SMARTAGRI
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SmartAgriCambodia: Advancing Sustainable Agriculture in Battambang

2025 - 2027

Waste Management

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It's widely recognized that **waste is a global growing crisis**

How?

- Rapid Population Growth & Urbanization
  - As the global population increases and more people move to cities, the volume of waste produced skyrockets.
  - Many cities, especially in developing countries, lack the infrastructure to handle this surge.
- Increased Consumption & Packaging
  - Modern lifestyles generate massive amounts of single-use plastics, electronics, and packaging materials…
  - More non-biodegradable waste that is difficult to process or recycle.

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Population

Years passed	Year	Pop. (billions)
–	1800	1
127	1927	2
33	1960	3
14	1974	4
13	1987	5
12	1999	6
12	2011	7
11	2022	8

How?

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Outputs

Improper waste management leads to:

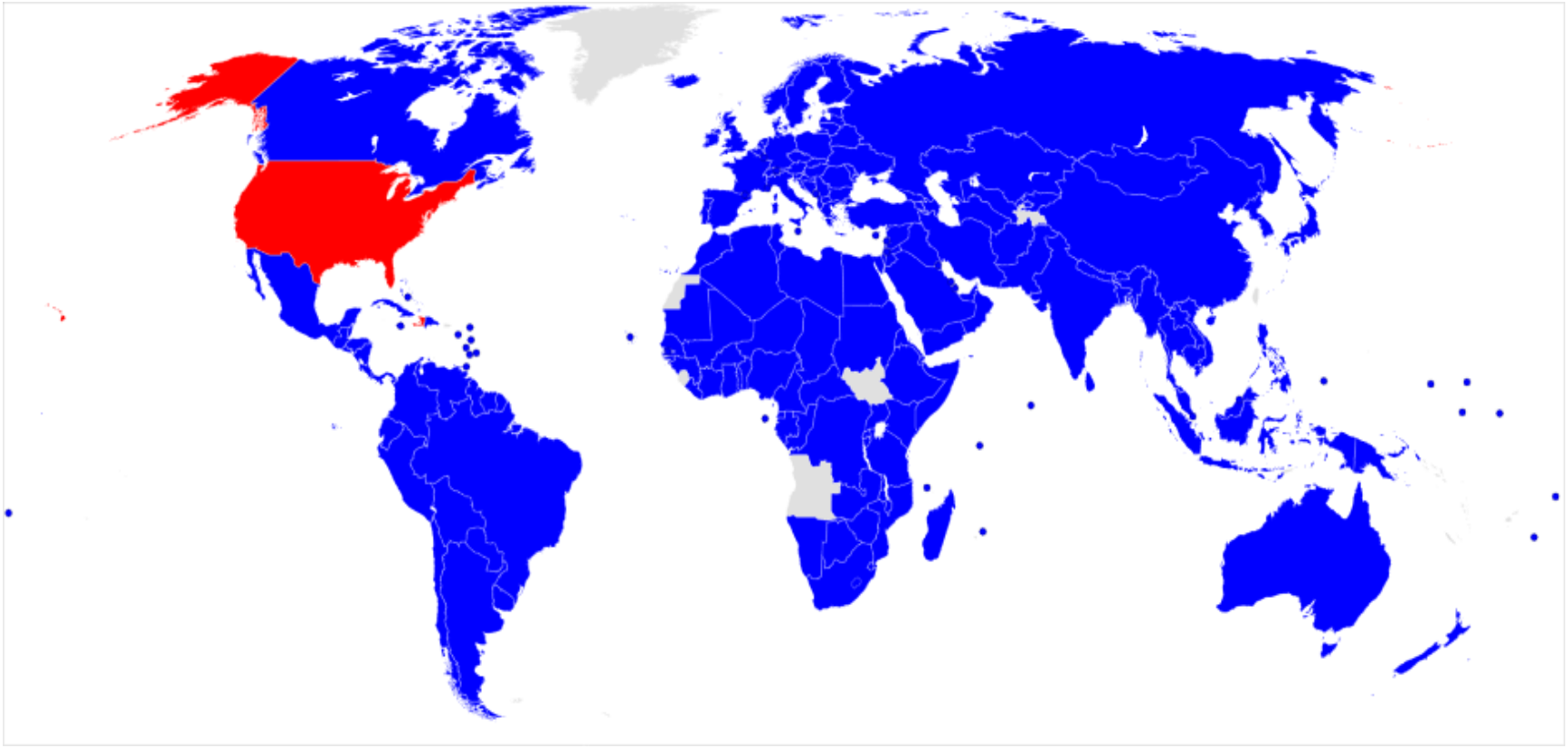
- Environmental Pollution
  - Air pollution (from open burning)
  - Water pollution (leachate from landfills contaminating water bodies)
  - Soil degradation
  - Marine pollution (plastic waste entering oceans)
- Climate Change Contribution
  - CH_4, CO_2…
- Health Hazards
  - Disease outbreaks, especially in poorer regions
  - Open dumps and burning waste expose people to toxic chemicals and respiratory issues

Outputs

Improper waste management leads to:

- Unequal Burden
  - Wealthy nations often export waste to poorer countries, shifting the environmental and health burdens.
  - Recipient countries may lack proper treatment and disposal systems.
- Recycling Challenges
  - Global recycling systems are overwhelmed or inefficient.
  - Many materials are difficult to recycle economically.
  - Contamination of recyclables reduces the effectiveness of recycling programs.
- Resource Wastage
  - Poor waste management = loss of valuable resources (metals, plastics, organic material).
  - Instead of recovering these materials, they are discarded, increasing pressure on raw resource extraction.

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal



Nations that have signed and ratified, along with nations that have signed but have not ratified the agreement.

Definitions of waste

- “Substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law” (Basel Convention).
- “Object the holder discards, intends to discard or is required to discard” (Waste Framework Directive 2008/98/EC).
- “Any discarded, rejected, unwanted, surplus or abandoned matter” (National Waste Report, Australia, 2010).
- Any material that is **discarded, useless or unwanted**.
- Any material which is not needed by the owner, producer or processor.
- ....

Classifications of wastes

According to **state of matter**: **solid, liquid, gaseous**

According to **properties**:

Biodegradable wastes - can be decomposed by the natural processes and converted into the elemental form (kitchen garbage, animal dung, paper, etc).

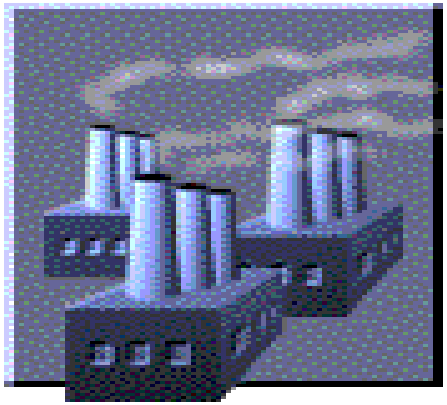
Non-biodegradable wastes - cannot be decomposed and remain as such in the environment. They are persistent and can cause various problems.

(plastics, glass, nuclear wastes, etc). Organic vs Inorganic?

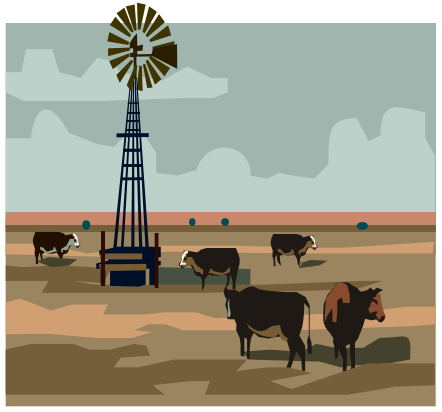
According to **composition**: **hazardous** wastes, **other** (non-hazardous) wastes.

Main types of waste (solid, liquid, gaseous)

(according to **origin**)



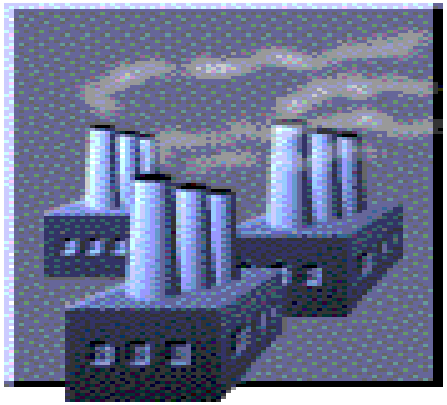
- **Municipal Waste**
- **Industrial Waste**
- **Agricultural Waste and Residues**



Hazardous (Toxic) Waste

Main types of waste (solid, liquid, gaseous)

(according to **origin**)



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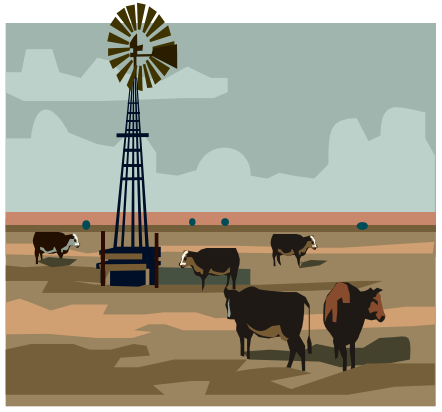


Hazardous (Toxic) Waste

Municipal (Solid) Waste (MSW)

1. **Household waste** (produced directly from homes)
2. **Commercial waste** (from offices, hotels, shops…)
3. **Institution waste** (schools and other institutions)
4. **Public waste** (from public sanitation and cleaning)
5. **Construction and demolition waste**






Household Waste

In this category are included leftovers, plastic, metal, glass, paper, packaging, cans, bottles, newspaper, magazines, rags etc. as are **small quantities of hazardous waste**, such as electric light bulbs, batteries, automotive parts and discarded medicines and chemicals. liquid, gaseous?

When improperly accumulated, **organic waste** can become serious polluter of soil, water and air. Besides that, the inadequate arrangement of waste creates an environment propitious to the development of pathogenic organisms.

Commercial and institution waste

Is originated from several shops and services like supermarkets, bars, restaurants, schools, universities, banking institutions, etc.

Restaurant vs school?

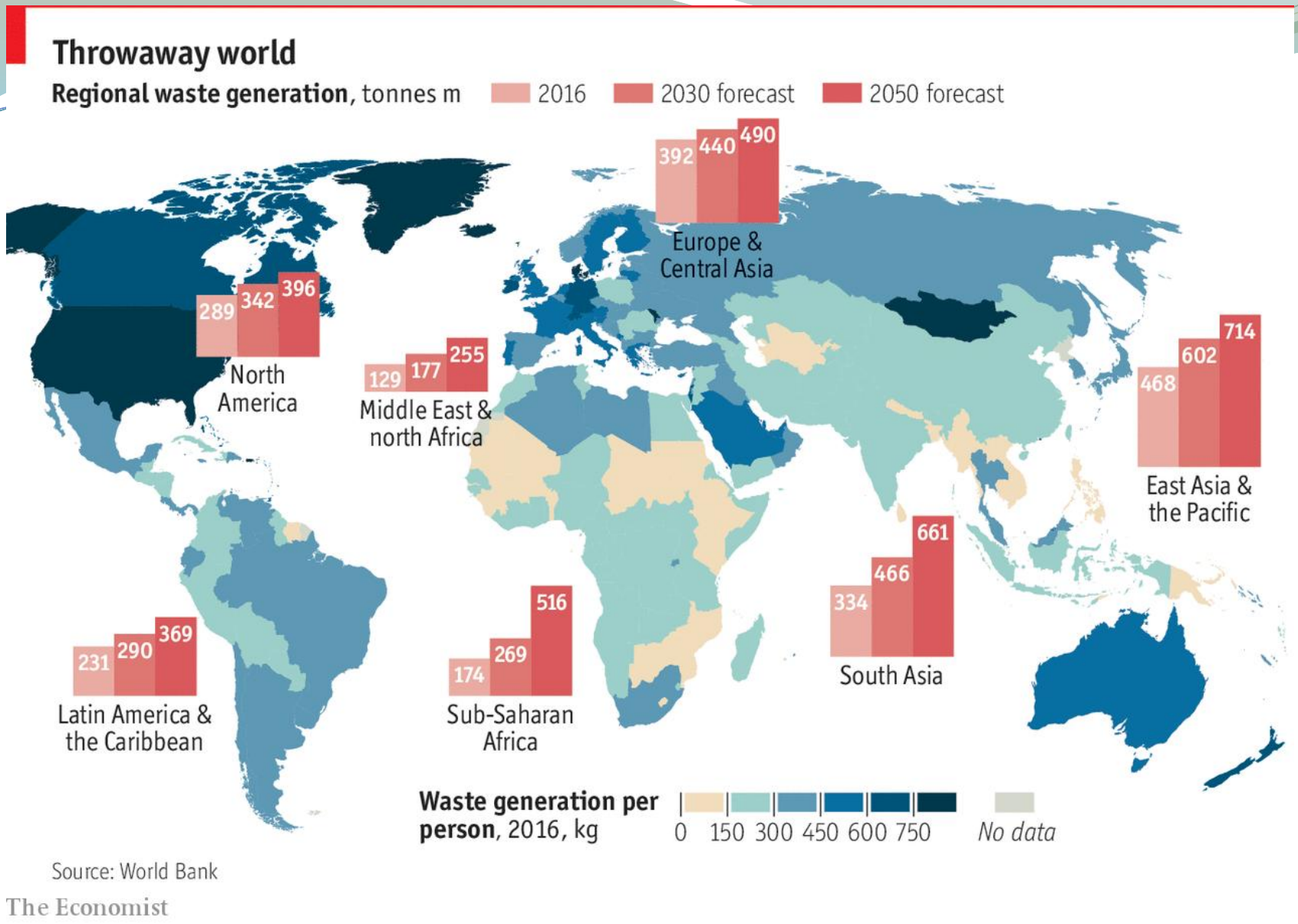
The trash of these establishments and services is mainly composed of paper, plastics, various packaging and toilet residues (towels, toilet paper, etc.)…

Public waste

Including all residues of sweeping waste of public roads, waste from the street, cleaning of beaches, tunnels, remaining of pruning trees, packaging, etc.

Construction and demolition waste

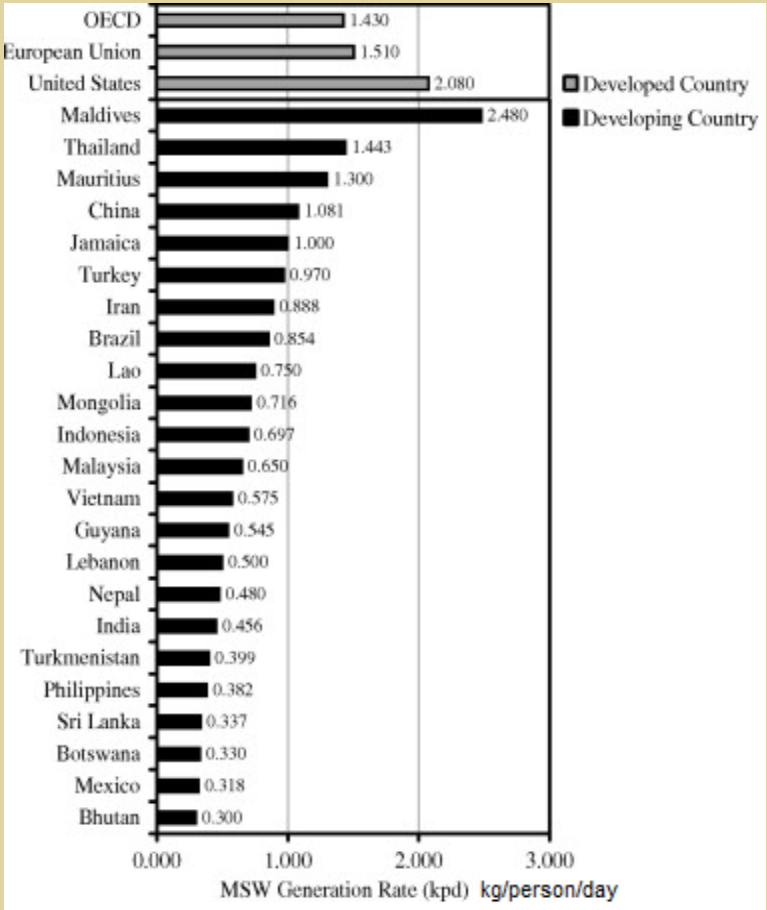
From construction, alteration, reconstruction, maintenance and demolition or collapse of buildings, such as soil, wood, mud digging.



Global waste generation will nearly double by 2050

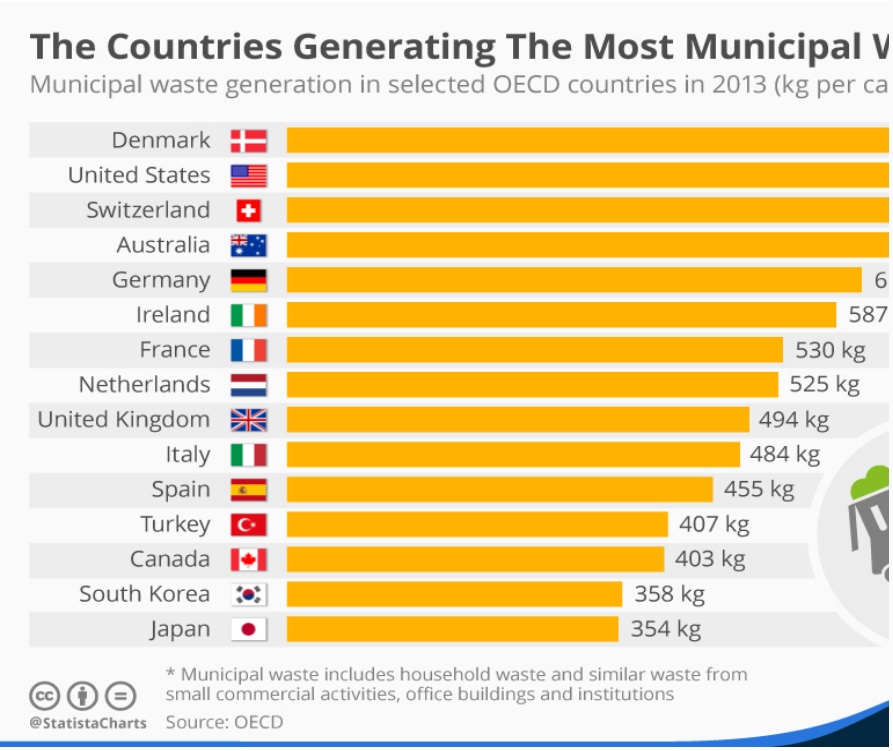
Most of the growth will come from the developing world

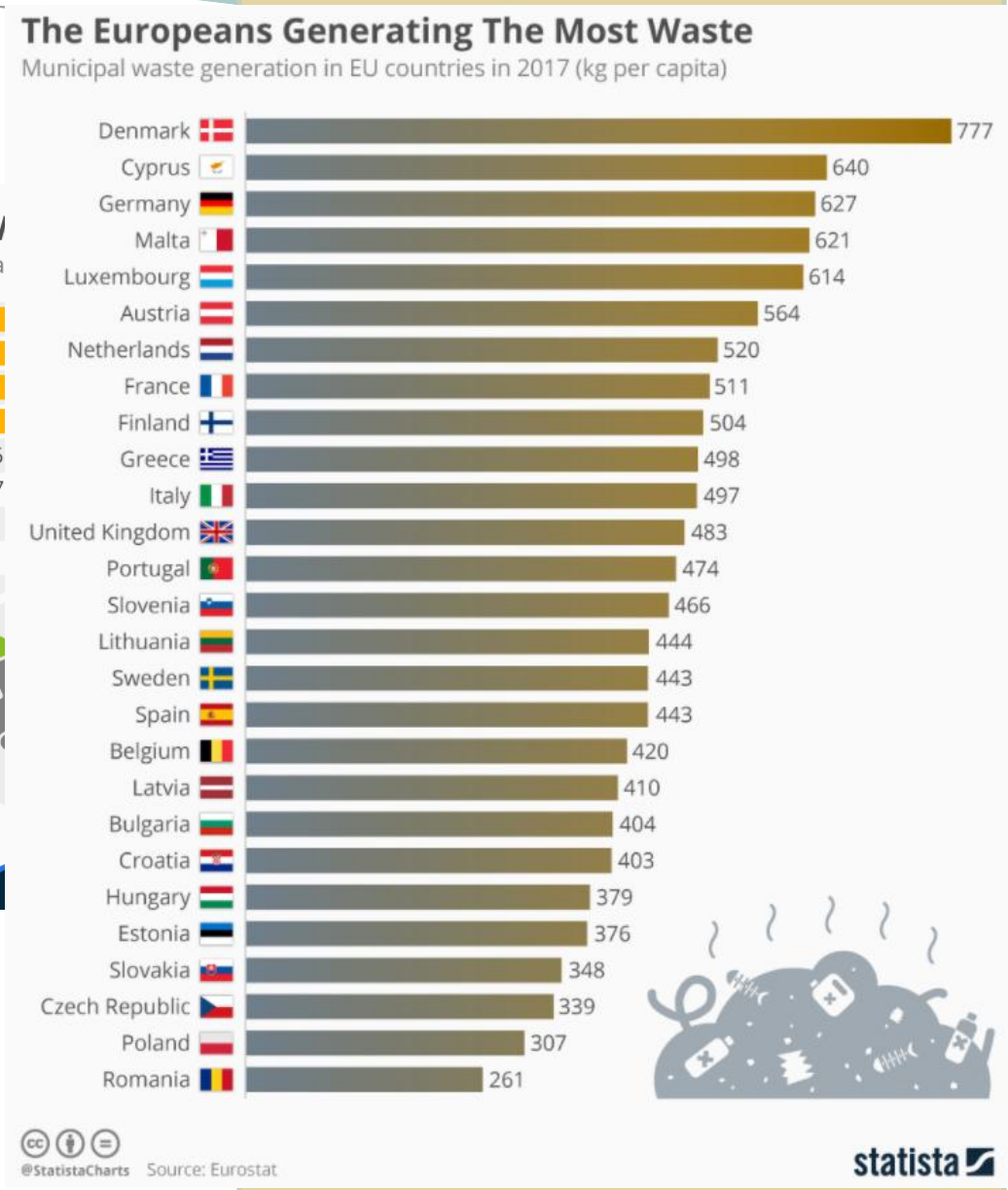
Municipal Solid Waste Generation rates (kg/person/day)



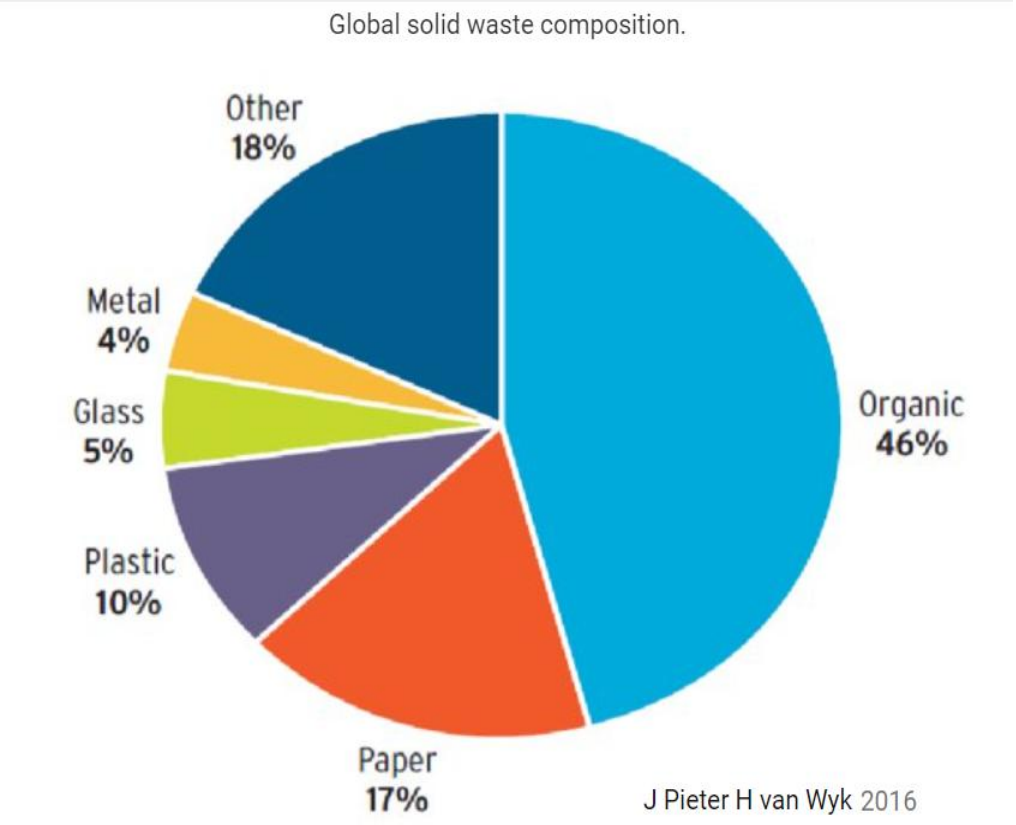
Source: Waste Management, **2009**
http://www.**sciencedirect**.com/science/article/pii/S0956053X08001669

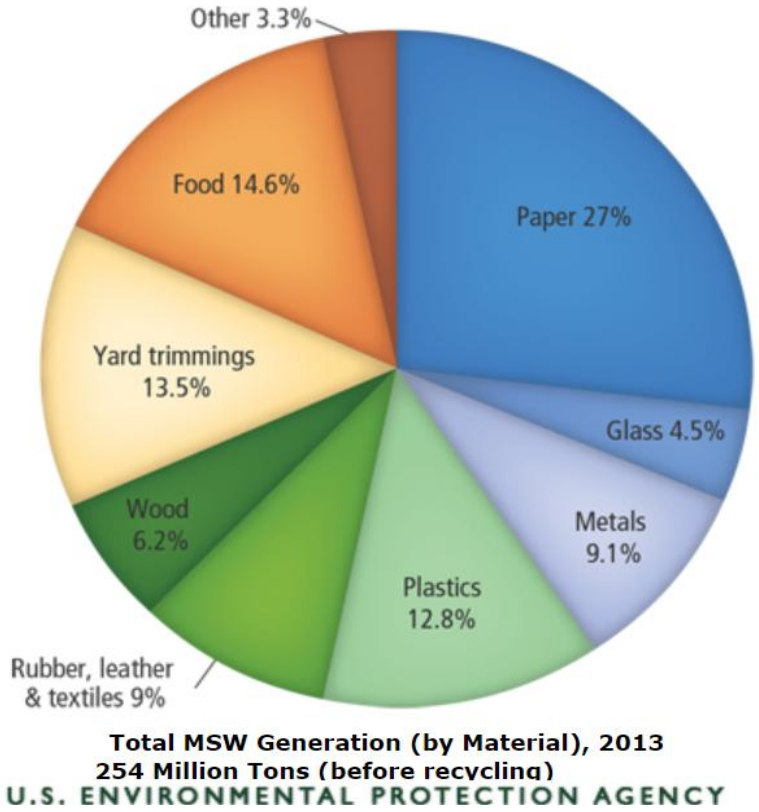
"**Maldives** has the highest MSW generation rate due to its greatest economic activity being tourism".


The Countries Generating The Most Municipal W
Municipal waste generation in selected OECD countries in 2013 (kg per ca
Denmark
United States
Switzerland
Australia
Germany 6
Ireland 587
France 530 kg
Netherlands 525 kg
United Kingdom 494 kg
Italy 484 kg
Spain 455 kg
Turkey 407 kg
Canada 403 kg
South Korea 358 kg
Japan 354 kg
* Municipal waste includes household waste and similar waste from small commercial activities, office buildings and institutions
@StatistaCharts
Source: OECD


The Europeans Generating The Most Waste
Municipal waste generation in EU countries in 2017 (kg per capita)
Denmark 777
Cyprus 640
Germany 627
Malta 621
Luxembourg 614
Austria 564
Netherlands 520
France 511
Finland 504
Greece 498
Italy 497
United Kingdom 483
Portugal 474
Slovenia 466
Lithuania 444
Sweden 443
Spain 443
Belgium 420
Latvia 410
Bulgaria 404
Croatia 403
Hungary 379
Estonia 376
Slovakia 348
Czech Republic 339
Poland 307
Romania 261
@StatistaCharts
Source: Eurostat
statista

Cambodia?


Global solid waste composition.
Other
18%
Metal
4%
Glass
5%
Plastic
10%
Paper
17%
Organic
46%
J Pieter H van Wyk 2016


Other 3.3%
Food 14.6%
Paper 27%
Yard trimmings
13.5%
Glass 4.5%
Wood
6.2%
Metals
9.1%
Plastics
12.8%
Rubber, leather
& textiles 9%
Total MSW Generation (by Material), 2013
254 Million Tons (before recycling)
U.S. ENVIRONMENTAL PROTECTION AGENCY

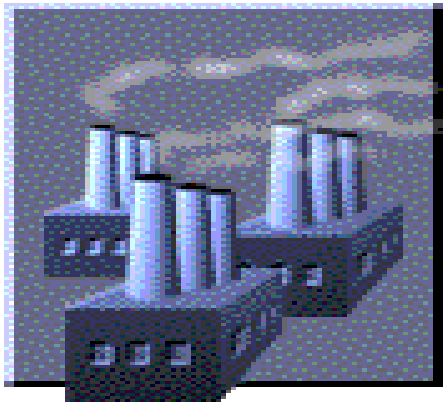
FOOD WASTE MEASUREMENT – HOW TO CONDUCT A FOOD WASTE DIARY METHOD

Sample 01				
Day 1	Type of food	Amount of food waste (g)	Where it was trough away	Reason
Breakfast				
Lunch				
Dinner				
Snacks				
Notes: **If left blank, please, explain (i.e. no food waste, meal skipped etc.)**				

Individual table for food waste diary recording

Main types of waste (solid, liquid, gaseous)

(according to **origin**)



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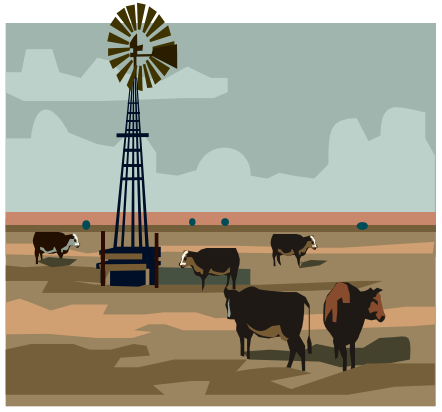


Hazardous (Toxic) Waste

Industrial (solid) waste

- Industrial waste is produced directly/indirectly by industries that supply people with goods and services.
- Some of the **largest waste** is generated by industrial sectors - by the **industry like metallurgical, chemical, petrochemical, paper, food**, etc.

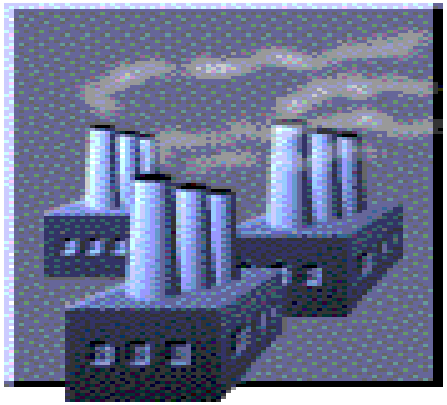
  The industrial waste is quite varied, as it can be represented by ash, sludge, acid waste or alkali, plastic, metals, paper, wood, fiber, rubber, glass, ceramics, oils, solvents, resins, paints, cloth, leather, waste from food processing, etc.

  Gas emission?
- Waste from manufacturing sector continues to rise, despite national and international declarations to reduce waste from manufacturing industries.

- In this category is included the majority considered **toxic waste**.

Main types of waste (solid, liquid, gaseous)

(according to **origin**)



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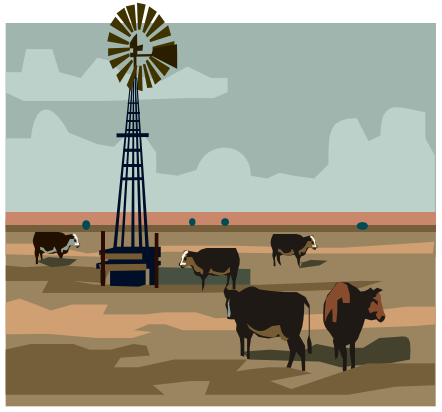


Hazardous (Toxic) Waste

Agricultural Waste and Residues

- Expanding agricultural production has naturally resulted in increased quantities of **livestock waste**, agricultural **crop residues** and agro-industrial by-products.
- It is composed of organic wastes and wastes such as scrapped machinery, fencing, pesticides, waste oils and veterinary medicines.

Hazardous Waste

Legally, hazardous waste is any discarded solid or liquid that contains substances known to be:

- **Fatal** to humans or laboratory animals in low doses
- **Toxic**, carcinogenic, mutagenic, or teratogenic to humans or other life-forms
- **Ignitable** with a flash point less than 60^{o} C
- **Corrosive**
- **Explosive** or highly reactive

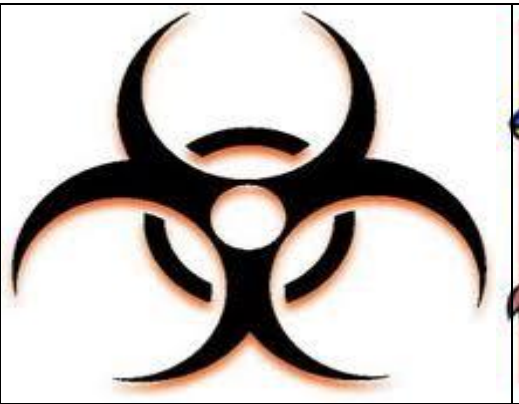
Hazardous Waste

Bio-medical waste

Radioactive (nuclear waste)

E-waste

Industrial, certain types of household waste….



Bio-medical waste (BMW)

Is the classification given to dangerous residues produced in hospitals, health clinics, pharmacies, laboratories, etc.

Hospital waste is generated during the diagnosis, treatment or immunization of human beings or animals and also in the research activities in these fields as well as in the production and testing of biologicals.

Expired pills?

Nuclear waste

- Nuclear waste is the radioactive waste leftover **from nuclear reactors**, nuclear research projects, and nuclear bomb production. Nuclear waste is divided into **low, medium, and high-level waste** by the amount of radioactivity the waste produces.

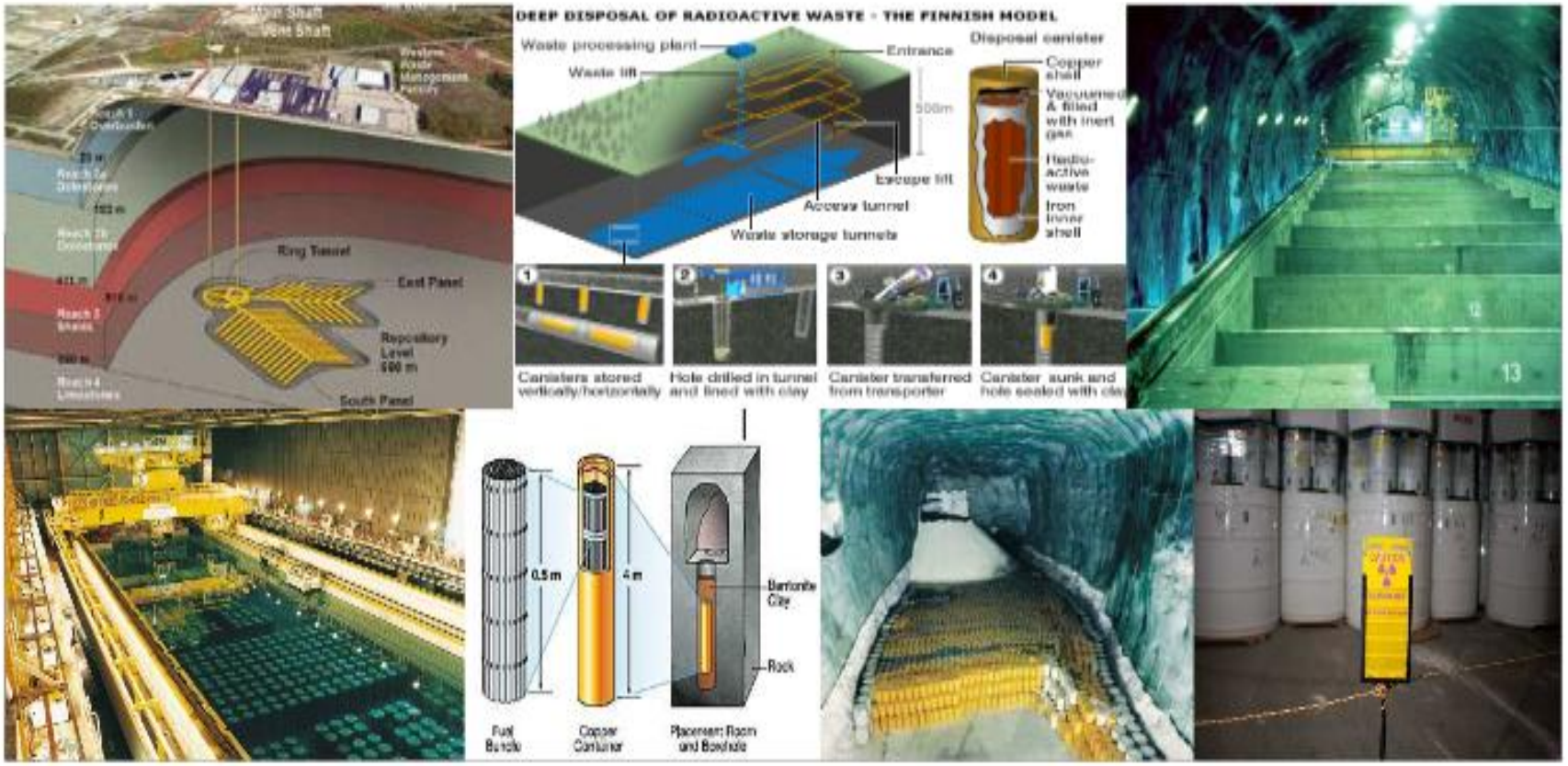
Because those materials continue to emit radioactivity for a long time, they need to be totally confined and isolated from the rest of the world.

© Michael Greenlar/The Image Works

Nuclear waste management

- **Deep geological depository**

http://teachnuclear.ca/all-things-nuclear/nuclear-issues/waste-management/



E-waste

- Electronic waste, e-waste, e-scrap, or Waste Electrical and Electronic Equipment (WEEE) describes loosely discarded, surplus, obsolete, or broken electrical or electronic devices (refrigerators, TV, freezers, telecommunication equipment, washing machines, hairdryers).

- A growing problem
- Some electronic scrap components contain contaminants such as lead, cadmium, beryllium, mercury, and brominated flame retardants.




These Countries Generate the Most Electronic Waste

Top 10 countries by the amount of e-waste generated in 2016*

* includes discarded products with a battery or plug including mobile phones, laptops, televisions, refrigerators, electrical toys and other electronic equipment

@StatistaCharts

Source: The Global E-waste Monitor 2017

statista

Environmental Impacts of Waste

- Nature's price - effect of chemicals and hazardous waste on soil, air and water conditions.
- Animals - effect of chemicals on wildlife and food cycles.
- Heath - waste accumulation breeds bacteria and is a good breeding area for vectors e.g., mosquitoes.
- Eye sore to man - destruction of the beauty and tranquility of the Earth.
- Economy - the long-term effects of waste on the environment are hard to see so it is much easier to ignore our waste now and leave the future generation to literally pay the price.

Definitions of Waste Management

- Waste management is the collection, transportation, processing, recycling or disposal and monitoring of waste materials.

- Solid waste management includes all activities that seek to minimise the health, environmental and aesthetic impacts of solid wastes.

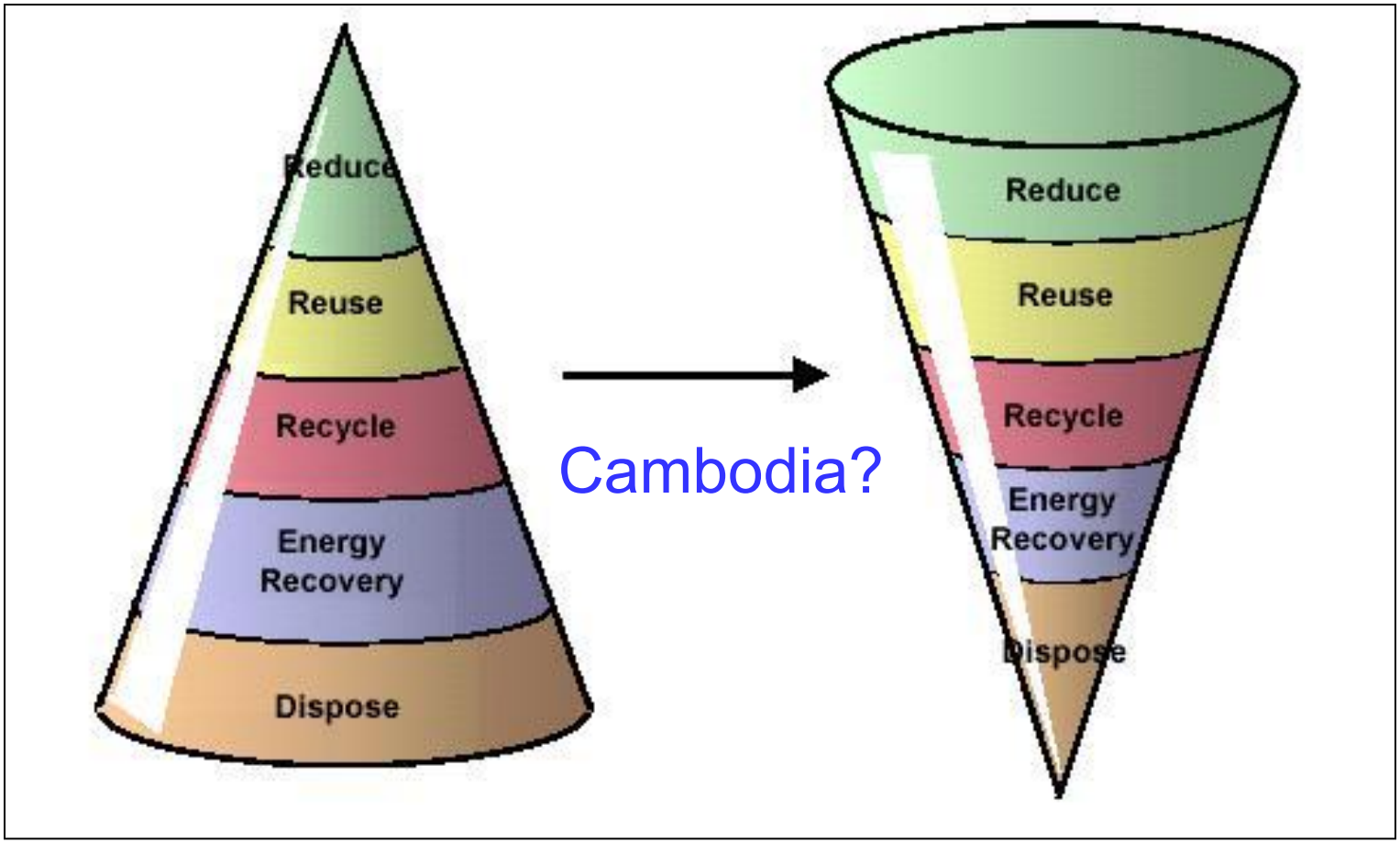
MSW Treatment Methods & Technologies

- **Open dumping** } **dispose**
- **Landfilling** }

- **Incineration** }
- **Pyrolysis** } **energy recovery**
- **Gasification** }

- **3 R (Reduce, Reuse, Recycle), Zero waste**

Waste hierarchy



https://www.youtube.com/watch?v=r-q5V6LDxEY

Open Dumping

- **Most widespread method** of solid waste disposal.

- **Uncontrolled disposal** of waste without measures to control leachate, dust, odor, gases or vermin.

- **Open burning** of waste is practiced at dumpsites.
- Waste is dumped along the shoreline and into the sea…

Drawbacks:

- scarcity of available land;
- build-up of gas, which can lead to outbreaks of fire and adverse health on adjacent residents…

Open Dumping

There is no control over these places, household waste is mixed with other chemicals that make this places an “environmental time bomb”.

Ocean dumping is nearly uncontrollable

- Of the 100 million tons of plastic produced annually, 10% ends up in the ocean;
- More than a million birds and marine animals die each year from consuming or becoming caught in plastic and other debris;
- Environmental groups estimate that 50,000 northern fur seals are entangled in this refuse and drown or starve to death every year in the North Pacific alone.

How it gets there?

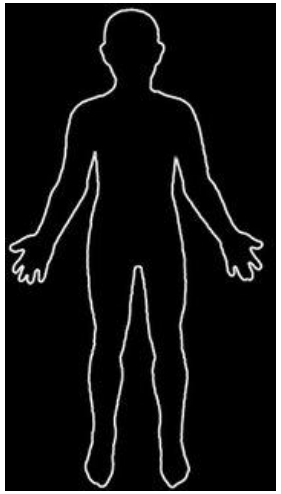
A Plastic Ocean
https://www.youtube.com/watch?v=6zrn4-FfbXw

Courtesy National Marine Sancturay, photographer Claire Fackler

A Plastic Ocean

https://www.youtube.com/watch?v=6zrn4-FfbXw

Chain Effect



Floating garbage is consumed by jelly fish and other organisms, which in turn is consumed by the fish that we eat.


Italy
Naples
Ligurian Sea
Adriatic Sea
Corsica
Tyrrhenian Sea
0 50 100 Kilometers
0 50 100 Miles
© pickatrail.com


THENEWSINPICTURES
FIRST POSTED MAY 30, 2007
Naples: dumped on
Thousands of tonnes of rubbish are piling up in Naples, southern Italy, because of a waste management crisis in local government that has been unresolved for 14 years. Tomorrow, the only remaining landfill will close; there are no plans for new sites
NEXT

Collection of wastes

Waste collection is the component of waste management which results in the passage of a waste material from the source of production to either the point of treatment/final disposal, or waste collection also includes the kerbside collection of recyclable materials that technically are not waste, as part of a municipal landfill diversion program.

- door-to-door collection
- indirect collection - containers, communal bins placed near markets, in residential areas and other appropriate locations. ??

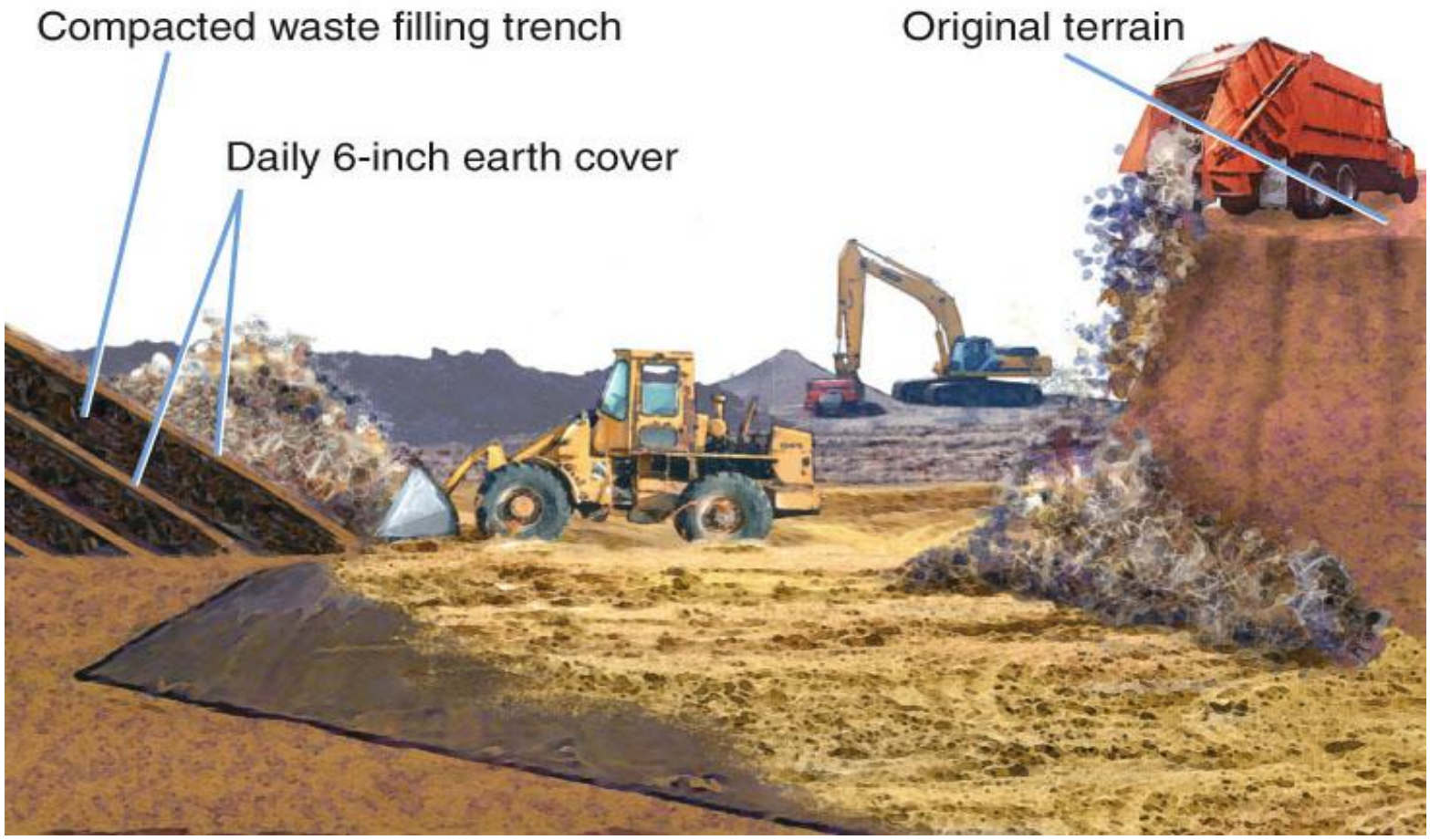
Landfilling

- Disposal of waste materials by **burial.**
- Landfills sanitation (sanitary landfills) are considered as a practical solution and a **relatively cheap** final destination of municipal (and industrial) waste.

- **Features:**

- controlled dumping
- careful and scientific site selection
- compaction of waste
- provision for collecting leachates
- landfill gas collection

Landfills



Landfill Operations

Base preparation

Production & Compaction

Cover (daily)

??

Landfill Operations

Leachate Treatment

Gas Treatment

Gas Monitoring & Collection

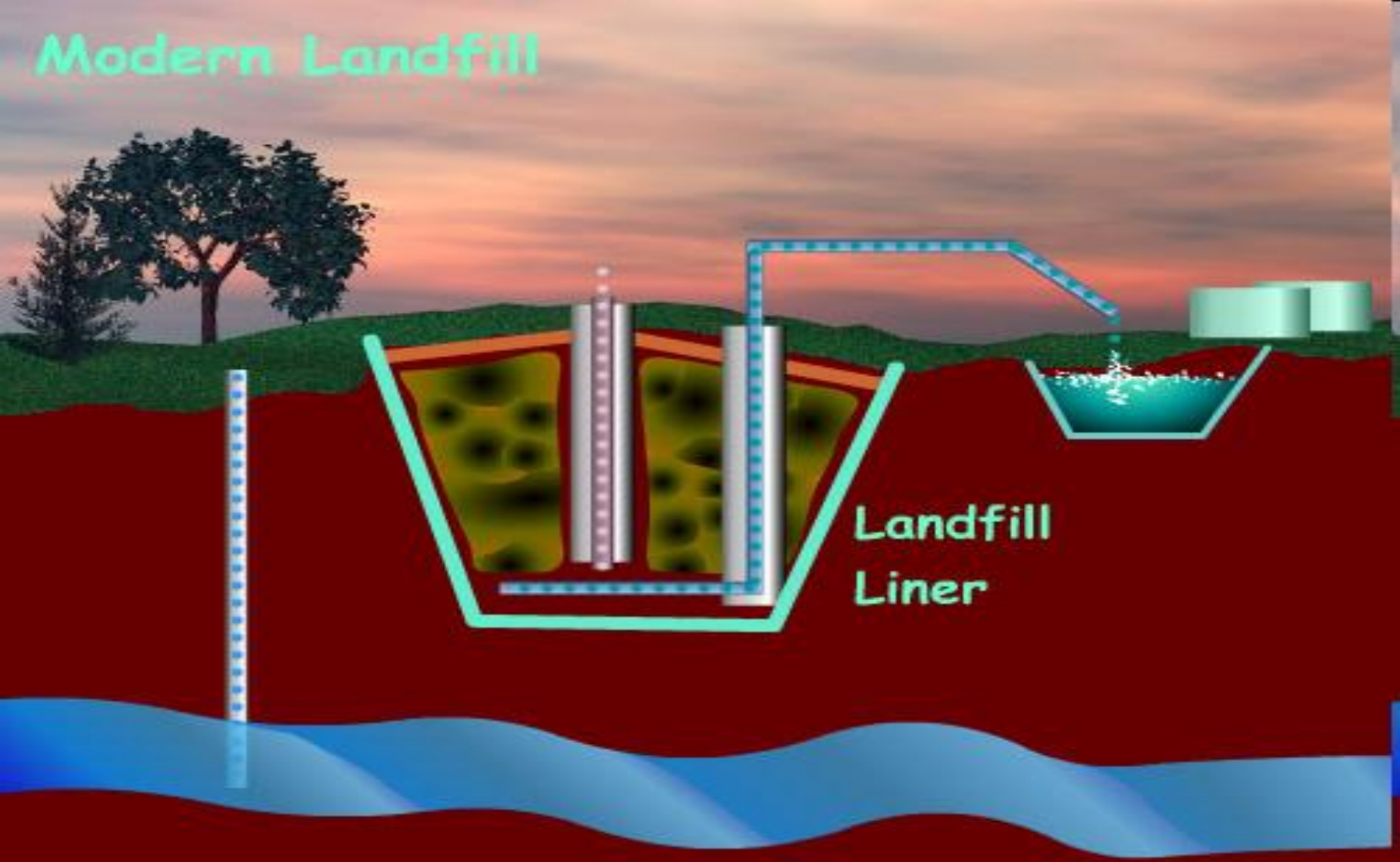
Landfill gas is a mix of different gases created by the action of microorganisms within a landfill as they decompose organic waste.

Landfill gas is approximately 40-60% methane (CH_4), with the remainder being mostly carbon dioxide (CO_2).

vs natural gas vs biogas?

- Organic wastes are degraded by **soil microorganisms**
- Microbes utilize the oxygen present inside the landfill
- Followed by **anaerobic decomposition** & landfill gas production
- Water soluble organic compounds generated in this process
- The construction of landfill sanitation requires a previously installed **water resistant**, which disables the liquids from infiltrating the soil. The remaining fluids are then sent to a treatment facility in order not to damage the environment.

Modern Landfill



The bottom and sides of the landfill are lined with more clay or a plastic liner. This lining is intended to prevent water that has been exposed to the waste (this liquid is called leachate) from escaping into the environment.

Landfill Operations

Recultivation a monitoring of landfill

https://www.youtube.com/watch?v=RYhQQziYA3s&t=4s

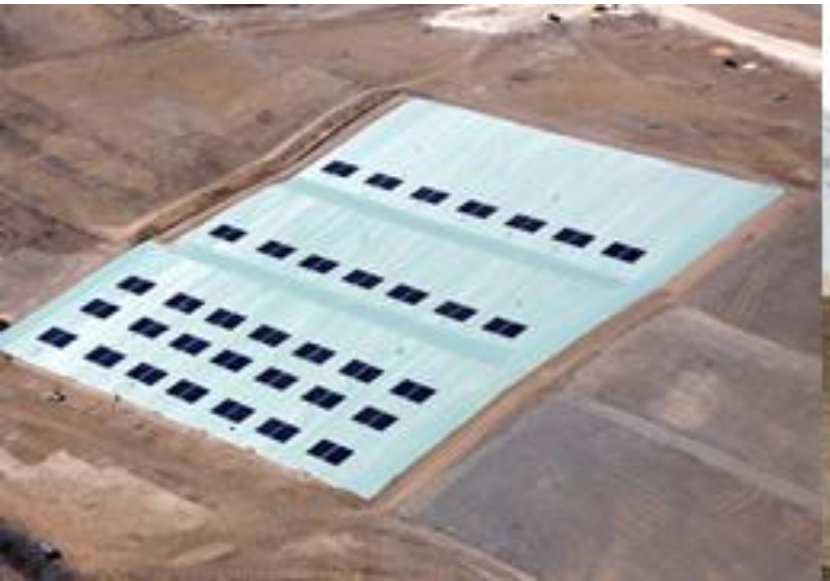
Landfill reuse

After a landfill reaches its full capacity, these areas can be decontaminated and used for other purposes.

Landfill Reuse: Renewable Energy

Wind power installed at a landfill in China

Solar Energy Cover replaces traditional closed landfill cover, Tessman Road Landfill outside San Antonio, TX



Negative impacts

- However, if is not properly sealed, it can become an agent of **environmental pollution**, due to the decomposition of organic waste.

- Its impacts includes:

- fatal accidents
- infrastructure damage
- pollution of local environment
- off gassing of landfill gas
- harboring of disease vectors
- land occupied by the landfill becomes unproductive
- insects, rodents, scavenger birds, bad odor are some of the aesthetic problems associated with (sanitary) landfill
- leachate contamination of ground water and soil are the environmental issues connected with (sanitary) landfill

RESIDUAL SEPARATION & RESEARCH FACILITY

- 1. Built at entrance to landfill
- 2. No material can enter landfill without it being separated and screened
- 3. Toxics removed and identified
- 4. Dirty organics biologically stabilized
- 5. Non-recyclable materials STUDIED

Nova Scotia, Canada has already built Residual Separation Facilities in front of their landfills to remove more recyclables, toxic …. fraction before landfilling.

Decomposition time of common wastes

Material	Decomposition Time* (Years)
Steel	10 to 100
Aluminium Can	80-250
Ceramics	Indetermined**
Bubble Gum	5
Nylon Strings	30 to 40
Sponges	Indetermined**
Cigarrete Filters	1 to 5 years
Isopor	Indetermined**
Wood	0.5
Rubber	Indetermined**
Paper and related	0.25 to 0.5
Plastic	450
Organic Waste	0.5 to 1
Glass Bottle	Over 1000000
Tissues	0.5 to 1
Diapers Leather Orange or Banana Peel	Over 450 500 2-5 weeks

The Table represents some of the most man-made products used in our daily lives and the time it takes for a full process of decomposition to occur.

Organic vs Inorganic?

*Open Air Conditions
**Linked to Soil Conditions

The average useful life of a plastic carrier bag is 12 minutes yet they take 450-1,000 years to break down in a landfill site ☹

Resource for new generations?

Waste management is a **global problem** because waste doesn't stay local — its impacts cross borders, affect ecosystems, public health, and the climate. Addressing it requires global cooperation, innovation, and sustainable practices.

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SmartAgriCambodia: Advancing Sustainable Agriculture in Battambang

2025 - 2027