

Reducing Land Pollution and Land Degradation through 3R Policy Initiative ~ What Circular Economy can offer?

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Introduction



- ❖ Estimated global MSW generated in **2025: 2.2 Billion tonnes/year**.
- ❖ The **illegal dumping of MSW**, release of **chemicals from industrial and agricultural activities**, as well as, **oil spillage** in to the environment constitutes an environmental hazard with global ramifications.
- ❖ **90% of land pollution is directly related to human activities** including deliberate waste disposal.
- ❖ **8.8 million metric tons of oil** are released into the world's water and soil every year.
- ❖ US Environmental Protection Agency reported that more than **40%** of the national priority list sites are **co-contaminated with heavy metals** and heavy polycyclic aromatic hydrocarbons (PAHs) (Reddy et al., 2011).
- ❖ Pollution of environment by hydrocarbons, pesticides, heavy metals and other chemicals is a serious threat to the environment.

Land pollution and causes



- ❖ Soil pollution or soil contamination is caused by the release of man-made chemicals or other alterations in the natural soil environment.
- ❖ It is **typically caused** by:
 - Oil spillage.
 - Improper disposal of waste.
 - Landfill leachate runoff and infiltration.
 - Industrial activities.
 - Agricultural chemicals.
 - Mining activities.

Some oil polluted sites in the world



Oil contaminated site (Israel)

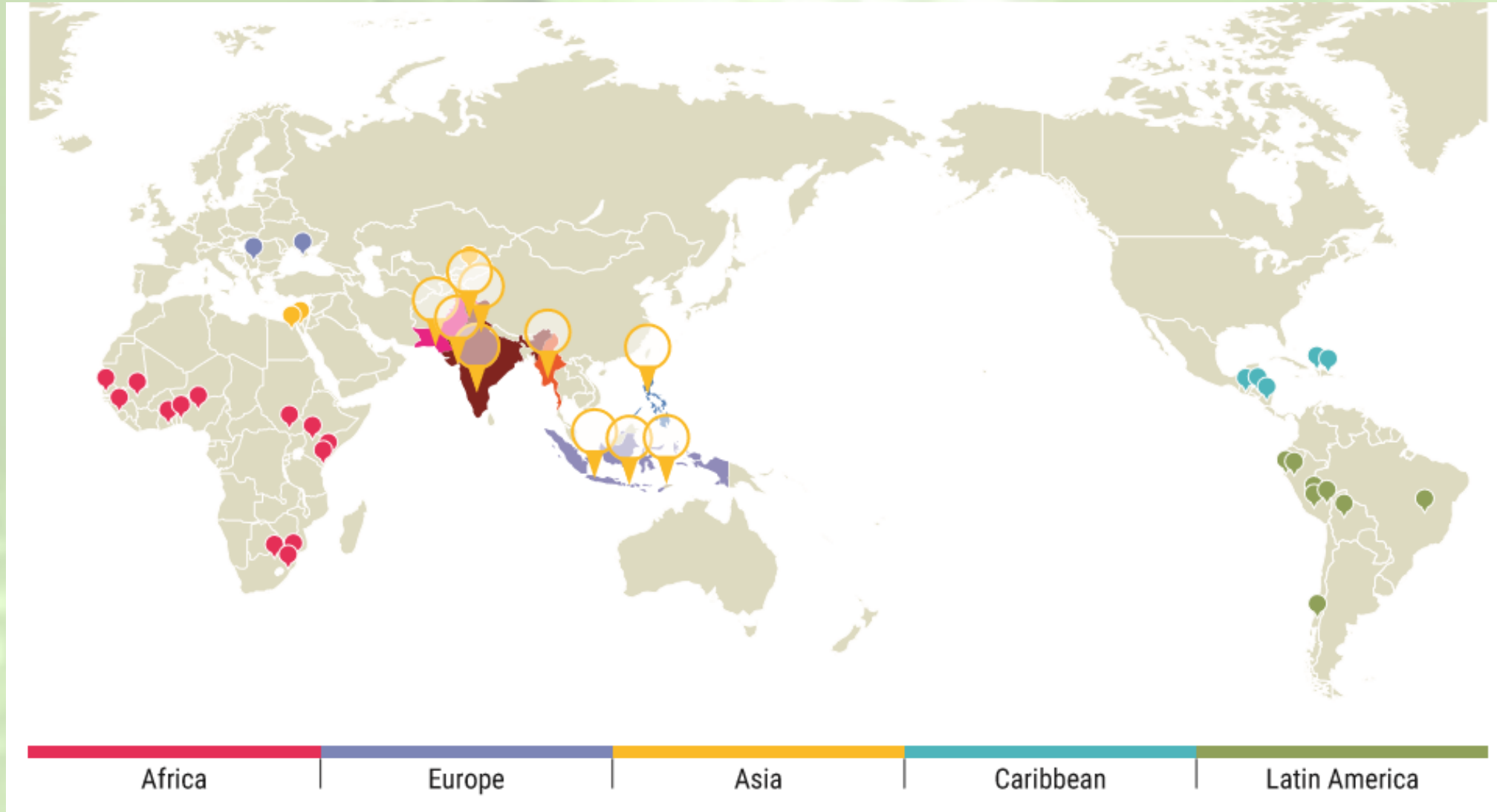


Oil contaminated site (USA)



Oil contaminated site (Lebanon)

Dump sites in the world



Out of the largest 50 dumpsites in the world, 17 dumpsites are found in Asia.

Some Open dump sites in the world

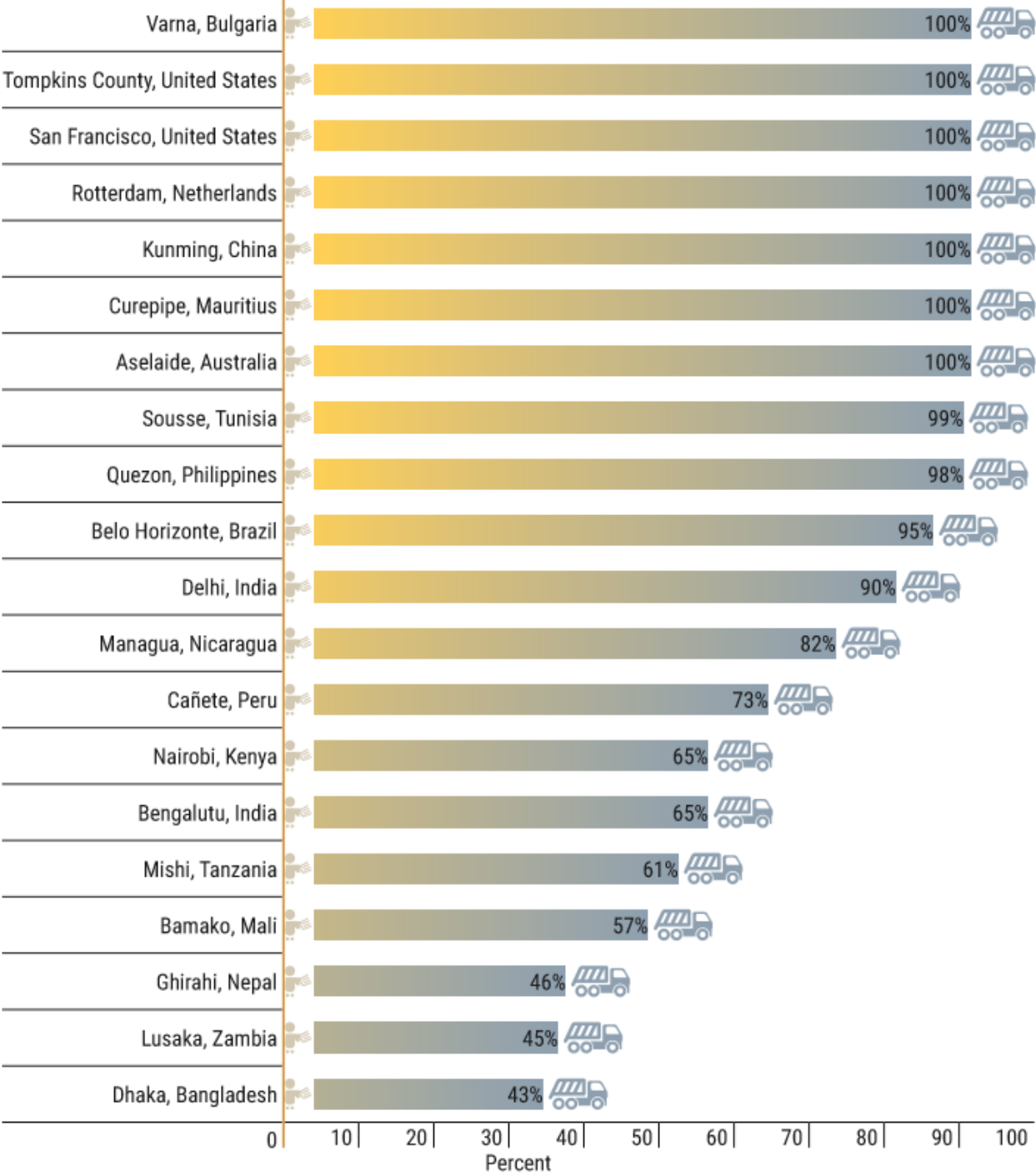


Open dump in Denpasar, Bali. Unsightly situation in Katmandu, Nepal
Open dump in Kampala, Uganda

Dumpsite in Southeast Asia

- In 2015, **2,000 tonens** of waste arrived everyday at Choeung Ek Dumpsite, Cambodia making it Cambodia's largest dump.
- Cambodia and wider Southeast Asia may soon receive a lot more rubbish after China's move to stop importing 24 categories of solid waste.
- E-waste is also on the rise across Southeast Asia. The volume of such waste grew by **90% in Vietnam** and **70% in Cambodia** between 2010 and 2015 – only China saw a higher growth rate at **107%** over the same period.
- While some of the **17,000 tonnes** of e-waste Cambodia produced in 2015 was salvaged by repair ships, the majority was either **dangerously burned or discarded in dumpsites**.

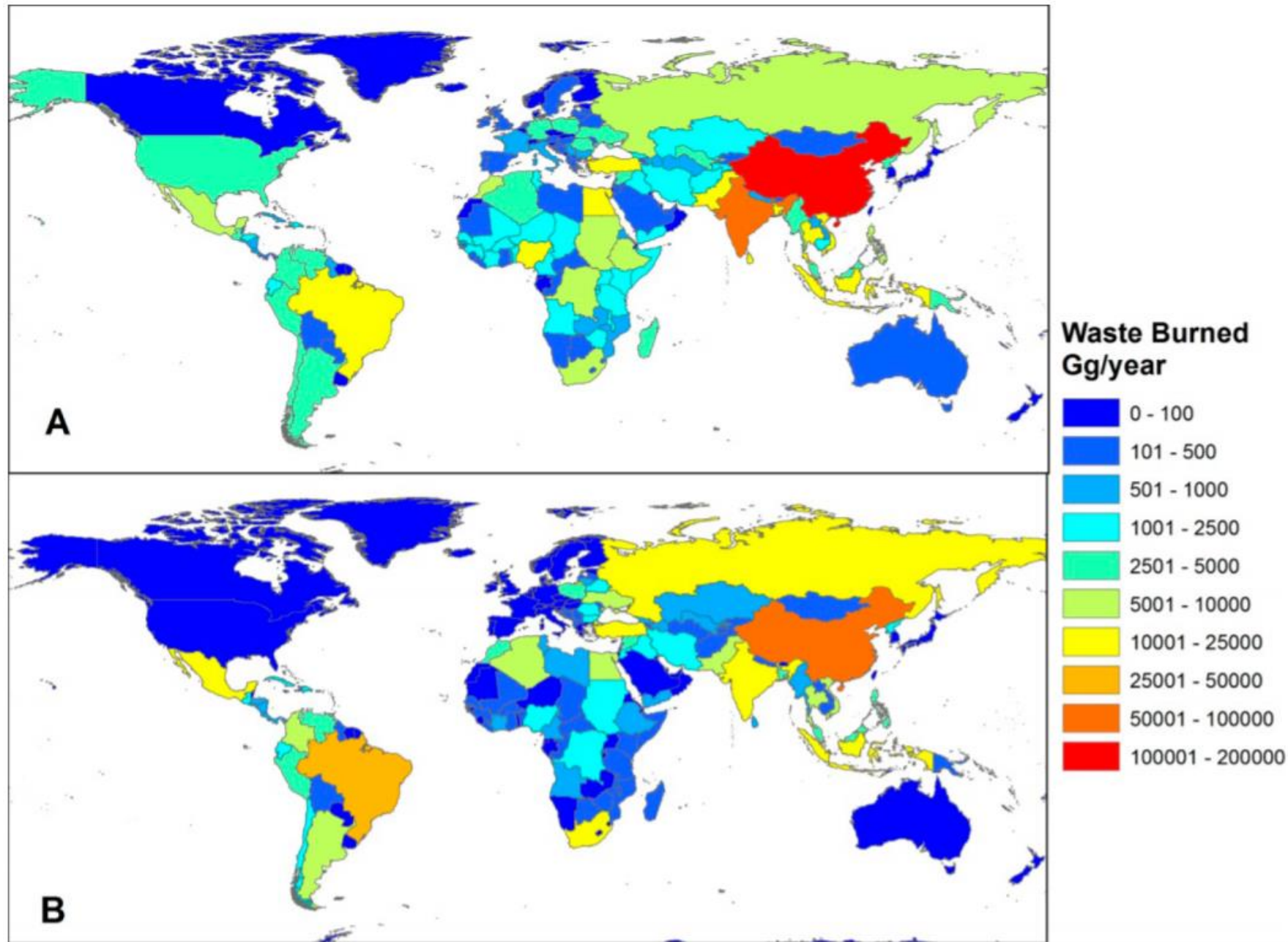
Collection Efficiencies for Several Municipalities



Open Burning of Waste

- Release variety of toxic pollutants into the air and exacerbate soil pollution, water pollution and food contamination.
- **41%** of global waste is burned openly.
- **620 million tons** of waste per year are burned openly.
- Mostly occurs in dumpsites that have been filled far beyond their maximum capacity.
- **Poor collection coverage and poor waste disposal methods lead to incidence of open waste burning and land degradation.**

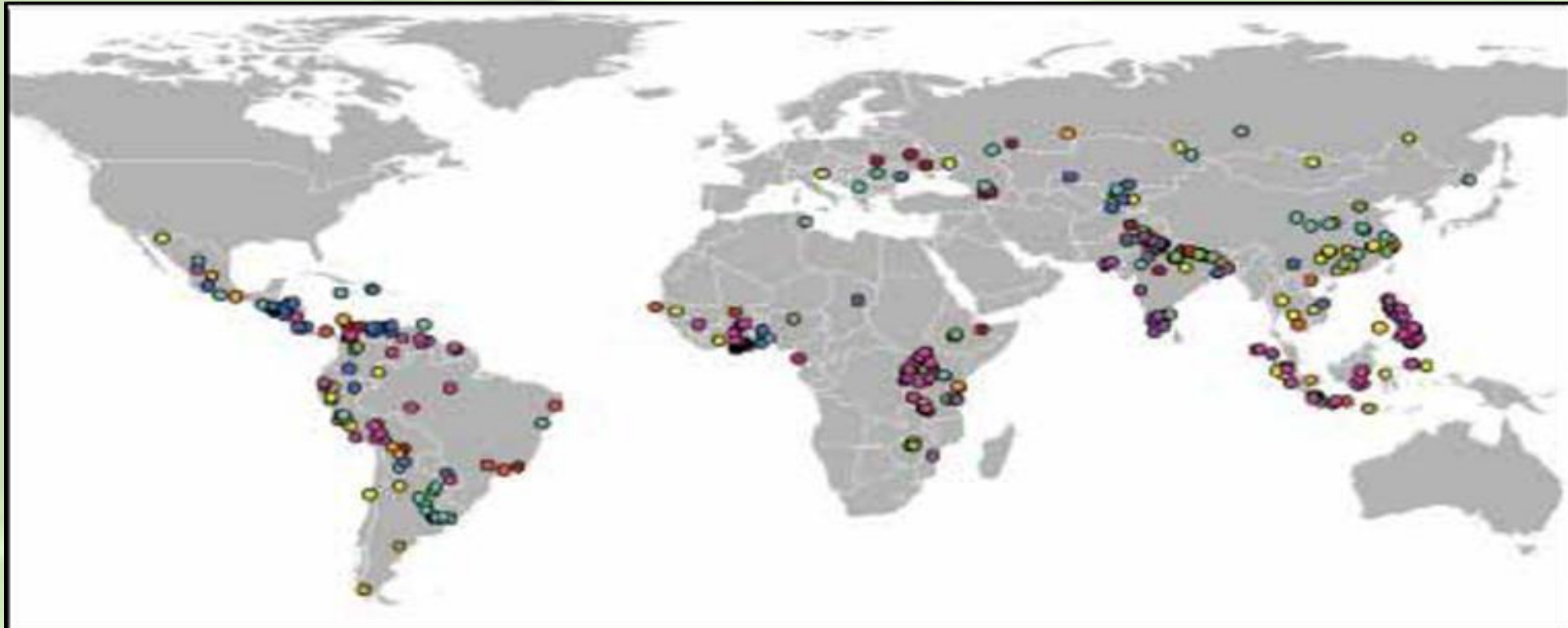
Estimated quantity of waste burned by country, residentially (A) and in dumps (B)



GHG Emissions due to open burning of waste and their health effects

Pollutant	Global Emission due to open burning (kg/year)	% of total global emissions of pollutant	Potential health impacts
Carbon Dioxide (CO ₂)	1.4 Trillion	5	<ul style="list-style-type: none">• Cardiorespiratory failure• Climate change associated risks
Methane (CH ₄)	3.6 Billion	1	<ul style="list-style-type: none">• Respiratory arrest• Climate change associated risks

Global land pollution caused by mining, industries and agriculture



- Artisanal Gold Mining – Mercury Pollution
- Industrial Estates – Lead Pollution
- Agricultural Production – Pesticide Pollution
- Lead Smelting – Lead Pollution
- Tannery Operations – Chromium Pollution

- Mining and Ore Processing – Mercury Pollution
- Mining and Ore Processing – Lead Pollution
- Lead-Acid Battery Recycling – Lead Pollution
- Naturally Occurring Arsenic in Ground Water – Arsenic Pollution
- Pesticide Manufacturing and Storage – Pesticide Pollution

Leachate pollution of soil



Leachate seep, US



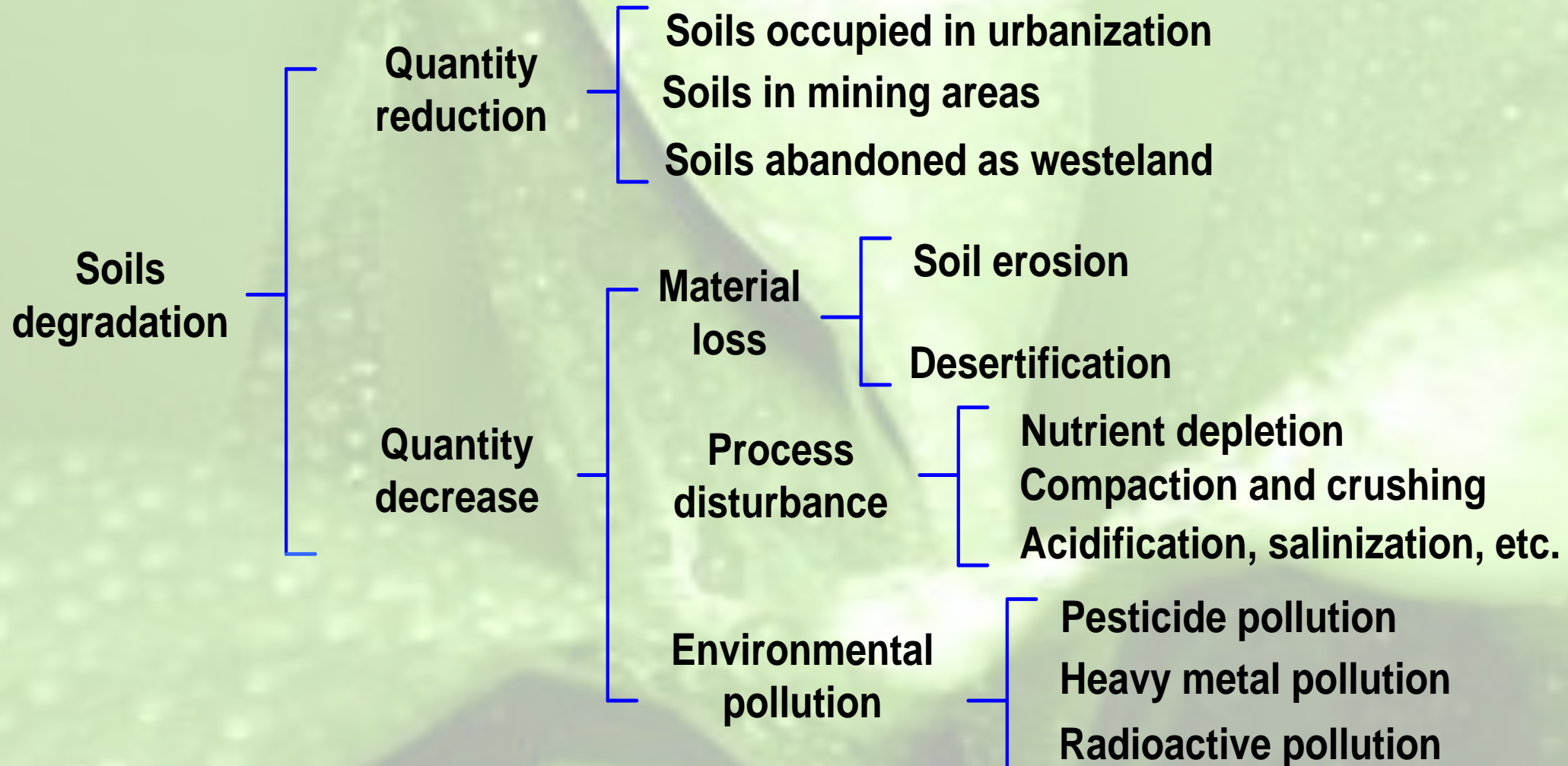
Landfill leachate and waste-contaminated site (India)

Land degradation and human causes

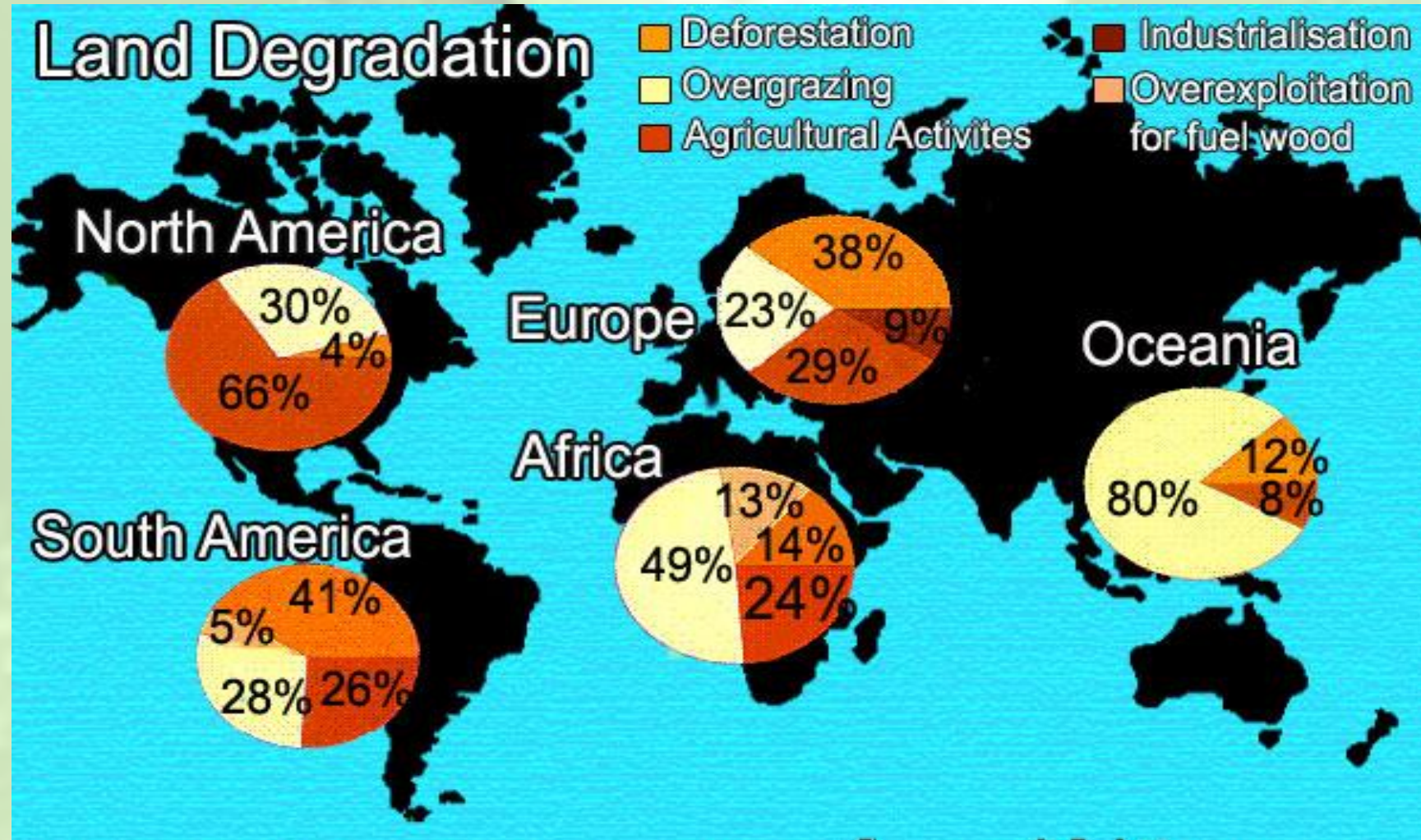


- ❖ The social and environmental processes are stressing the world's arable lands and pastures essential for the provision of food and water and quality air.
- ❖ Some of the causes include:
 - Industrialization.
 - Deforestation.
 - Overgrazing.
 - Overexploitation for fuel wood.
 - Agricultural activities.

Classification of land degradation



Global land degradation



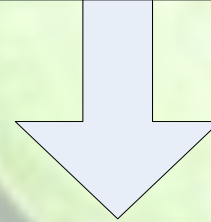
Efforts to Prevent Land Pollution and Degradation and Associated Health Impacts

1. Utilization of organic waste and biomass for sustainable farming and energy. Biocover in Landfills
2. Circular economic utilization of waste streams in achieving SDG 11 and SDG 15.
3. 3R business for clean land through landfill mining.

Utilization of organic waste and biomass for sustainable farming



Use of organic fertilizers



Green manure

Compost

Farmyard manure

Crop residues

Slaughter house waste

Biogas compost

Poultry manure

Utilization of organic waste and biomass for sustainable farming cont.

❖ Green manure



The bed on the right has 'green manure' fully-grown and ready to dig into the soil.



The use of Broad Bean as green manure

Utilization of organic waste and biomass for sustainable farming cont.

Some green manure plants and their efficiencies

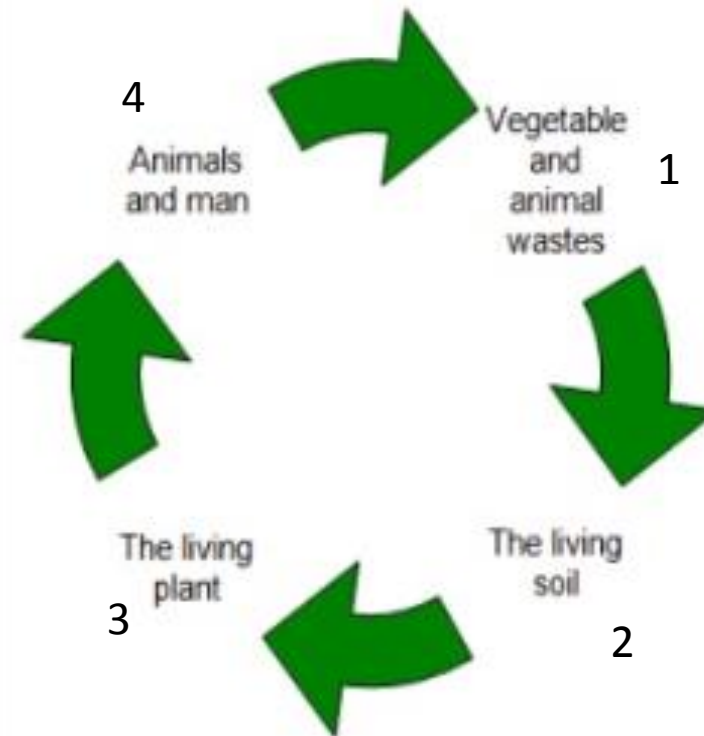
Average biomass yields and nitrogen yields of some legumes	Biomass tons acre ⁻¹	Nitrogen lbs acre ⁻¹
Sweet clover	1.75	120
Berseem clover	1.10	70
Crimson clover	1.40	100
Hairy vetch	1.75	110

Utilization of organic waste and biomass for sustainable farming cont.

❖ Compost manure



Compost manure



Nutrient cycling through compost

Remediation options

The major remediation techniques are:

- ❖ Biological treatment
- ❖ Chemical treatment
- ❖ Physical/Mechanical treatment
- ❖ Thermal treatment

Biological treatment of Land

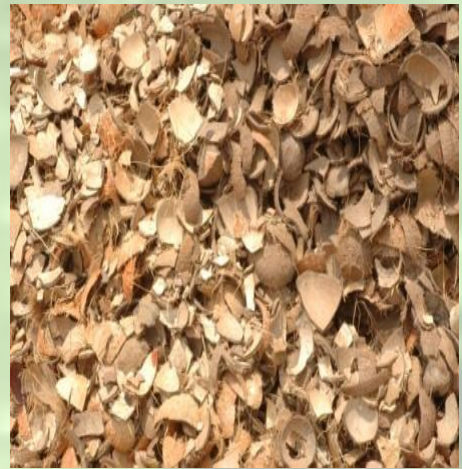


- ❖ It involves the use of living or dead organisms (biomass) to decontaminate polluted environments.
- ❖ **Bioremediation** – is the use of microorganisms to detoxify or remove pollutant through microbial enzymatic activities to transform or degrade organic contaminants.
- ❖ It is cost effective.
- ❖ It transform pollutant completely into innocuous substance.
- ❖ It can be enhanced through the use of organic solid waste.
- ❖ **Biostimulation** – addition of nutrient.
- ❖ **Bioaugmentation** – addition of specialized microorganisms.
- ❖ **Phytoremediation** – use of plant to remove contaminants.
- ❖ **Biosparging** – addition of oxygen/air below groundwater surface to stimulate microbial activity and degradation.
- ❖ **Bioventing** – addition of oxygen/air to soil vapor phase to stimulate aerobic degradation.

Some effective recycling organic wastes to enhance bioremediation of land



Sugarcane largesse, Spent mushroom compost, Chicken manure, Teal leaf Waste coffee grounds



Garden waste,

Coconut shell

Rice husk

Banana skin

Brewery spent grain

Utilization of organic waste and biomass for sustainable energy



Japan's Norin Green No. 1, a test plant for-bioethanol



Photos courtesy of J.C. Chen, LRI, Taiwan ROC.

Wastewater treatment and biogas production facilities from animal manure at the Livestock Research Institute (LRI), Taiwan ROC.

Utilization of organic waste and biomass for sustainable energy cont.



Overview of the global potential of bioenergy supply over the long-term for a number of categories. Source 2 –IEA RETD Bioenergy

Biomass category	Technical potential in 2050 (EJ/yr)
Energy crop production on surplus agricultural land	0–700
Energy crop production on marginal land	<60–100
Agricultural residues	15–70
Forest residues	30–150
Dung	5–55
Organic wastes	5–50+
Total	<50 to>1,100

Sustainable Development Goals



Facts and Figures:

- **2.6** billion people depend directly on agriculture
- **52%** of the land used for agriculture is moderately or severely affected by soil degradation
- As of **2008**, land degradation affected **1.5 billion** people globally
- **74%** of the poor are directly affected by land degradation globally

Goals

- By **2030**, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world



11 SUSTAINABLE CITIES AND COMMUNITIES



Facts and Figures:

- Rapid urbanization is exerting pressure on fresh water supplies, sewage, the living environment, and public health

Goals

- By **2030**, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management

2. Circular Economic Utilization of Waste Streams in Achieving SDG 11 and SDG 15

Overview of Some **Circular Economy**-related Initiatives in Asia

Japan

Law for the Promotion of Efficient Utilisation of Resources, passed in 2000.

Key facts & Impacts

- ✓ Japan's recycling rate for metal is 98%
- ✓ Up to 89% of the materials in e-waste is recycled

2. Circular Economic Utilization of Waste Streams in Achieving SDG 11 and SDG 15

Overview of Some **Circular Economy**-related Initiatives in Asia

China Adopting the Circular Economy Promotion Law in August 2008

Key facts & Impacts

- ✓ Since 2009, China has developed more than 200 pilot projects in three levels of single business, eco-industry parks and circular economy cities and regions
- ✓ China has set a first Five Year Plan of the Circular Economy (2011-2015) including a resource productivity improvement target of 15%

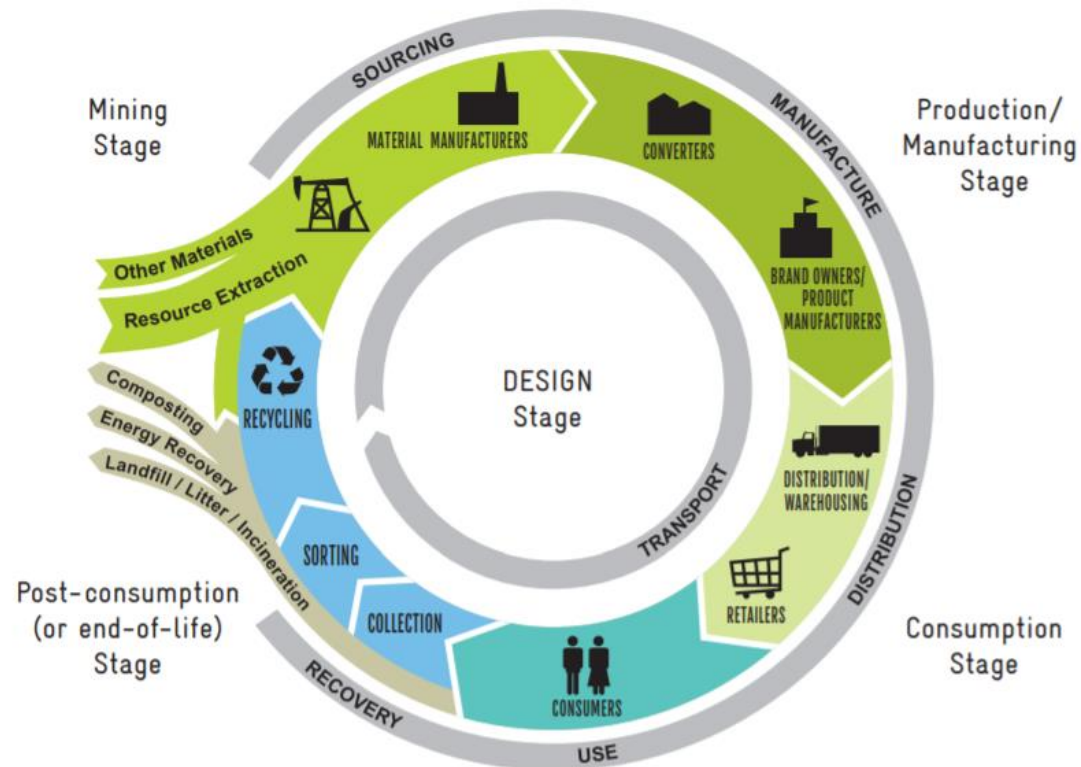
2. Circular Economic Utilization of Waste Streams in Achieving SDG 11 and SDG 15

Overview of Some **Circular Economy**-related Initiatives in Asia

India

Set up of the Indian Resource Panel in October 2015 under the Ministry of Environment, Forest and Climate Change (MoEFCC)

Life-cycle approach



Overview of Some **Recycling**-related Initiatives in Asia

Republic of Korea

Korean Extended Producer Responsibility (EPR) System in 2003

Key facts & Impacts

- ✓ Quantity of recycled products and packaging materials rose to 1,519 thousand tons in 2012 (62% more than the number in 2002)
- ✓ Savings on landfill expenses amount to **2,888 billion KRW** and **3,055 billion KRW** has been generated from selling recycled goods and materials.
- ✓ Up to 9,769 jobs were created over 10 years.

Overview of Some **Recycling**-related Initiatives in Asia

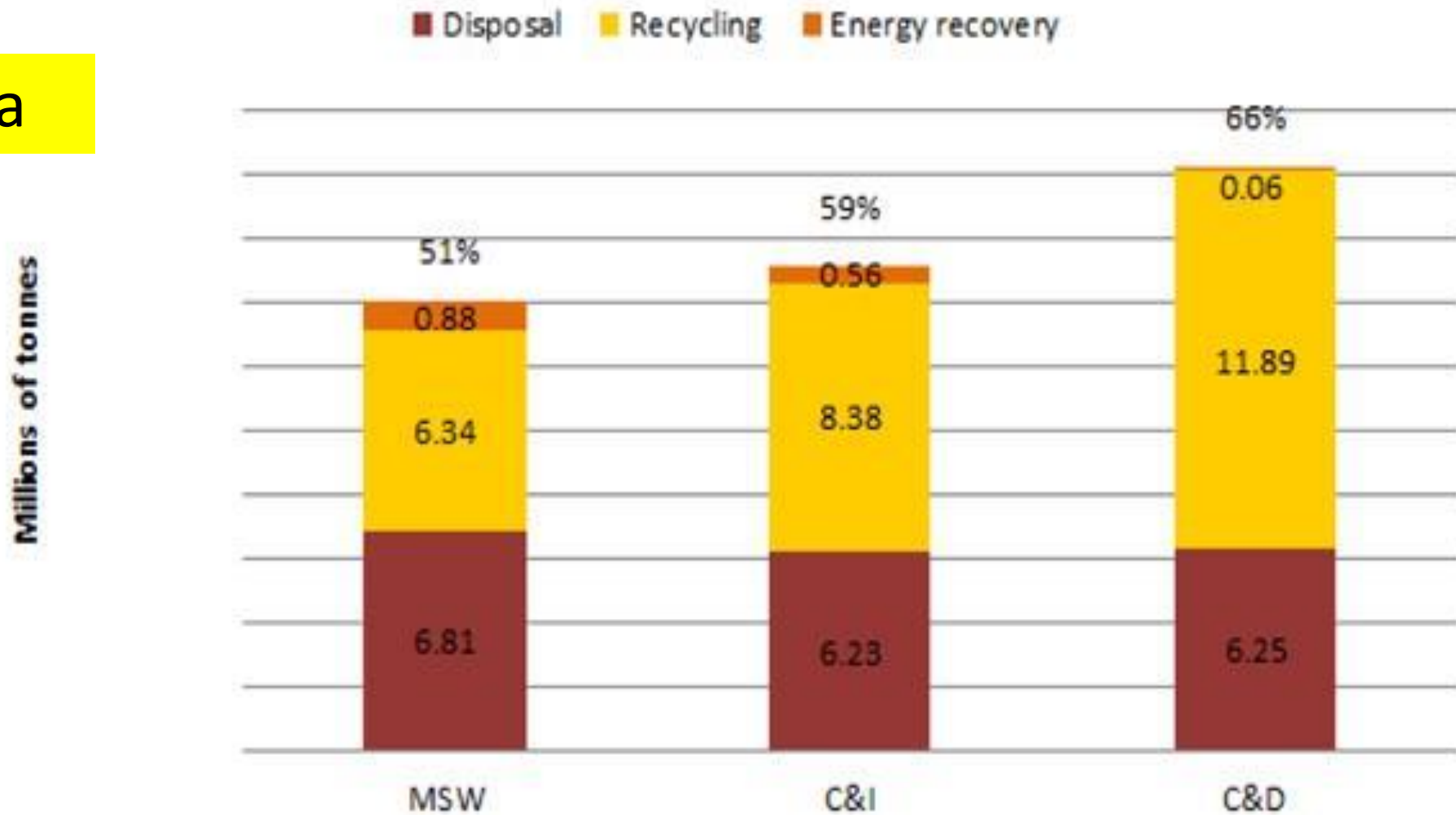
Indonesia

3R Implementation on Agro-industries in Indonesia

Agro-industries	3R Implementation
Slaughter House	Compost, biogas & methane capture-electricity
Fish Market	Farm animal food
Milk Industries	Compost
Sugar Plant	Compost, bio-fuel
Palm Industries	Compost, bio-fuel, liquid fertilizer
Forestry and Horticulture	Bio-fuel

Overview of Some Recycling-related Initiatives in Asia

Australia

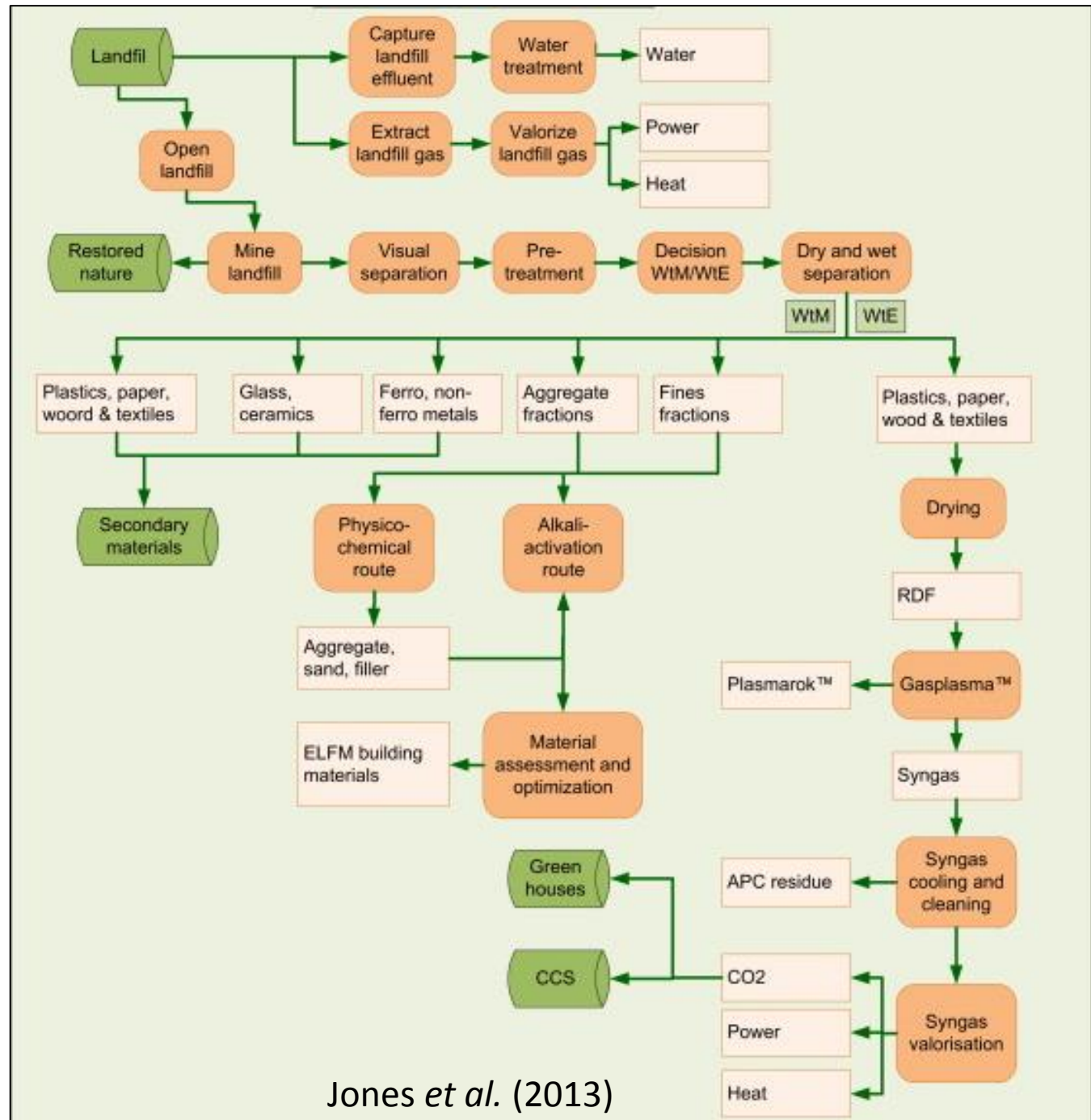


Australia total waste generation by stream and management (excluding ACT), 2010-2011

3. 3R Business for Clean Land through Landfill Mining

Enhanced Landfill Mining (ELFM)

General ELFM process flow diagram



Jones et al. (2013)

Benefits and Costs of Landfill Mining

Benefits

Increased disposal capacity

Avoided or reduced costs of:

- Landfill closure
- Post-closure care and monitoring
- Purchase of additional capacity or sophisticated systems
- Liability for remediation of surrounding areas

Revenues from:

- Recyclable and reusable materials
- Combustible waste sold as fuel
- Reclaimed soil used as cover materials, sold as construction fill, or sold for other uses

Land value of sites reclaimed for other uses

Costs

Expenses incurred in project planning

Capita costs:

- Site preparation
- Rental or purchase of reclamation equipment
- Rental or purchase of personnel safety equipment
- Construction or expansion of materials handling facilities
- Rental or purchase of hauling equipment

Operational costs:

- Labor
- Equipment fuel and maintenance
- Land filling non-reclaimed waste or non-combustible fly and bottom ash if waste material is sent off site for final disposal
- Administrative and regulatory compliance expenses
- Worker training in safety procedures
- Hauling costs

Conclusion

- ❖ Open burning and open dumping of waste represent a global environmental and health disasters with a large amount of potential effects.
- ❖ Implementation of circular economy and recycling is another way to reduce waste from industrial sector send to landfill.
- ❖ Bioremediation enhanced with biomass utilization is cost effective and environmentally friendly as pollutants are readily transformed into innocuous substances through the use of organic solid waste.
- ❖ Remediation combine with enhanced landfill mining can generate an income for public waste agencies to cover the cost of remediating mining smaller, less economic landfills that pose short-term environmental and health risk.

Thank you