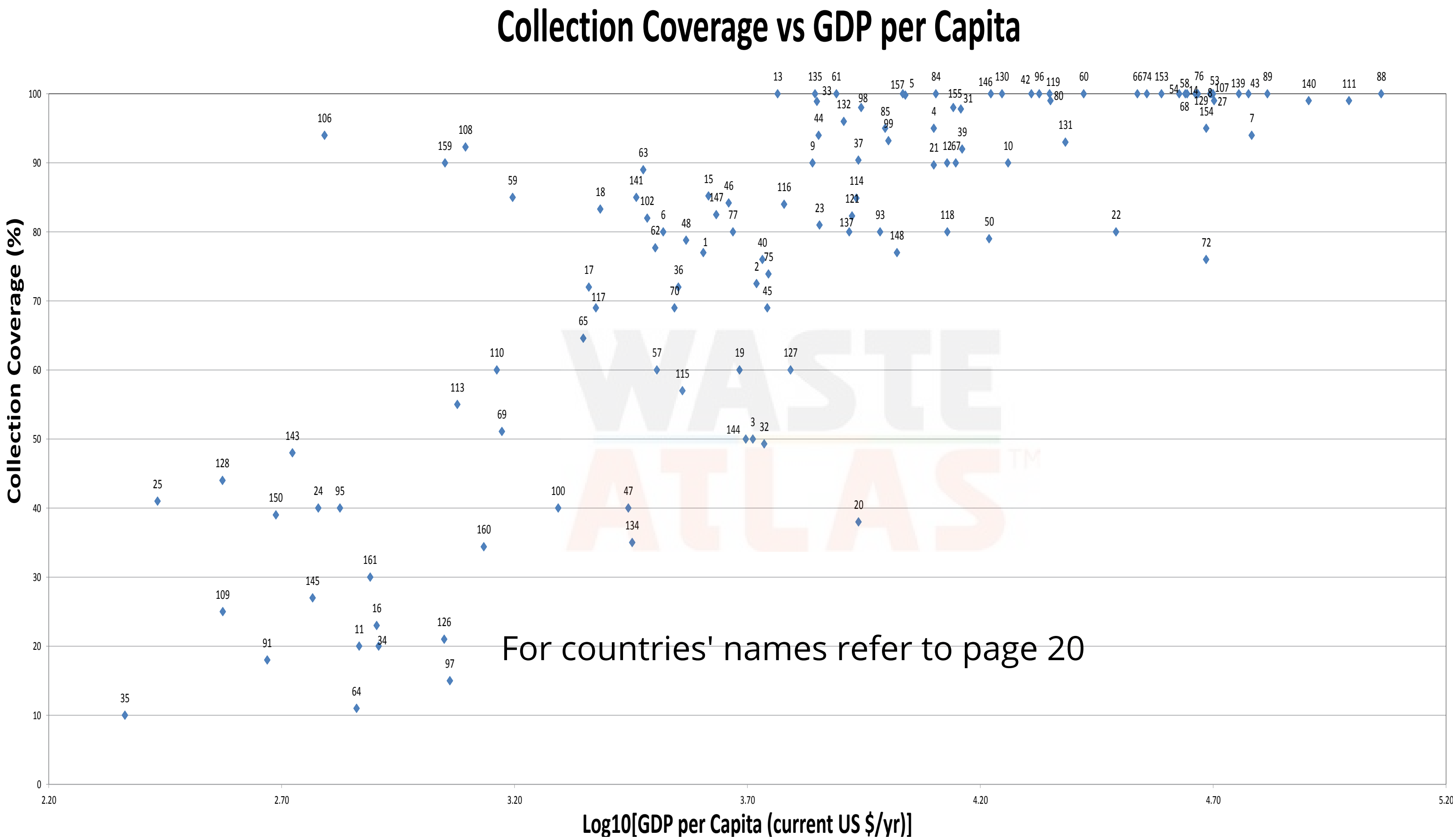

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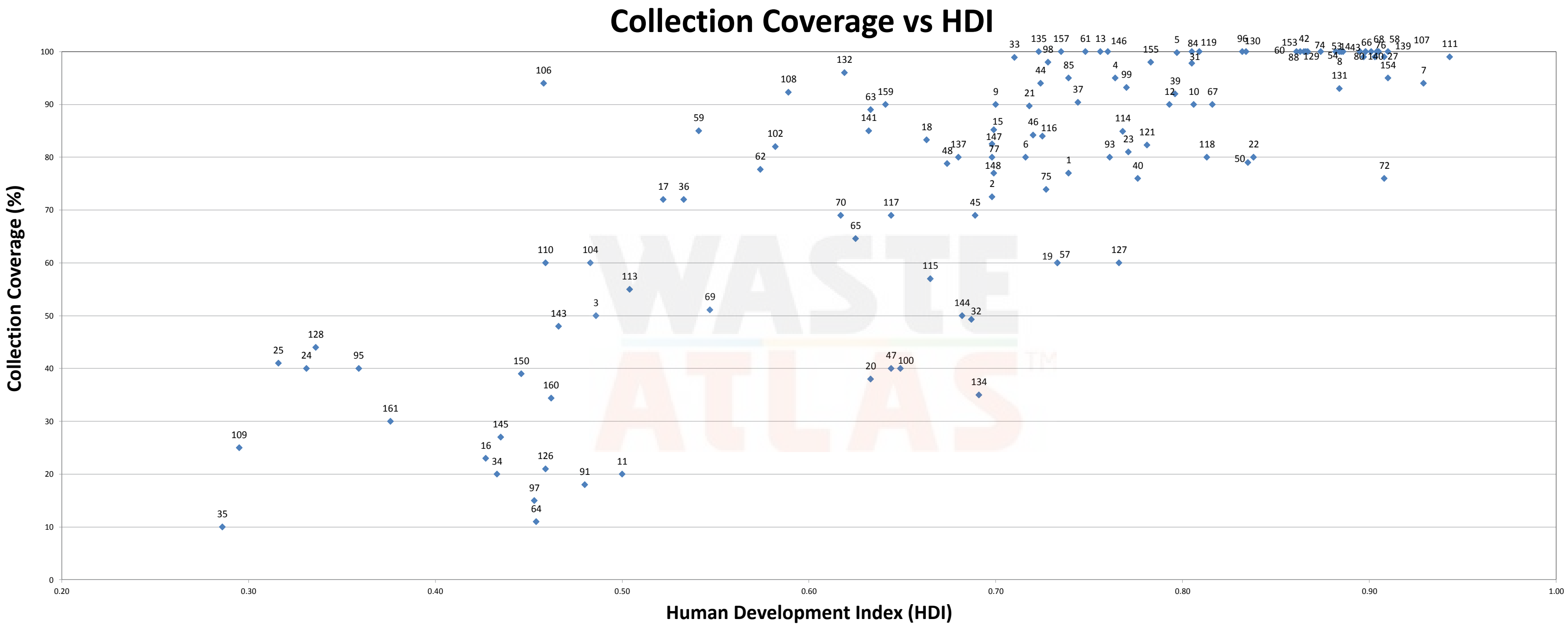

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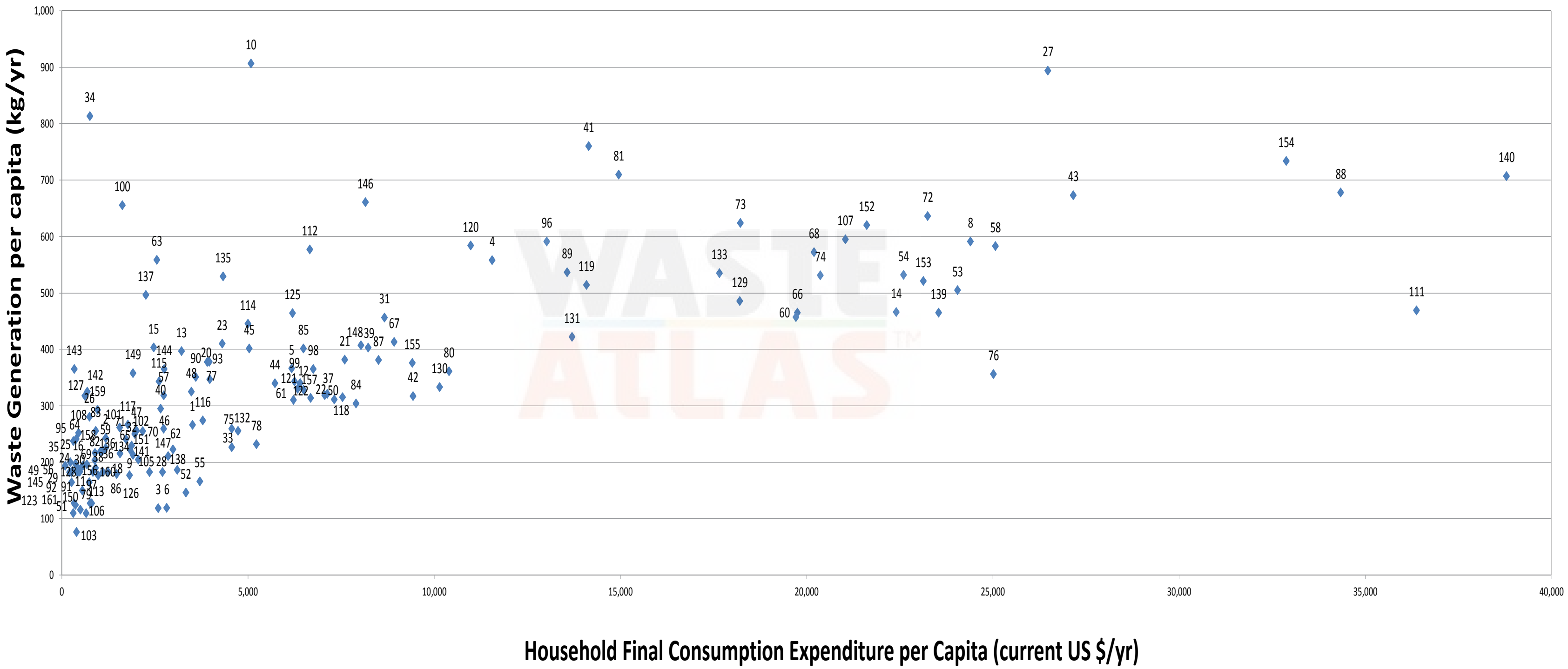
Waste Generation per capita vs Household Final Consumption Expenditure per Capita



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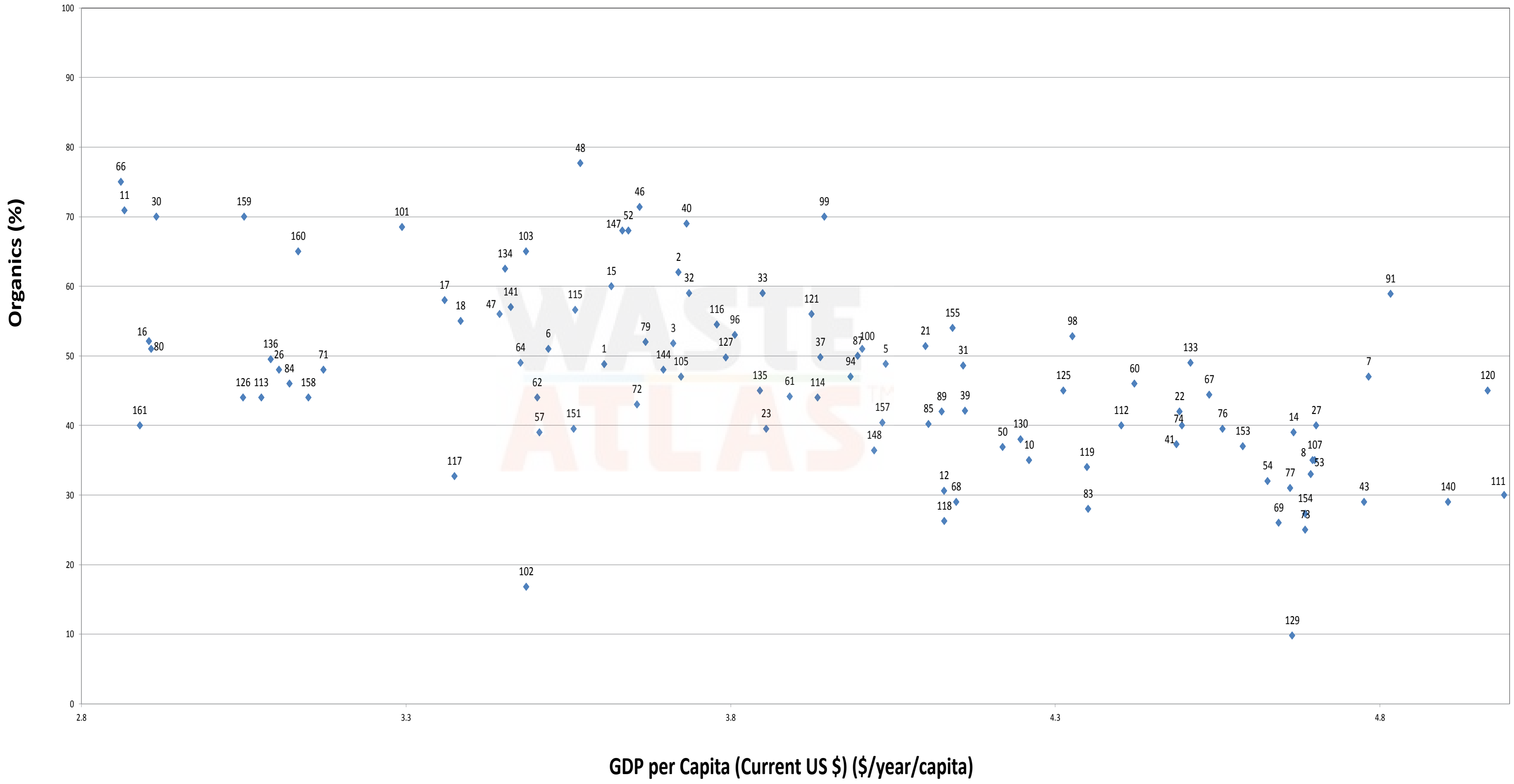
Organics vs GDP per Capita



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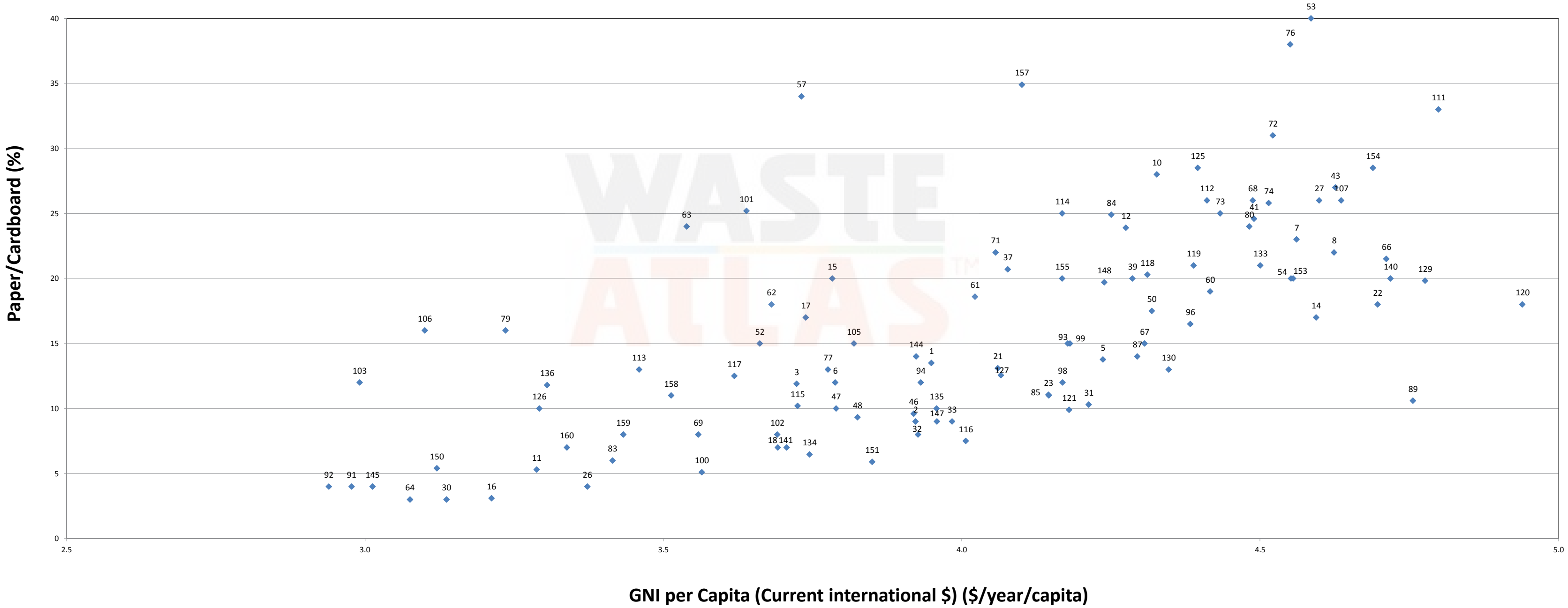
Paper/Cardboard vs GNI per Capita



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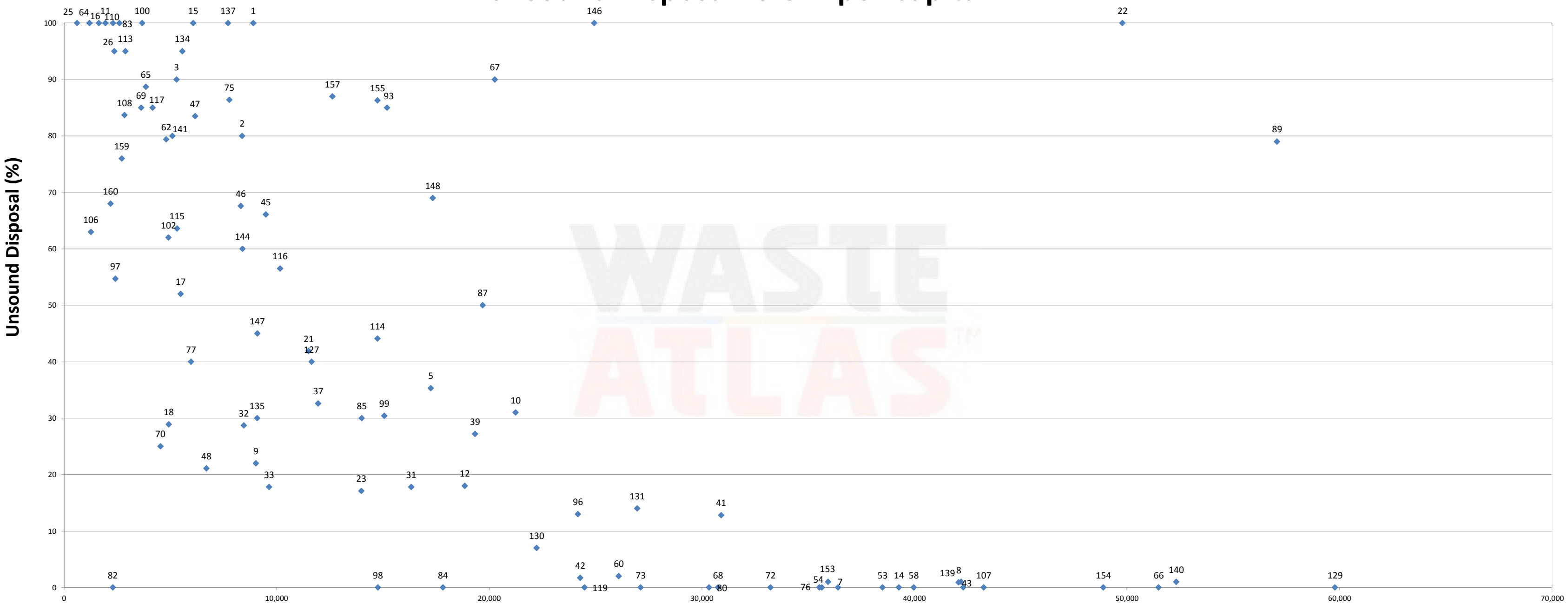
Unsound Disposal vs GNI per Capita



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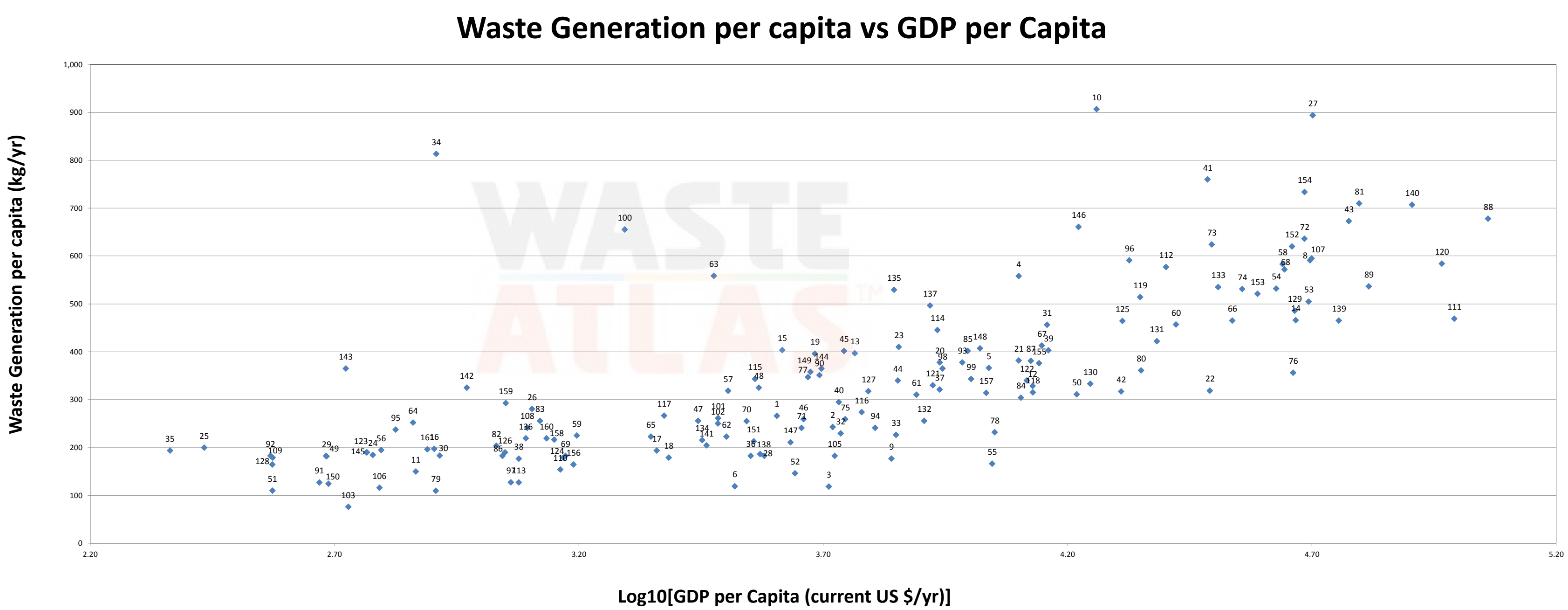

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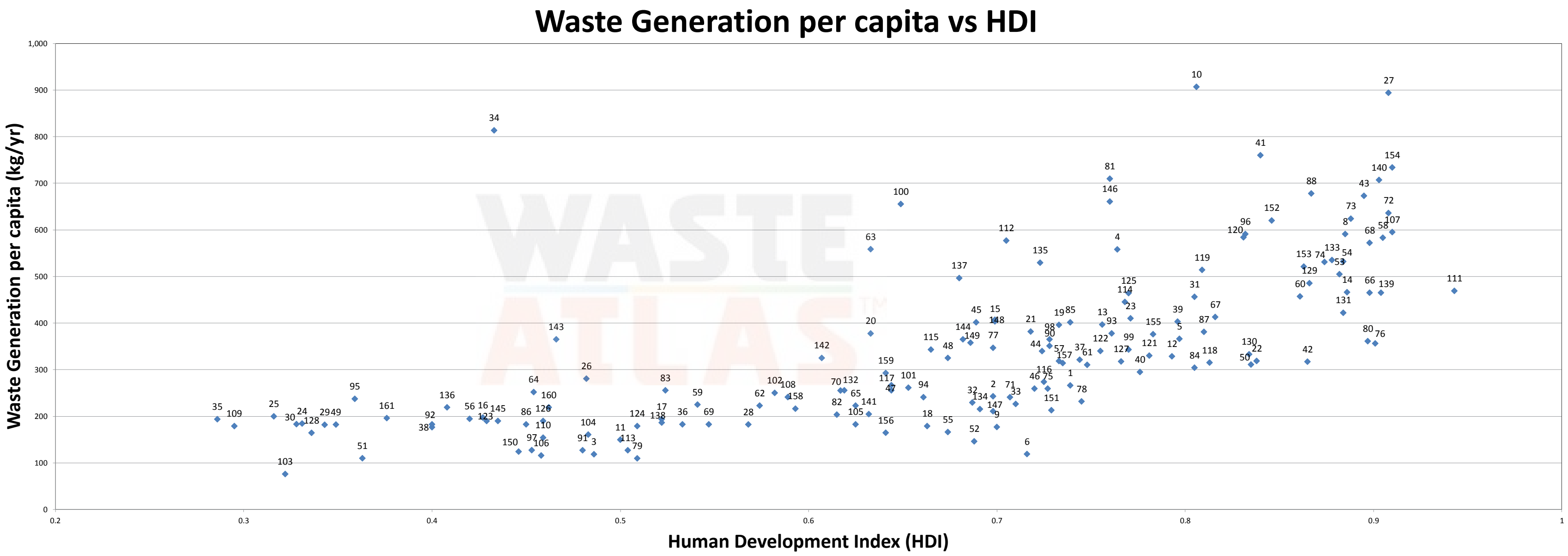

For countries' names refer to page 20

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GLOBAL WASTE MANAGEMENT MAPS


1.09
0.4
0.1
0.04
0.01
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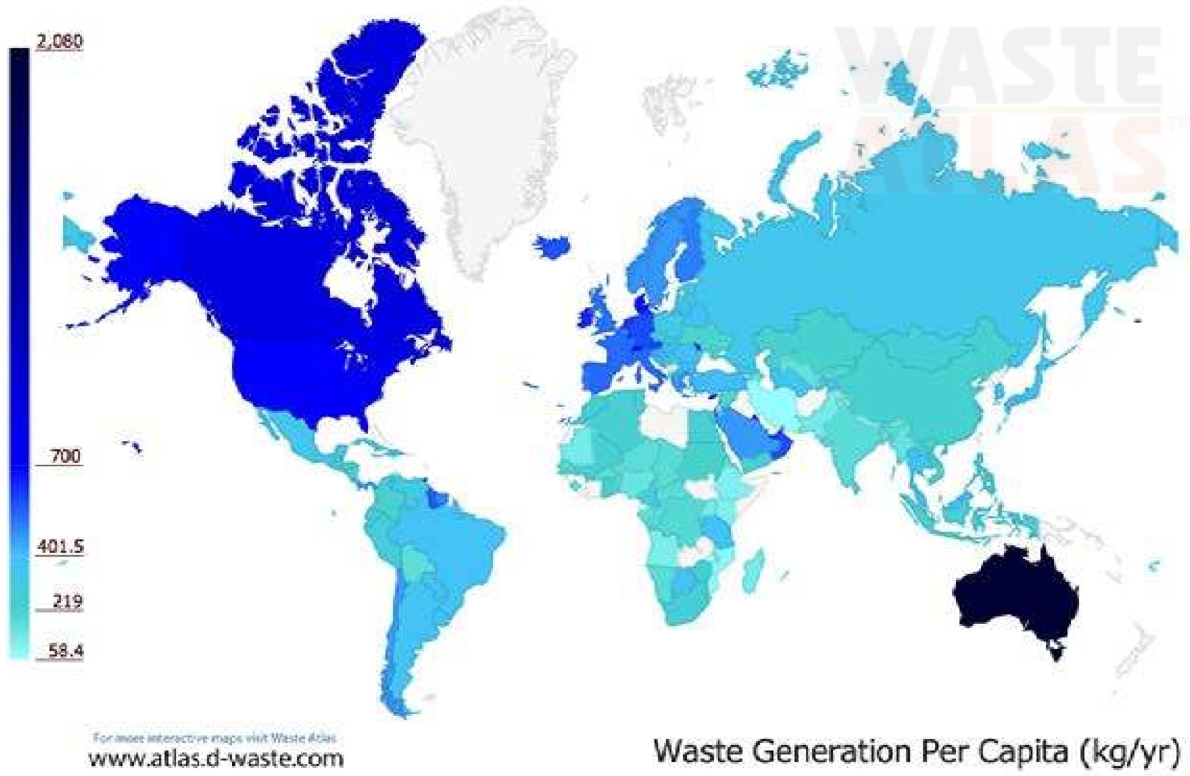
Waste Intensive Consumption (kg/$)


2,080
700
401.5
219
58.4
For more interactive maps visit Waste Atlas
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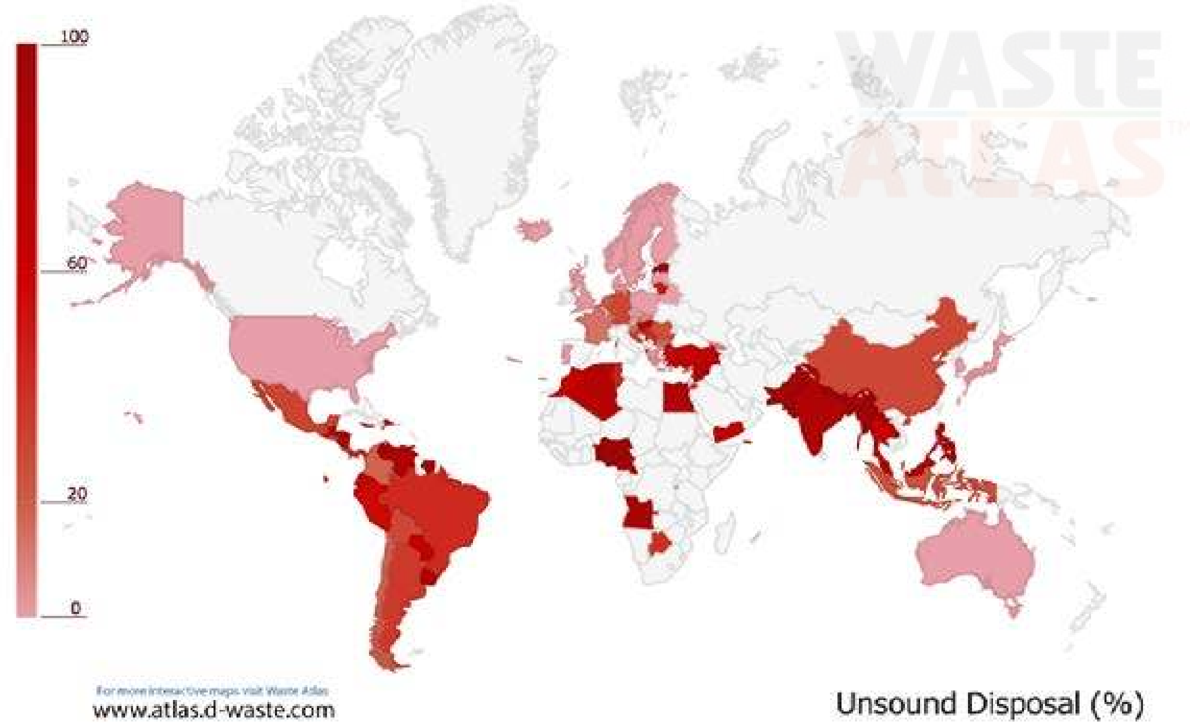
Waste Generation Per Capita (kg/yr)


100
60
20
0
For more interactive maps visit Waste Atlas
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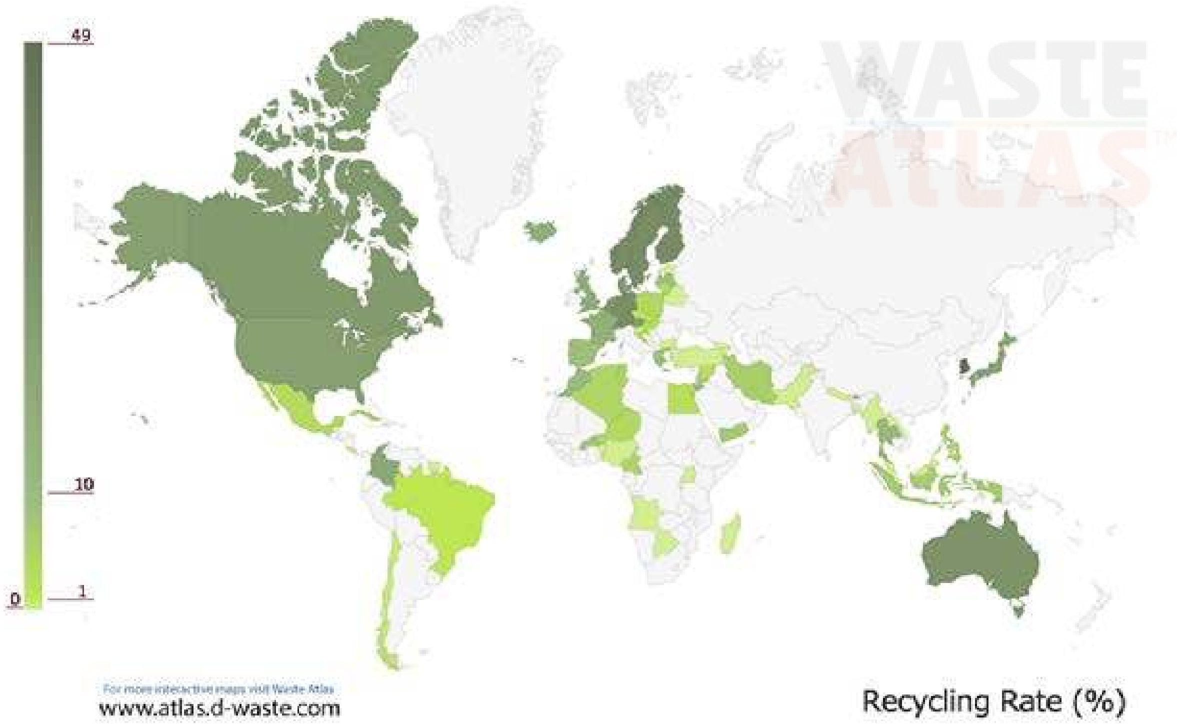
Unsound Disposal (%)


49
10
1
0
For more interactive maps visit Waste Atlas
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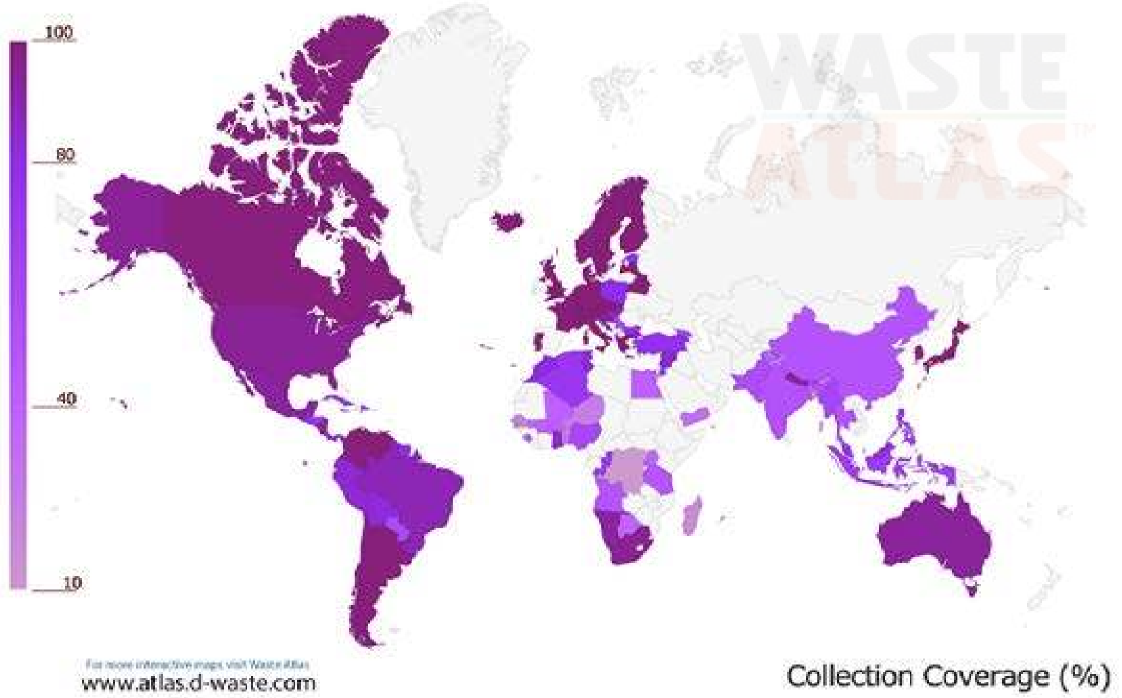
Recycling Rate (%)


100
80
40
10
WASTE ATLAS
For more interactive maps visit Waste Atlas
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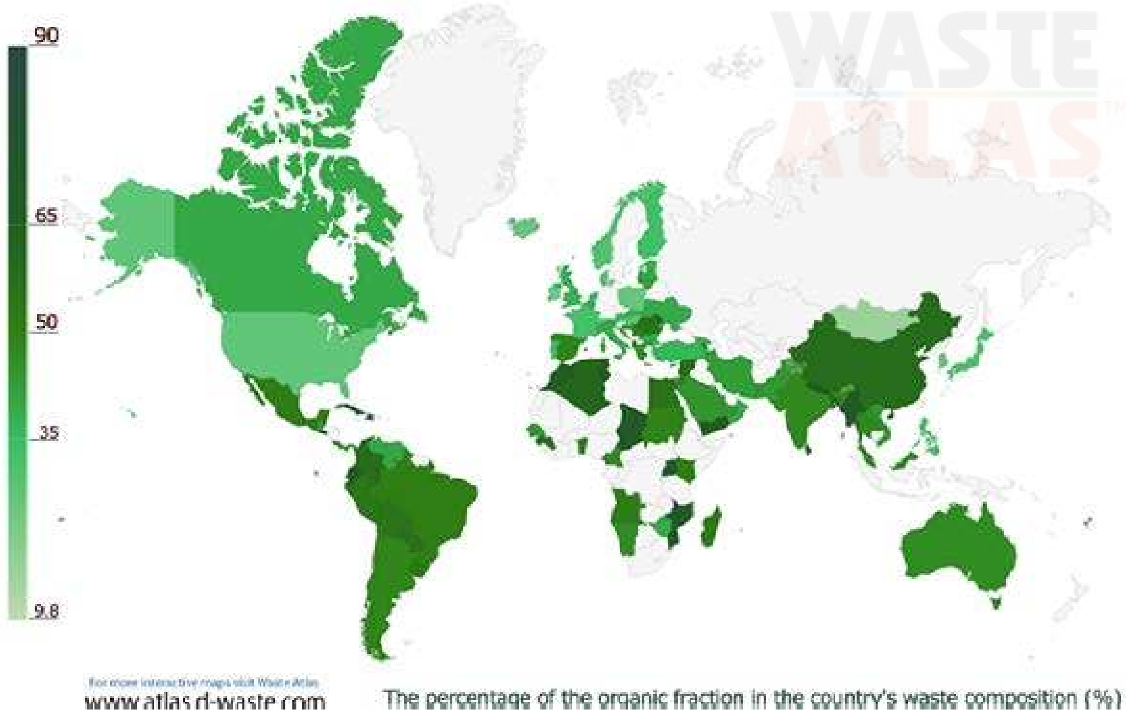
Collection Coverage (%)


90
65
50
35
9.8
WASTE ATLAS
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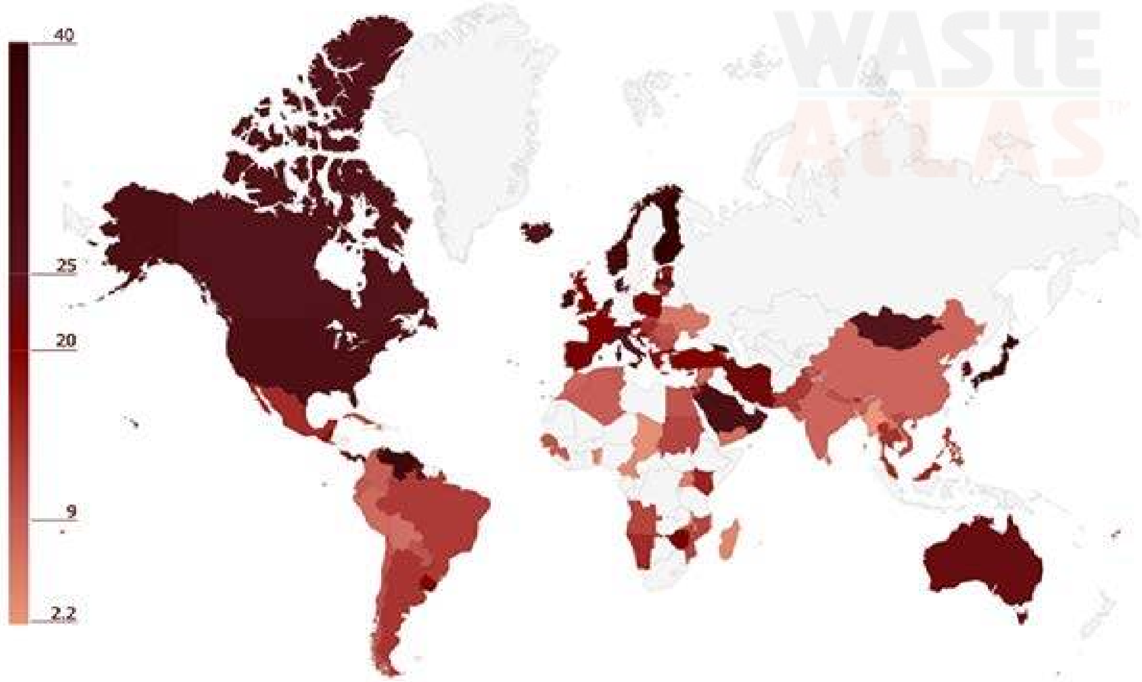
The percentage of the organic fraction in the country's waste composition (%)



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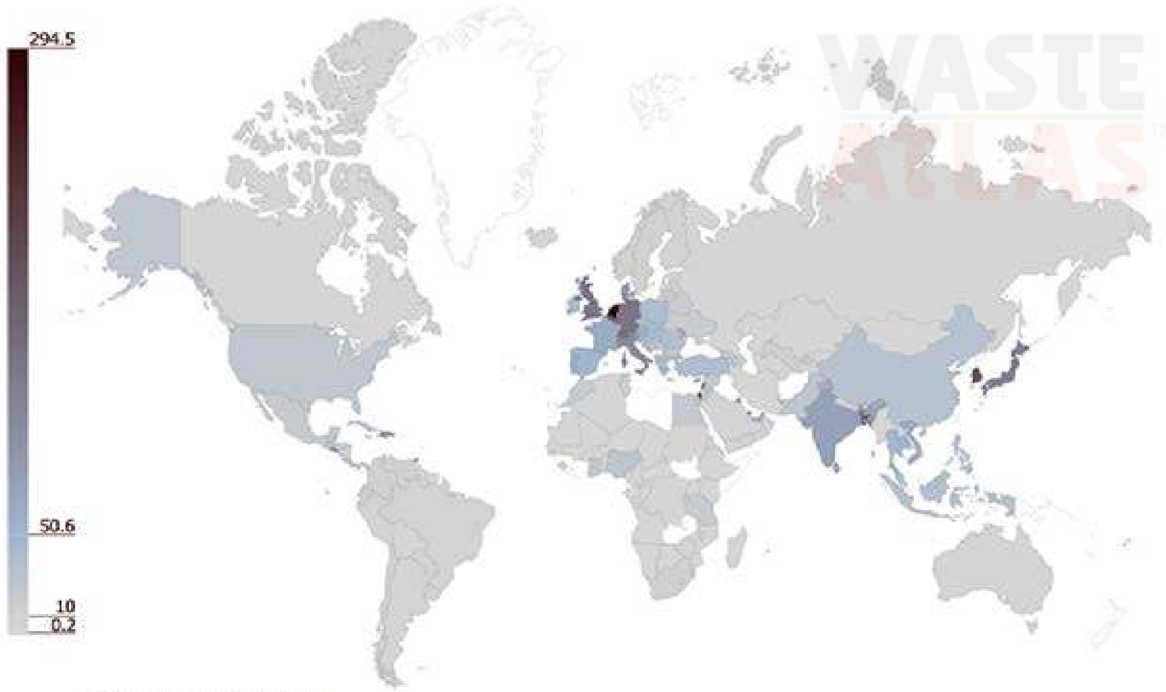
The percentage of the paper/cardboard fraction in the country's waste composition (%)



For more interactive maps visit Waste Atlas
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Environmental Stress (tn of MSW/km²)

PUTTING WASTE ATLAS IN PRACTICE – ASSESSMENT OF CURRENT SITUATION

Waste Atlas aims to gather useful information around solid waste management in one place. All this great amount of data uploaded creates a huge potential that enables users to conduct easily comparisons between countries and cities of similar size or wealth, as well as to make conclusions about waste management practices and trends.

This section presents the outcomes of a recent assessment about the current global solid waste generation, the average solid waste generation per capita, as well as the average solid waste composition. Calculations were based on data for 162 countries from all over the world, data that is already available on Waste Atlas and that covers 97% of the global population.

Making the necessary calculations, it was assessed that current solid waste generation is up to 1.84 billion tonnes, whereas average solid waste generation is assessed to 271.7 kg/cap/year. Figure 2-2 presents the average global waste composition.

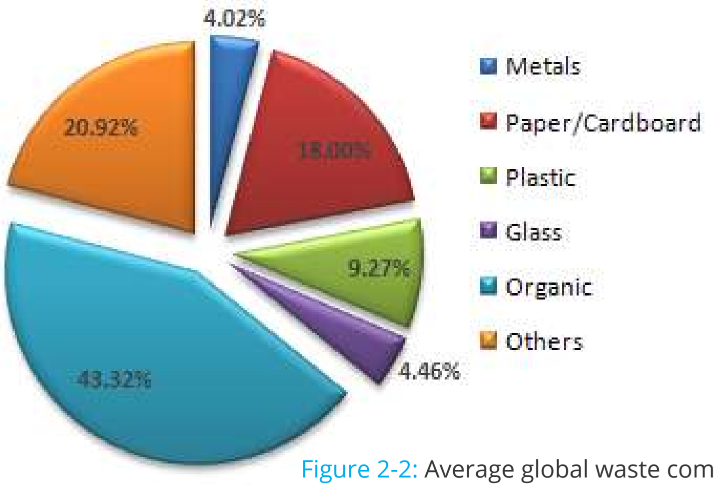


Figure 2-2: Average global waste composition

In addition to the abovementioned outcomes, Table 2-1 summarizes average figures from the data already uploaded on Waste Atlas. More specifically it provides info about the average Waste Intensive Consumption, the average Recycling Rate and the Average Unsound Disposal rate. For every indicator, the number of countries counted is also provided.

Table 2-1: Global Average Indicators

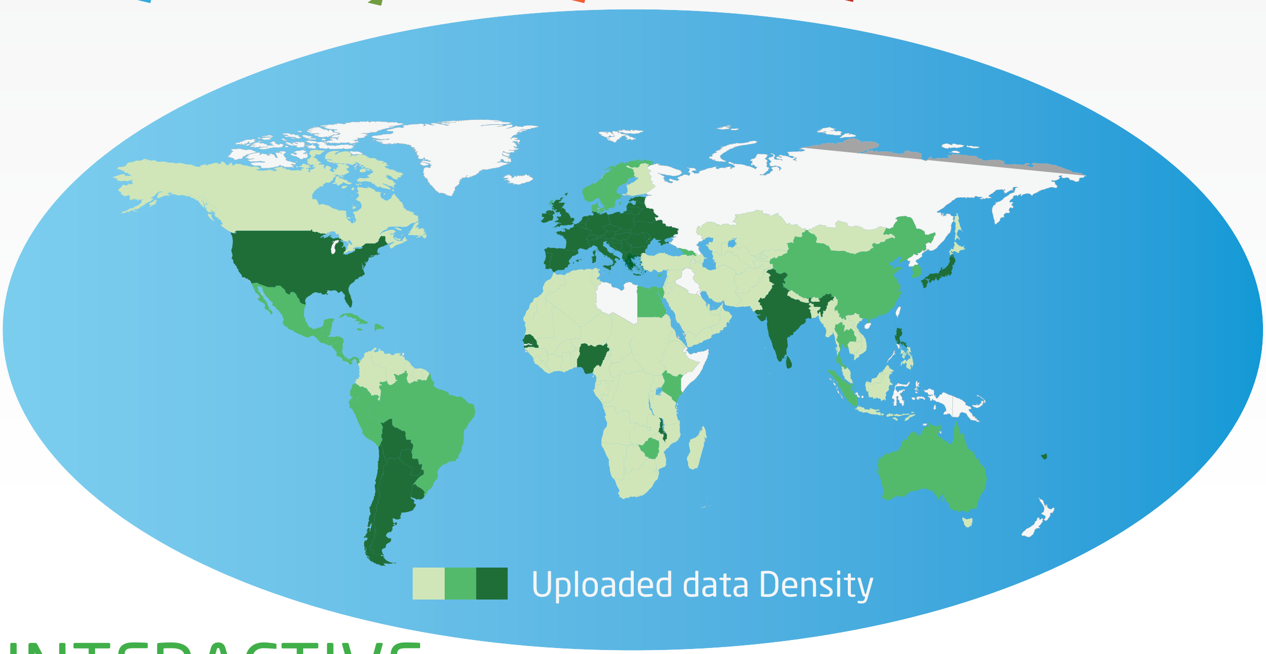
Indicators	Quantity	Units	Number of countries counted
Municipal Solid Waste Generation	1.84	10^9 t year^{-1}	162
Municipal Solid Waste Generation per capita	271.7	Kg cap^{-1} year^{-1}	162
Collection Coverage	73.9	%	122
Recycling rate	16.0	%	91
Unsound disposal rate	38.0	%	96
Environmental Stress	14.9	t (km^2)$^{-1}$	162
Waste Intensive Consumption	0.05	Kg \$$^{-1}$	155

Assessment of the current global situation is an example of the outcomes that may arise from the use of Waste Atlas, including amongst others waste projections and benchmarking studies. For practical examples you can download Antonis Mavropoulos' presentation in Lisbon GRAPESB conference from http://www.d-waste.com/presentations/utilizing-waste-atlas-detail.html#.UlKa5oa9lgE

WASTE ATLAS

162 Countries | >1,700 Cities | Users from 122 countries

97% of global MSW Generation | Full profile for 100 biggest cities | More than 1,700 Waste Treatment Facilities | 5,000 unique users 1,000 contributors



INTERACTIVE

Dynamic waste management tool

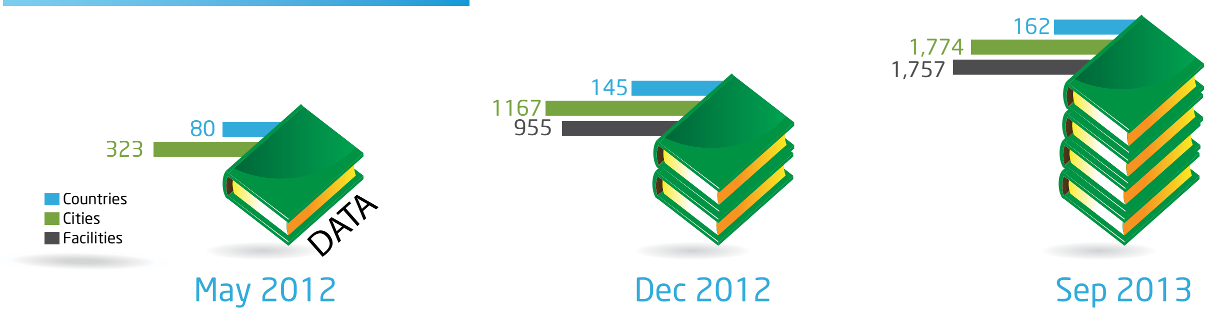
The only global waste management map

Unique Visual Maps

Global Correlation Graphs

Customized Charts

Free
Crowdsourced
Benchmarking



The biggest waste management database

UNIVERSITY OF LEEDS · ISWA · SWEEPNET · WIERI · SWAPI

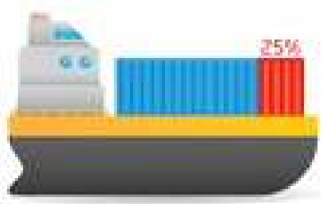
A global partnership

Partners' coverage: 72 countries

The waste world in one place

Global waste generation

1.9 billion tons
equal to
25% of the shipments
traded in 2011



Metals	3.48 %
Paper Cardboard	16.26 %
Plastic	10.47 %
Glass	3.78 %
Organic matter	45.34 %
Other	20.66 %

**Global Generation
Per capita**

One
generates annually
waste equal to
3-4 times his weight

CONCLUSIONS & CHALLENGES

The implementation of Waste Atlas was a substantial learning experience and several difficulties and challenges were encountered during its first year. The most important conclusions and challenges are summarized below.

• The very positive critiques and the popularity of Waste Atlas with users and contributors demonstrated the necessity of such a project and highlighted the need for more efforts that will shape the global picture of waste management and provide data sets that will allow benchmarking.

• Waste Atlas aims to collect waste management data from all over the world in a single place and to visualize it spatially on a map. For this reason, the data collected had to be edited, composed and converted into a uniform way that would facilitate comparisons and benchmarking. In addition, exact location of facilities had to be identified, an action that in most cases proved to be difficult and time consuming. Although humanity lives in “the big data” era, waste management seems still to remain in the big “lack of data” era. This reflects the underestimation of waste management and recycling in the global political agendas and it highlights the need for serious coordinated efforts to upgrade it.

• The collection of data in the first year of operation has highlighted the problem of data inconsistency and the lack of a global methodology that will support global uniform data collection and interpretation. This issue is of high importance especially for institutions, policy makers and financial authorities in country and city level, requiring coordinated actions to deal with it efficiently.

• A year’s work has proved that combining crowdsourcing with dedicated expertise is a way to deal with the problems mentioned above. The global waste management and recycling community should further focus on crowdsourcing activities as a means to provide solutions to the lack of data that can be utilized for decision making procedures.

• Already a large amount of data has been collected and remains unpublished, waiting for further utilization and development. The first year's experiences documented the need for a more concrete and consistent database development and for a more broad scientific support in order to utilize the huge data sets in the best way.

ANNEX I

KEY REFERENCES

A wide range of studies, scientific and technical papers and free access databases have been used for the upload of data on Waste Atlas. As for socio-economic data, it was all taken from World's Bank database, with the exception of HDI which is an index established by United Nations Development Programme (UNDP). The following publications have been the main contributions to the conceptualization and implementation of Waste Atlas.

1. Wilson DC, Rodic L, Scheinberg A, Velis CA and Alabaster G (2012) Comparative analysis of solid waste management in 20 cities. Waste Management & Research 30(3): 237-254. Available at: http://wmr.sagepub.com

2. Scheinberg A, Wilson DC and Rodic L (eds) (2010) *Solid Waste Management in the world's cities*: Water and Sanitation in the World's Cities. Earthscan for UN-Habitat, London and Washington DC. Available at: http://www.unhabitat.org/pmss/listItemDetails.aspx?publicationID=2918

3. Hoornweg D and Bhada-Tata P (2012) What a Waste – a Global Review of Solid Waste Management. World Bank, Washington, DC, USA. Available at: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTURBANDEVELOPMENT/0,,contentMDK:23172887~pagePK:210058~piPK:210062~theSitePK:337178,00.html

4. D-Waste (2012) Waste management for everyone. Available at: www.d-waste.com

ANNEX II

Access to improved sanitation facilities	Access to improved sanitation facilities refers to the percentage of the population with at least adequate access to excreta disposal facilities that can effectively prevent human, animal, and insect contact with excreta. Improved facilities range from simple but protected pit latrines to flush toilets with a sewerage connection. To be effective, facilities must be correctly constructed and properly maintained
Access to improved water source	Access to an improved water source refers to the percentage of the population with reasonable access to an adequate amount of water from an improved source, such as a household connection, public standpipe, borehole, protected well or spring, and rainwater collection. Unimproved sources include vendors, tanker trucks, and unprotected wells and springs. Reasonable access is defined as the availability of at least 20 litres a person a day from a source within one kilometre of the dwelling
Biological treatment facilities	Biological treatment facilities are defined as the facilities that receive source segregated organic waste and within them only biological processes, such as composting and biomethanization – anaerobic digestion, take place
Collection Coverage	The amount of Municipal Solid Waste (MSW) collected as a proportion of total MSW generated
Dumpsites	As Dumpsites are defined those sites used for the disposal of waste that do not fulfil certain environmental criteria
Environmental Stress	The amount of the municipal solid waste generated in a country divided by country's area, expressed in tonnes per square kilometre (tonnes/km^2)
GDP per capita	GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars
GNI per capita, PPP	GNI per capita based on purchasing power parity (PPP). PPP GNI is gross national income (GNI) converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GNI as a U.S. dollar has in the United States. GNI is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad. Data are in current international dollars
Household Final Consumption Expenditure	Household final consumption expenditure per capita is an indicator generated by D-Waste by dividing the Household Final Consumption Expenditure of each country with its total population. This indicator is used to correlate the waste generation patterns with the consumption patterns. Data for Final Household Consumption Expenditure per capita are in U.S. dollars per person
Human Development Index (HDI)	A composite index measuring average achievement in three basic dimensions of human development—a long and healthy life, knowledge and a decent standard of living
Mechanical Biological Treatment (MBT) facilities	As Mechanical Biological Treatment facilities are defined the facilities that receive commingled waste, use mechanical separation to remove recyclables and the dry fraction, and use biological methods to treat the organic fraction
Municipal Solid Waste	As Municipal Waste is defined as th e waste mainly produced by households, including also similar waste generated from sources such as commerce, offices and public institutions. The amount of municipal waste generated consists of waste collected by or on behalf of municipal authorities and disposed of through the waste management system

Population density	Population density is midyear population divided by land area in square kilometres. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship-except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of their country of origin. Land area is a country's total area, excluding area under inland water bodies, national claims to continental shelf, and exclusive economic zones. In most cases the definition of inland water bodies includes major rivers and lakes
Poverty headcount ratio at $2 a day (PPP)	Population below $2 a day is the percentage of the population living on less than $2.00 a day at 2005 international prices. As a result of revisions in PPP exchange rates, poverty rates for individual countries cannot be compared with poverty rates reported in earlier editions
Recycling Rate	The amount of Municipal Solid Waste (MSW) recycled as a proportion of total MSW generated
Sanitary Landfill	As Sanitary Landfills are defined those sites used for the disposal of waste, that fulfil certain environmental criteria, including amongst others limited access to the site, cover of waste with soil materials, leachate control, landfill gas control, etc
Unsound Disposal	The percentage of total Municipal Solid Waste (MSW) generated that is disposed or burnt in controlled and uncontrolled dumpsites
Urban population (% of total)	Urban population refers to people living in urban areas as defined by national statistical offices. It is calculated using World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects
Waste Composition	The detailed description of the material composition of the waste streams, using percentage of material types. The streams adopted in Waste Atlas are: organic, paper/cardboard, metal, plastic, glass and others
Waste Generation per capita	The average amount of Municipal Solid Waste (MSW) generated annually per person
Waste Intensive Consumption	The amount of Municipal Solid Waste generated in a country per dollar of household consumption expenditure
Waste to Energy (WtE) facilities	In Waste Atlas as Waste to Energy facilities are defined those facilities that treat thermally the waste and generate either energy or steam or both

WASTE ATLAS™