



## 2. 3R CONCEPT-REDUCE-REUSE- RECYCLE



Waste / waste management is one of the most important criteria in protecting the environment and ecological balance. The recovery of non-renewable raw materials greatly affects many parameters, including climate change and soil/water production resources (Berrini & Bono, 2010). When properly managed, waste can turn into a potential resource. Waste dumped directly into nature causes resource losses, and correspondingly, economic losses (Treanor, Connolly & McEvoy, 2015).

In this context, the EU Waste Framework Directive (2008/98/EC) is the cornerstone for the waste policy of EU. According to the waste management hierarchy defined in this directive, waste management strategies should focus primarily on preventing and “reducing” the generation of waste. If this is not possible, waste materials should be “reused”, “recycled” and “recovered”<sup>1</sup>. This mentioned hierarchy should be implemented with the methods that give the best environmental result, and the last and the least preferred option is the method of destruction (Figure 2.1) (T.C. Avrupa Birliği Bakanlığı, 2013)

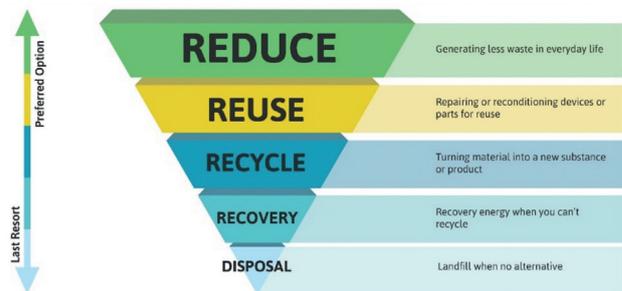


Figure 2.1. EU Waste Framework Directive waste hierarchy (URL-1)

This hierarchical approach, basically called the 3R principle (Reduce-Reuse-Recycle), means that the large amount of waste production must initially be reduced, and other respective preferences should be selected with a decreasing priority. This rule supports generating less waste, reducing the carbon footprint, becoming a more responsible consumer, and savings.

<sup>1</sup> A new “R” that has entered terminology in recent years, “Recovery”, is defined as obtaining different products from wastes used as raw materials as a result of a number of industrial processes.



## 2.1. Symbols and Definitions

The recycling logo emerged as the winning design of a competition organized to raise awareness about this issue at the end of the 1960s. The symbol that became a world standard was inspired by the Möbius<sup>2</sup> symbol. The 3 arrows in the symbol represent the 3 steps of the recycling process: the collection, the recycling process itself, and the purchase of these recycled products (URL-2).



Figure 2.2. Recycling symbol (URL-2)

The classic recycling symbol, whose design and colors can be varied, is used in two different ways. Normal use indicates that the object can be recycled, while the use of the symbol in a circle indicates that the object is made of recycled material (URL-2)

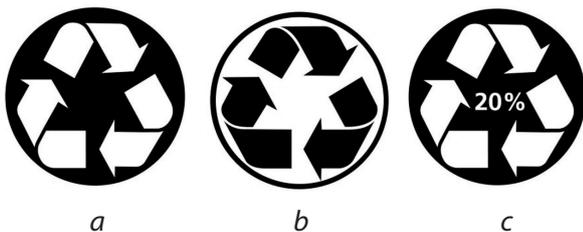


Figure 2.3.

- a) The symbol indicating the object completely produced from the recycled material.
- b) The symbol indicating the object produced from partially recycled material and partially raw material.
- c) The symbol indicating the proportion of the recycled material in objects that are not completely produced from recycled materials. (URL-2).

Another international symbol for recycling is the German-origin "Green Dot". This symbol on a package means that the economic enterprise that launches that packaged product has fulfilled its legal obligations regarding the recovery of packaging waste (URL-2).



Figure 2.4. Green Dot symbol (URL-4)

Other well-known symbols about recycling are the "Tidy man" symbol, which represents a person who throws the waste to the right place and encourages behaving responsible (Figure 2.5a), and the symbol demonstrating a human figure placing a bottle in the recycle container to indicate that the glass can be recycled in an attempt to remind the responsibility of the consumer (Figure 2.5b).

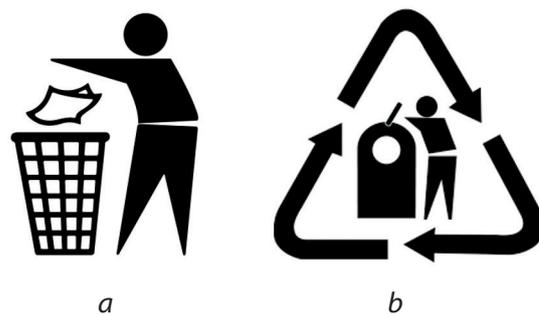


Figure 2.5. Recycling symbols about the consumer responsibility

A proper waste is an important part of the recycling process. For this reason, in order to facilitate the process, certain codes were created to describe the materials they are produced from. As a symbol, the codes divided

<sup>2</sup> The source of inspiration and the name of the Möbius (also used as Mobius) cycle, which also refers to infinity and continuity, is the one-faced geometric shape Möbius strip, invented in 1858 by German mathematicians August Ferdinand Möbius and Johann Benedict Listing (URL-2).



into 7 groups are represented as numbers within the simplified classical recycling symbol, and below the symbol is the shortened name of the plastic-derived material.

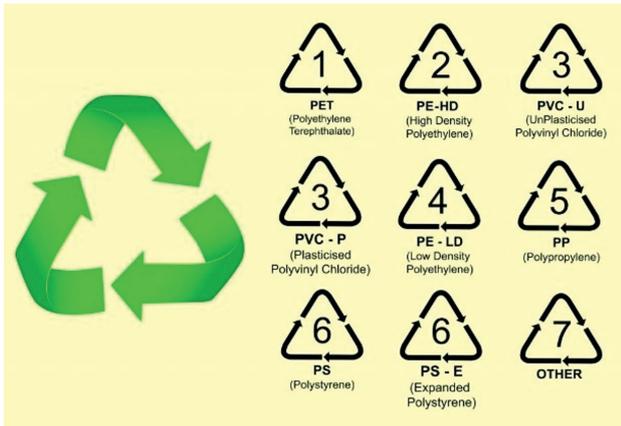


Figure 2.6. Plastic identification codes (URL-5).

1. **Pete or Pet (Polyethylene Terephthalate):** It is the most used material in food packaging since it is light, soft, low-cost in production, and easy to recycle. It is safe to use with food, but repetitive use is not recommended as it cannot be adequately cleaned. It is not health-wise to wash in the dishwasher and use in the microwave. It is widely used in water, oil and other beverage bottles. After being recycled, it can be used for car parts, furniture, carpets and occasionally new food packaging.
2. **HDPE (High Density Polyethylene):** It is a kind of plastics that is resistant to chemical products, easy to manufacture, but not very flexible. It is used in garbage and shopping bags, cleaning products, personal hygiene products, milk, juice and yogurt containers. It can be washed in dishwasher and used in microwave oven. After being recycled, it can be used in the production of tubes, oil or detergent containers, and garden furniture.
3. **PVC (Polyvinyl Chloride):** Recycling of these materials is quite rare and is not preferred for foods. It is not used for foods due to its chloride content, which occurs when heated, but because of its high resistance to acid and hardness, it can be used in pipes and tubes, detergent containers, medical devices or shoe soles.
4. **LDPE (Low Density Polyethylene):** It is a very flexible and transparent plastic, usually used in bags, laboratory containers or frozen food. It can be washed in dishwashers and used in microwave ovens. After being recycled, it can be used again in containers and garbage bins, panels, pipes or tiles.
5. **PP (Polypropylene) or PE (Polyethylene):** These materials with high melting point are considered safe plastic species that do not release harmful substances and do not harm the food they contained. They are commonly used in production of yoghurt containers, microwave containers, ketchup bottles, caps, drinking straws, and medical purposes (syrup bottles, medicine bottles, etc.). Their use in dishwasher and microwave oven is safe. After being recycled, they are also common for brushes, trays, battery cables or light signals after recycling.
6. **PS (Polystyrene):** Due to its low melting point and easy toxin-spreading properties, it is another type of the least recommended materials to be used for food. However, because of its low cost and robustness, it is commonly used in disposable plates and cups, cosmetic packaging, or CD boxes. Moreover, its recycling is difficult.
7. **Other:** This is the code used for objects containing different material mixtures other than the 6 types of material identified above. There are a variety of plastic materials that are very difficult to recycle such as the sunglasses, DVDs, dispenser-size water bottles, some water bottles, and food containers (URL-2, URL-5).

## 2.2. 3R Approach Basic Concept and Definitions

### 2.2.1. Reduce

The best way to manage waste is to take measurements to reduce waste generation. When the waste generation is decreased with changing consumption habits, an important contribution will be made towards the reduction of environmental pollution. At the same time energy and raw material consumption will decrease. In this context, the following measures will contribute positively to the reduction of waste generation.



### Waste reduction measurements:

- Doing shopping consciously and in need,
- Buying products in bulk. Larger, economical-sized products or products in concentrated form use less packaging and often cost lower per unit price.
- Buying local and seasonal food,
- Choosing fresh products instead of processed products,
- Avoiding over-packaged products, especially packaged with various materials such as plastic, foil, and paper. These materials are difficult to recycle and cost higher in terms of paying more for the package.
- Using long lasting and durable products.
- Using energy-efficient electrical products.
- Using renewable sources in energy production.
- Giving priority to walking, cycling and public transport. Avoiding waste through conscious and careful use of energy and water (reducing the use of air conditioning, taking showers for a few minutes instead of long showers, turning off unnecessary lamps, running the washing machine and dishwasher full, etc.) (URL-6).

### 2.2.2. Reuse

It is the process of using the waste over and over for the same or different purposes until its economic life is complete without any treatment other than cleaning and repair (URL-7). Reuse provides an important incentive to change the “inexhaustibility” misbelief and to create an awareness on protection of resource and environment. An object can be evaluated to give it a second useful life. Before discarding and replacing it with a new one, it can be repaired for the same use, or a different area of use can be created with imagination. Reuse, the previous step in the waste hierarchy before recycling, “suggests the reusing of existing structures or objects in a different context, rather than expensive recycling of elements that are still available after disposal” (Kendir Beraha, 2019). Thus, the amount of waste is reduced, over-consumption of natural resources is prevented, and the energy to be spent on the next phase, recycling, is saved.

### Examples of Reuse

- Producing decorative objects from wood, iron, steel, paper, cardboard, tin, glass bottles, plastic.
- Garden irrigation and use of grey water in toilet.
- Using parts of damaged devices to repair others.
- Repairing old clothes and reusing them for different purposes
- Reusing containers used to store liquids.

The new production, which results from the reuse of waste, has a wide range of uses in the interior spaces, in urban spaces, and in architecture. There are many examples where glass, wood, plastic and metal materials are evaluated in various ways in different areas without being subject to recycling (Figure 2.7, Figure 2.8).



*Figure 2.7. Examples of waste reuse in interior spaces (URL-8).*



*Figure 2.8. Examples of waste reuse in urban spaces (URL-9, URL-10, URL-11, URL-12, URL-13, URL-14)*

As in many areas, the most sustainable way of building construction is to reduce the amount of unprocessed material use. In this context, the utilization of waste materials is a practical option against the consumption of untreated materials. The Collage House, built in Bombay, India, is a fine example of the reuse of waste material in architecture. The facade of the building was created by a collage of old doors, windows, and pipes recovered from the collapsed buildings. (Figure 2.9)



Figure 2.9. Collage House, Bombay (URL-15)

Another successful example is the office building in Shanghai, whose facade is constructed from aluminum fizzy beverage cans placed into an aluminum frame. In this way, the energy spent on recycling is saved by reusing the cans in their current form. (Figure 2.10)

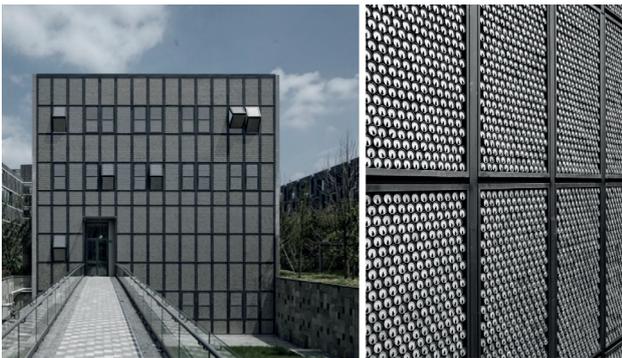


Figure 2.10. Can Cube office building, Shanghai (URL-16)

### 2.2.3. Recycle

Recycling is a process in which the waste is reproduced through a series of processes and is sold as a new product. It is potentially aimed to evaluate useful materials as raw materials for other uses so that the environmental damage is reduced. Recycling ranges from simple household habits to the facility procedures of private and complex international regulations (URL-17).

#### Measurements to increase recycling

- Buying products made from recyclable or recycled material.
- Sorting wastes in line with their types with the help of suitable recycling bins (glass, plastic, paper, household, and electronic waste etc.) (Figure 2.11)

- Using organic waste and food residues to fertilize the soil.



Figure 2.11. Urban recycling bins that allow waste to be collected separately according to types (URL-18)

## 2.3. Classification of the Wastes

Designing, building, and operating the waste classification, collection, transportation, and disposal systems are of vital significance in terms of regaining the recyclable materials for the economy and concerning energy production from these wastes. Wastes can be classified by different approaches according to their raw material, composition, or environment in which they were formed.

In general, the wastes are divided into two groups, organic and inorganic, according to their composition and the properties of the substances they contain (URL-19).

### Organic Wastes

Organic wastes that can be summarized as the remnants of living things (leaves, branches, peels, fruit residues, vegetables, fertilizer, stones, paper...) and they are biodegradable<sup>3</sup>. Therefore, they can be decomposed, and organic fertilizers or composts can be obtained. Organic waste is very important for fertilizing the soil naturally. Sorting these wastes reduces the amount of waste, which goes to landfills and causes environmental hazards. Organic wastes, which are thrown together with inorganic wastes in open landfills, have a negative impact on the habitats of many species due to the methane gas they emit and infiltration into groundwater.

<sup>3</sup> The substances that are decomposed by various microorganisms or enzymes in nature by biological means and separated into their natural components and then can again participate in this cycle in nature are called biodegradable substances (URL-20).



## Inorganic wastes

Inorganic wastes, which are very difficult and slow to decompose due to their synthetic content, cause serious damage to the environment.

There are 6 groups of inorganic waste produced at home:

- Paper, cardboard (milk containers, newspapers ...)
- Metal
- Plastic bags and bottles
- Glass
- Textile products
- Electronic devices and batteries

## 2.4. Waste Sorting

The classification of wastes according to their types is the first step in the recycling process. The success of this classification depends on both the sensitivity of the public and the physical infrastructure that allows the collection of wastes according to their types. In this context, it is extremely important for the recycling bins and containers to be accessible in urban and rural areas.

According to European Parliament data (URL-21) 5 tons of waste per capita were generated in 2016 and 2538 million tons of waste in total. When the sectoral distribution of this waste generation is examined, it is observed that the leading sector is the building sector with 36.4%, followed by mining (25.3%), manufacturing (10.3%), waste and water services (10.0%), households (8.5%) and other (9.5%) economic activities.

According to 2016 statistics, 37.8% of the waste in the EU is recycled, while 45.7% is dumped into the landfill sites. However, the situation greatly differs among the member states. There are many waste landfills in Eastern and Southern European countries, while there are almost no landfills in the rest of the member countries. The EU's target for reuse and recycling of household waste by 2025 was determined as 55%.

At the individual level, choosing and separating the waste produced at home depends on personal consciousness and responsibility. Therefore, it is enough to have garbage bins that allow us to sort the garbage in a simple way.

Recycling bins for different types of wastes are part of the process of sorting and recycling the domestic waste to reduce personal pollution and protect nature and public health. In this context, different colors are used for containers to collect wastes that can be recycled according to the determined standards (Figure 2.12). Although the colors of the bins sometimes vary according to the preferences of the local authorities, they are generally classified as follows.



Figure 2.12. Different colors of containers to help sorting the household waste while collecting (URL-22)

### Blue container

Paper and cardboard boxes, cardboard cups, egg packages, etc. newspapers and magazines, shoes are thrown into the blue container. These products can be recycled. Products that should not be thrown into the blue container are listed below:

- Used paper towels or napkins in the kitchen. (They should be thrown into the organic waste container.)
- Diapers (should be thrown in a grey container.)
- Corks (should be thrown into yellow container.)
- Milk or juice boxes. (They should be thrown into yellow containers because they contain plastic and aluminum, while glass bottles should be thrown into green containers.) (URL-22)

### Green container

Glass and glass bottles, perfume and cosmetic bottles, food jars (jam cans etc.) are thrown into the green container. The following products should not be thrown into the green container:

- Light bulbs (Must be thrown to the clean point because they contain toxic substances.)
- Broken mirrors, plates, cups (if they do not pose



a danger, they should be thrown into the organic waste container otherwise, to the clean point.)

- Pottery, ashtrays, crystal products (should be thrown into organic waste container or clean point.)

The biggest problem encountered in the green container is mixing the glass wastes with the crystal wastes. The melting temperatures of glass products (consisting of sand, sodium carbonate and limestone) and crystal materials (containing lead oxides) are different and must be separated in order to be considered as qualified in the recycling process (URL-23).

### Yellow container

Plastic bottles and containers, plastic and metal caps, corks, deodorant bottles, toothpaste tubes, juice, yogurt and milk cans, plastic bags are thrown into the yellow container. It should be noted that the yellow container does not belong only to products with plastic content. However, the following products should not be thrown into the yellow container:

- Toys
- Diapers, toothbrushes (contaminated with biological waste. They should be thrown into organic containers)
- Household goods (spatula, plastic scissors ...)
- CDs, pens, lighters
- Silicone molds used in cooking

The 6 types of plastic (HDPE, LDPE, PVC, PET, LDPE, PS, PP) previously identified are recyclable and can be thrown into yellow containers. But not all plastics can be recycled. In recent years, many types of plastics have emerged that do not allow simple recycling or reuse (URL-22, URL-23). Plastics mixed with other materials such as glue, aluminum, plastic outdoor furniture, pigmented plastics (O) cannot be recycled. There are different recycling processes used for recycling plastics and the main ones are as follows:

- Mechanical recycling: Through this process, the plastic parts are cut into small grains to be processed later. The work is mainly done with macromolecules from polymers.
- Chemical recycling: Plastics are break down with

heat to obtain new simple molecules from which other plastics or fuels can be produced.

- Energy recycling: It is the easiest way to recycle energy from plastics, burn it and use heat for another process or generate electricity.

Plastic is one of the most nature-polluting elements. Micro plastics accumulate in flora and fauna and alter the ecosystem. Therefore, re-use of plastic products with various creative ideas is very important and today, the preparation and implementation of environment-friendly and effective waste policies should be the prior target.

### Grey container

All wastes that are not suitable for other containers and do not have a special collection system are suitable for the grey container.

Used napkins, toys, bottles, pacifiers, utensils (crockery, pottery, cutlery, etc.), diapers, ceramics, pet sand, hair, vacuum cleaner powder, cigarette butts etc. are thrown into the grey container. Since it is not possible to use these wastes for composting, it is the most appropriate approach for them to be taken to incinerators which provide energy recovery in terms of efficient waste management. The following products should not be thrown into the grey container:

- Organic waste: peels, fish bones, plants, eggshells, tea or coffee grounds, used napkins, etc.
- Batteries, mobile phones, computers, CDs
- Furniture, mirrors, and household appliances
- Expired drugs (URL-22, URL-23).

### Brown container

All biodegradable food waste, such as plants, fruit peels, meats, coffee beans, tea bags, vegetables, and sawdust, which can be accepted as organic waste, are thrown into the brown container. Wastes deposited in the brown container can be used for composting, as fertilizer and even as bio-waste that will provide energy recovery. The following products should not be thrown into the brown container:

- Food boxes,
- Sweeping dust, cigarette butts, fireplace ashes,



- Diapers, cloth, wet wipes, floss,
- Bandages, cotton, gauze (URL-22, URL-23).

### Clean Point

The wastes other than all these mentioned classifications should be collected through mobile vehicles or collection points located in certain parts of the city (Figure 2.13). In these “Clean Points”, which must be provided by municipalities, the following items are collected:

Household or motor oils, mobile phones and batteries, light bulbs, paints, electrical small appliances (iron, toaster, hair dryer etc.), CD, DVD, computer, hard disk, mouse, cartridge etc., syringes, and rubber materials. Products that should not be thrown in these areas are listed below:

- Glass, paper, cardboard, board,
- Organic waste,
- Large waste: furniture, beds, doors etc.



Figure 2.13. Various Clean Point tools (URL-24)

In many European cities, the local authorities have furniture and white appliances (refrigerators, washing machines, etc.) collection services. Instead of being abandoned on the street, such items are transported to clean spots through the services called when needed.

Clean spots in cities are crucial to sustainable and healthy living. Because some waste (batteries, CD, DVD etc.) is dangerous in terms of their contents. This type of waste needs to be separated and recycled by special methods. Otherwise, the toxic chemicals contained in

these wastes are released into nature, causing serious damage to the environment and serious danger to the health of living things by participating in the life cycle.

### 2.5. General Outlook on the Recycle Approaches of Countries

Recycling costs less than reproduction. Therefore, recycling, which is provided both on a large scale and at a domestic level, can be the answer to important environmental and economic problems.

There are many institutions and organizations that achieve great economic benefits and create employment through recycling. However, another important aspect of the issue is the international garbage trade. Some countries have turned recycling into an economic resource through importing the garbage exports of some countries. In this way, they cannot employ a conscious recycling process, moreover, they waste energy, money and natural resources by producing waste.

In this context, countries such as Slovenia, Austria, Belgium, Germany, Switzerland, and the Netherlands are among the countries that have the best practices for recycling waste. Slovenia has the largest and most modern recycling plants in Europe (URL-25), and the proportion of rubbish produced in Germany, Belgium and Austria is over 55% (URL-26). With the policy implemented in Switzerland to increase the recycling rate of household waste, the country’s recycling performance has increased rapidly. According to this policy, throwing away household waste is paid, but recycling is very cheap or free. This means that in Europe the recycling rate of household waste is 28%, whereas in Switzerland it is 54%, almost twice the European average (URL-27). In the Netherlands, the recycling rate is 51%. The practices for the reuse of recycled plastic in different areas (road construction, urban furniture, etc.) contribute to the reduction of ecological footprint. The Netherlands also has the best environmental policies in the world in water management (URL-28).

On the other hand, Bangladesh, Saudi Arabia, India, China, Egypt, Brazil and Russia are among the world’s most polluted countries. Bangladesh, the most



polluted country according to the World Air Quality 2018 report, reached an average of 97.10 pollution particles in the air quality index. The industrial sector and its associated pollution are growing exponentially in the country, which has a population of 165 million (Figure 2.14). On the other hand, oil, the main source of Saudi Arabia's economy, affects farmlands, water resources, the sea and cities. In India, which has a very high pollution rate due to rapid industrialization and population, air pollution has exceeded 60 times the maximum level considered safe for humans. China, another country among the most polluted due to similar high industrialization and population growth, has twice the amount of CO<sub>2</sub> emitted by the US. However, awareness and new measures against environmental pollution have started to yield positive results. The rapid industrialization process in Egypt causes many of the developing companies to produce large amounts of CO<sub>2</sub> and waste. In the capital Cairo, pollution is 20 times the acceptable level. In Brazil, low awareness of the population and a paucity of government measures have led to an exponentially increase in CO<sub>2</sub> emissions. Pollution in Russia is based on large amounts of nuclear and industrial waste. The city of Karabash is one of the five most polluted cities in the world. The country's drinking water is very scarce. This has caused serious illnesses in the residents, and environmental measures have been taken in the past decade. Indonesia is the country with the most polluted rivers in the World (Figure 2.15). (URL-29).



Figure 2.15. Citarum River (Indonesia) (URL-31)

## 2.6. Conscious Consumption

Waste, its management, disposal and recycling are one of the most important global problems to be addressed in this century. We are living in a world where excessive consumption produces more waste and has harmful consequences to the environment.

In this context, changing consumption habits is an important part of the solution to environmental problems. Consumer education and providing information are essential. Price should not be the only factor to consider when choosing products or services. Conscious consumption includes the purchase of the needed product or service, taking into account its social and environmental impact throughout its entire life cycle, from its production to its disposal. It should be our individual and collective responsibility to demand sustainability along the production chain. Governments must develop policies that will raise awareness to change habits in people's daily lives (Food, clothing, energy use, water consumption, etc.)

One of the best ways to motivate people in this direction is to render them knowledgeable about the significance of recycling. Reducing, reusing and recycling (3R) are crucial actions that should be encouraged to fight the planet's pollution in homes and schools.

By promoting these ecological practices at homes, working environments, among friends and colleagues, one must never forget the meaning of these actions, which create a true ecological conscience. If this lifestyle is adopted, which is achieved with minimal effort, it will significantly reduce the amount of garbage that currently pollutes the planet so much.



Figure 2.14. Bangladesh (URL-30)



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