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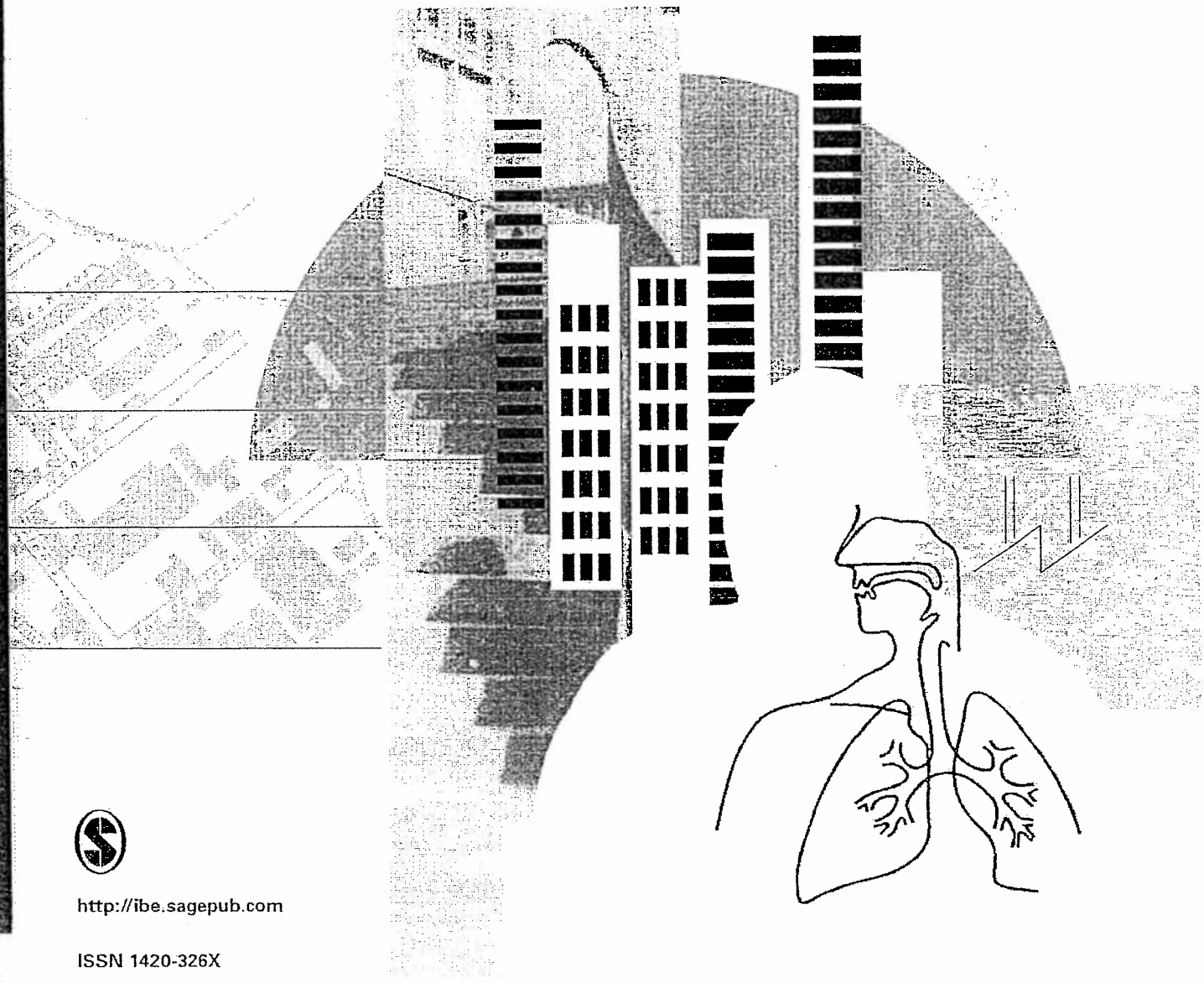

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# Landfilling with Mixed Wastes: Environmental Effects of Wastes and their Management in the Eastern Black Sea Region of Turkey

Dilek Beyazli Şinasi Aydemir

Architecture Faculty, Department of Urban and Regional Planning, Karadeniz Technical University, Trabzon, Turkey

**Key Words**

Land filling of waste · Waste dumping · Shore ecology · Health hazards · Eastern Black Sea

**Abstract**

Adding mixed waste to coastal landfill areas is common in the Eastern Black Sea Region of Turkey. The area studied in this paper covers the coastal cities of Ordu, Giresun, Trabzon, and Rize. All these cities have gained extensive landfill areas from the shores just in front of them. Residential waste and rubble has been infilled along the shores of the cities for a distance of ~30–50 m from the sea side since the 1970s. This now supports a double lane road construction that follows the shore line. Both actions have caused damage to sea shore ecology.

The consequences of using mixed waste in landfill is discussed under the following headings: health impacts of wastes (scavenging sea gulls may carry infectious diseases); composition and chemical properties of wastes; visual and environmental impact; lack of integration with development plans for the re-use of filled lands; dumping techniques. This paper was prepared by analysis of maps, visual and photographic analysis, site investigations and evaluation of municipal records from the region.

## Introduction

This study has examined waste disposal and landfill problems in the area of the coastal cities of Ordu, Giresun, Trabzon, and Rize on the Eastern Black Sea Region of Turkey (Figure 1). All these cities have created extensive landfill areas created seawards from their original shorelines.

Urbanization and urban growth cause transformation of natural landscapes within and around cities that brings increased pollution and waste for disposal, both of which present increasingly severe problems. The more the population increases the greater the production of all sorts of pollution and accumulation of wastes. Improvements in the quality of life lead to higher consumption of manufactured foods and goods and increase in the amount of waste presented for disposal. Solid industrial and household wastes should be dumped in approved sites, but this does not always happen.


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Dr D. Beyazli
Department of Urban and Regional Planning, Karadeniz Technical University, 61080, Trabzon, Turkey.
Tel. +90 462 3774060, Fax +90 3252763, E-Mail dsen@ktu.edu.tr

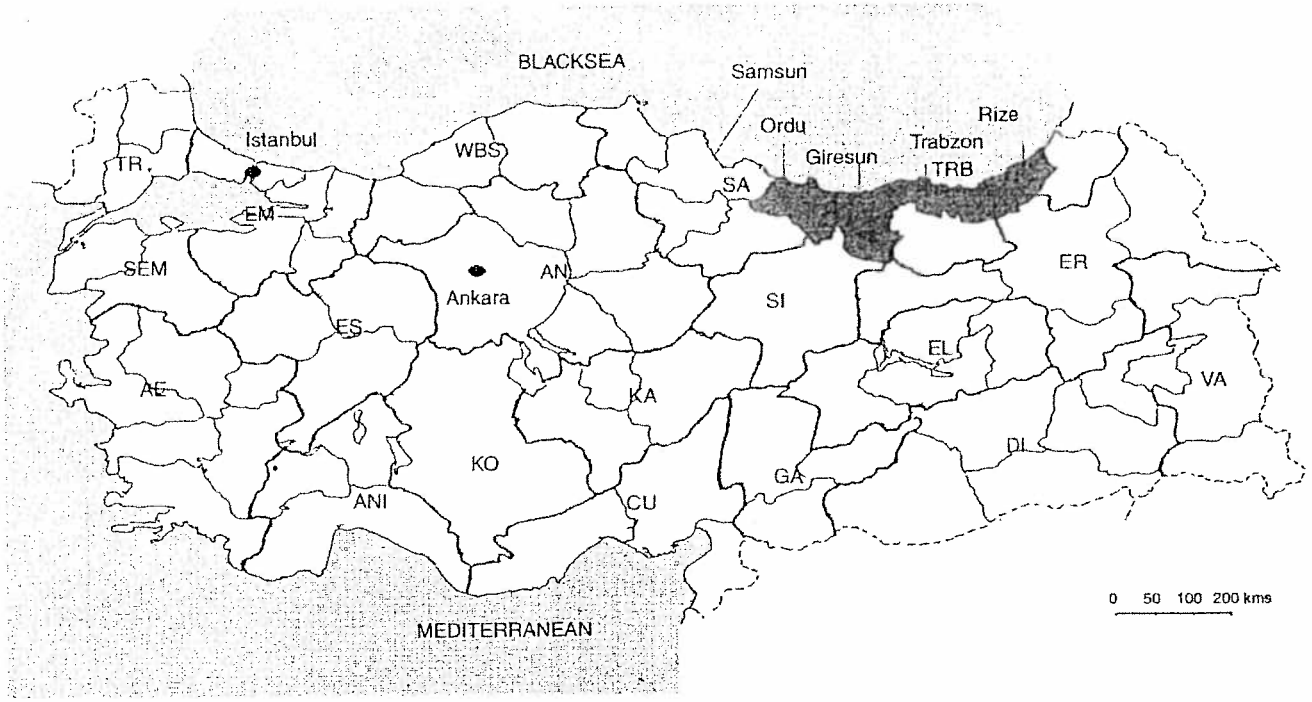



**Fig. 1.** Map of Turkey showing major Black Sea cities studied from the Ordu to the Rize.

Even with approved sites, if necessary precautions are not taken against leakage then soils, ground water and even coastal fisheries can become contaminated [1,2].

Municipal waste is the total waste produced in people's daily life. In the process of collection, transport and disposal, any harmful compounds in the wastes can contaminate the air, soil or water, not only seriously influencing the quality of urban sanitation, but also threatening to become a major social hazard [2,3]. Different people look at this issue from different points of view; they may look at economic and industrial development and urbanization processes, various technical factors, also the behavior of citizens, their households and institutions all of which are closely related to economic, political and technical changes.

The pace of installing and constructing urban infrastructure for waste treatment and management is inadequate and so this lags behind the rate of urbanization causing major planning and management issues for municipalities. In this context, with urban wastes becoming a major problem, urban health quality can be seriously affected.

## Waste Management: Waste Collection and Treatment

"Collection and disposal of solid waste is important to human health and the daily operation of a city. Waste produced by households and commercial sources is collected and transferred to a landfill, a site dedicated and specifically managed for waste disposal. It may be close to the city or carried to a distant location. Municipal solid waste originates from daily activity in households, hotels, hospitals and health care facilities, and restaurants,...". To this list could be added animal waste from slaughterhouses, other commercial waste and waste from health care facilities, wastes from water treatment plants, and other wastes such as construction and demolition debris. "...and it contains 10–50% wet and putrescible organic material. The high organic content is a potential food resource and harborage for insects, pest birds, and rodents. The utility this material has to these pests (is) influenced by the techniques used for collection, and the short- and long-term disposal." [4].

Open refuse sites provide the most basic solution to the collection of wastes from urban areas. These sites are by their nature exposed and may be simply an otherwise vacant plot of land. Their size will vary depending on the needs of the area served. Unfortunately such a site leaves any organic refuse vulnerable to pest infestation. However, "concentrating household refuse in designated sites enables efficient removal and is better than uncollected garbage in the street." [4]. A number of factors, not least climate and seasonal temperatures, affects the bio-diversity of creatures that infest open dumps.

Animals may include dogs, cats, goats, and others as well as the more expected rodents and flies. However, it is the rodents and flies that are of particular concern, not least because of their role as disease vectors. On a long-lived site they may become endemic and spread to nearby areas and buildings. One point relevant to the region considered is that hot and dry weather can reduce the attractiveness of waste to flies while hot and wet weather may increase it [4].

*Criteria for Disposal of Solid Wastes*

Before the collection of waste it should ideally be held in closed containers. In reality many of the lids on waste containers, and indeed the containers themselves, may not completely prevent entry of rodents, or insects. This means that when the waste is removed by a collection vehicle it could already contain a mixed population of pests. However, this sort of domestic waste should not be destined for landfill, but should be disposed of by other means. Land fill waste should be restricted to non-biodegradable, inert waste and other waste materials that are not suitable either for recycling or for biological processing. Regrettably this is all too often not the case. For economic and other reasons any landfill site should be large enough to last for 20–25 years, and should be away from residential areas and habitation clusters, wetlands and places of importance such as those of cultural, historical or religious interest [2].

A buffer zone of no-development should be maintained around landfill sites and their development should be incorporated with land use plans. Wastes, particularly putrescible organic wastes, should be covered immediately they are dumped or at the end of each working day with minimum 10 cm of soil, inert debris or construction materials.

When tipping has finished a vegetative cover should be actively developed over the completed site using a selection of locally adapted non-edible perennial plants that are resistant to drought and the extremes of temperature that may be experienced. These plants should be such that their roots do not penetrate more than 30 cm. They should be plants selected to thrive on low-nutrient soil with minimum nutrient addition, also they should grow at a sufficient density to minimize soil erosion.

Regardless of whether the waste is compacted or merely allowed to settle under its own weight it is essential that the landfill is covered to reduce smell and to avoid attracting pests. Soil is the best material to use and where available is commonly used for cover. Ideally the layer should be thick enough to suppress flies. Some 150 mm has been found to be a minimum depth, but this is not really sufficient to prevent fly emergence completely. Some flies can move to the surface from beneath much greater depths. If soil is unavailable or the costs for it are high, other materials may be used. When there is direct sunlight plastic sheets may be used as temporary covers since these create in the underlying refuse a microclimate with temperatures high enough to prevent fly development. However, if left in place for any length of time, these sort of sheets may interfere with rain water percolation and natural compaction and over time trap landfill gases. [4].

As will be shown in the course of this paper, the infilling that has been carried out at Trabzon was not fully consistent with the above criteria and neither was this the case for most of the other cities in the region.

## The Cases of Trabzon, Rize, Giresun, Ordu Landfilling and their Waste Management

There are a number of general points to be made concerning this Black Sea region.

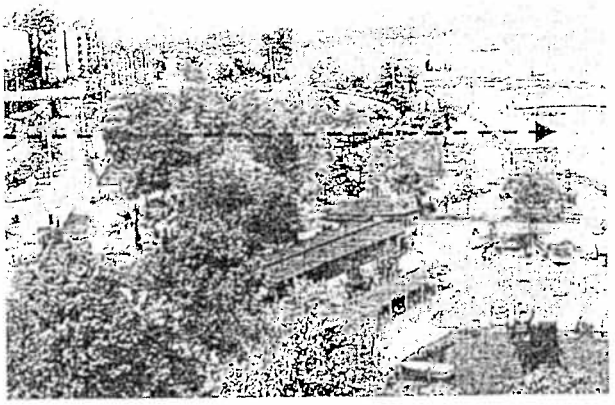
- A major part of the regional population live on the coastal zone which has become a high density urban zone and all kinds of public services are located by the sea.
- Fishery and agriculture are the main inputs to the regional economy.
- Those involved in regional handicrafts as well as small and large-scale industries are found in districts either located on the coastal zone or at no great distance behind the shore.

The extent of the landfill sites and subsequent development including tree planting is illustrated in Figure 2(a,b) (landfill areas marked). Details of waste type, collection and disposal is given in Tables 1 and 2 and the overall plans are illustrated in Figure 3.

*In Filling: infill for Road Construction*

- The Hopa- Samsun Regional State Highway was constructed mainly on landfilled areas in the years between 1950 and 1960. Since the 1990s this State Highway has been enlarged (Figure 4(a,b)).
- Part of the double lane route crosses the shore and part of it is inland.
- Although, there are expected benefits from the motorway, road construction has been causing severe damage to sea shore ecology. Something that now occupies the public agenda.

(a)



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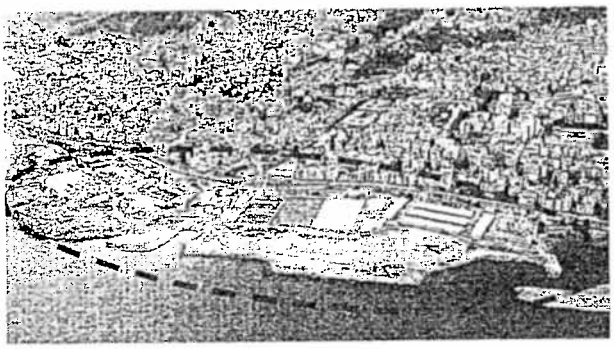


**Fig. 2.** (a) Extent of infill strip and plantation developed at Trabzon, (b) Extent of infilled area at Trabzon.

**Table 1.** Comparison of the case cities

| | Trabzon | Rize | Giresun | Ordu |
|---|---|---|---|---|
| Waste per head (kg) | 1.39 | 0.9 | 0.7 | 1.0 |
| Daily waste collected (kg) | 370–400 | 90–105 | 80–100 | 150 |
| Size of waste filling site ($m^2$) | 93,894 | 70,000 | 50,000 | 63,000 |
| Height of waste filling site (m) | 5 | 5 | 10 | 7 |
| Volume of waste filling site ($m^3$) | 469,000 | 350,000 | 500,000 | 441,000 |
| Chemical components | + | – | – | + |
| Waste classification | + | + | – | + |

After the initial road was constructed a narrow strip of land (the remains of the sea shore) was left and it was found that the work had destroyed the ecology of the coast line, to some degree. Then in filling re-started in 2000, to create more land (~50–70 m wide). (Figure 5) to build a double lane motor way. This construction has proved more damaging for the sea shore ecology than previous infill

Besides landfill specifically for road construction, infilling simply for disposal of wastes is common throughout the whole region. The following sections of this paper will enlighten the reader on the waste management; collection, decomposition problems and general dumping of household and industrial wastes and other debris in the Eastern Black Sea Region.

*Re-use of Infilled Sites*

In Trabzon some 670,000 $m^2$ of area have been gained by infill (Figure 6(a–e)) Some 93,834 $m^2$ (equivalent to 469,000 $m^3$ of waste) of the total infilled land comes from its use as a place to pile waste and a general dumping area. The rest of the infilled land was filled with construction residue and other debris. However, now the area that is being infilled is stretching to the west of the city. Another example is Rize where the amount of land gained by infill is 70,000 $m^2$ (representing 350,000 $m^3$ of waste) (Figure 7(a–c)).

At present, except for the site where waste is presently dumped, the rest of the land gained is designated for recreational use, such as mini-football pitches, restaurants, exhibition halls, and pedestrian walkways. Some of these have already been created.

*Waste Collection*

Waste collection methods vary between municipalities depending on the amenities they have. The most common methods are:

- collecting wastes from house-to house, community bin collection, collecting to a regular prearranged time and schedule
- devising collection of waste from localities including hotels, meat and fish markets, fruit and vegetable markets. These wastes are biodegradable in nature and should be managed to make some use of them.
- health care or bio-medical facilities generate waste, both infectious and noninfectious, and this should be dealt separately, just as industrial waste should not be mixed with municipal solid waste
- construction or demolition wastes and debris should be collected separately and disposed of following the approved norms.

*The Case of Trabzon*

For almost 40 years, every kind of waste has been collected from houses, commercial premises, small scale industries and, health services and transported to a designated site called Moloz, in the middle of the city, on the shore. Household wastes, industrial wastes and bio-medical wastes are collected separately without any pretreatment.

**Table 2.** Location of wastes filling sites and their characteristics

| | Trabzon | Rize | Giresun | Ordu |
|---|---|---|---|---|
| Location of waste sites | Sea shore | Sea shore | Sea shore | Sea and river shore |
| Measure | Fortification wall | Fortification wall | Fortification wall | Fortification wall + whitewashing |
| Waste collection technique | | Wild storing[1] | | |
| Bio-medical waste | On the same site | On the same site | On the same site | On the same site |
| Odour | Present | None | Present | Present |
| Visual Impact | Negative | Negative+ positive | Negative | Negative |
| New functions for waste depot | Present | Present | None | None |
| Nearby functions | Recreation, housing, sport, public use | Green space, vegetable market | Industry, housing, public use | Industry, housing |

[1]Storage without any controls or systematic procedures is known as "wild storing".

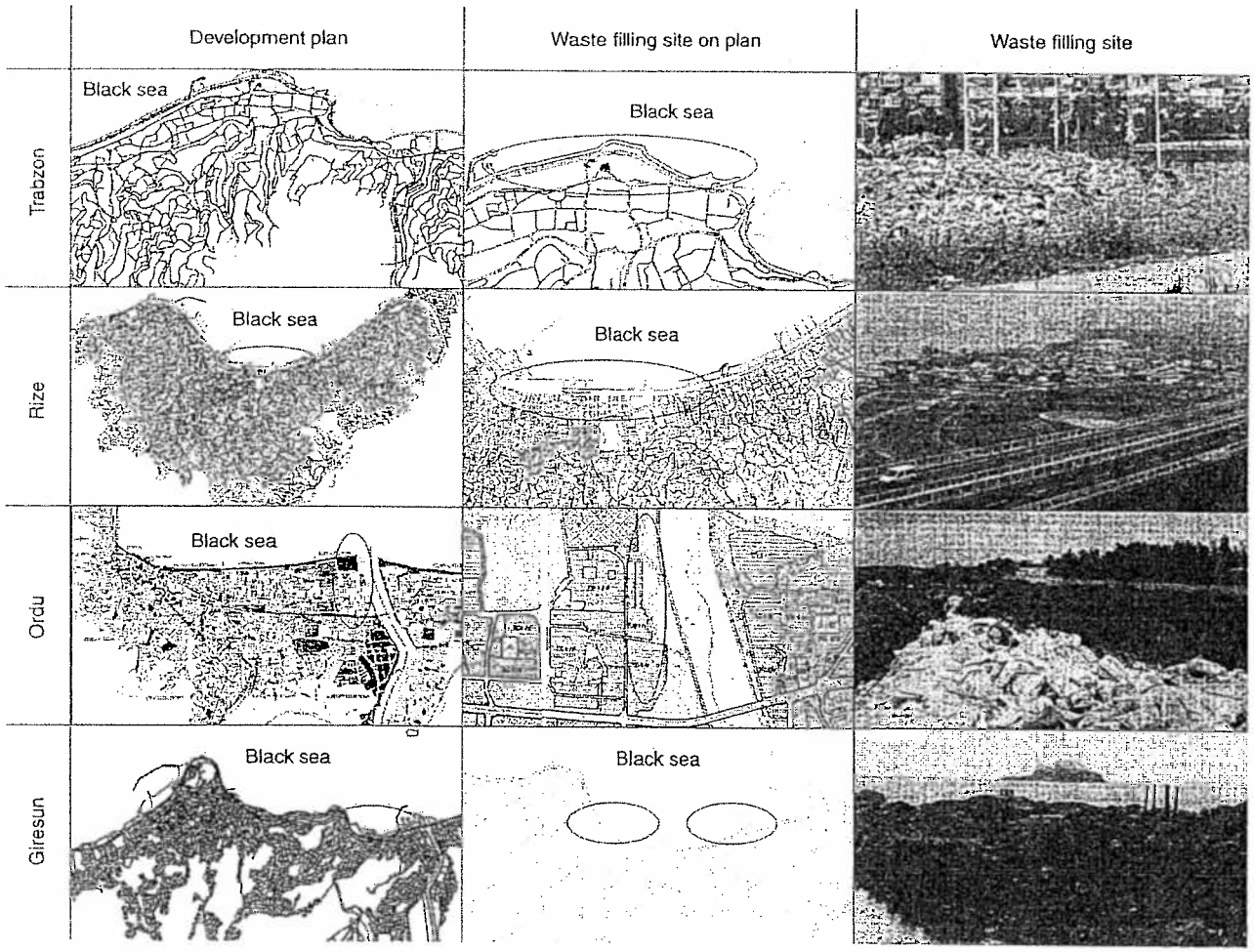
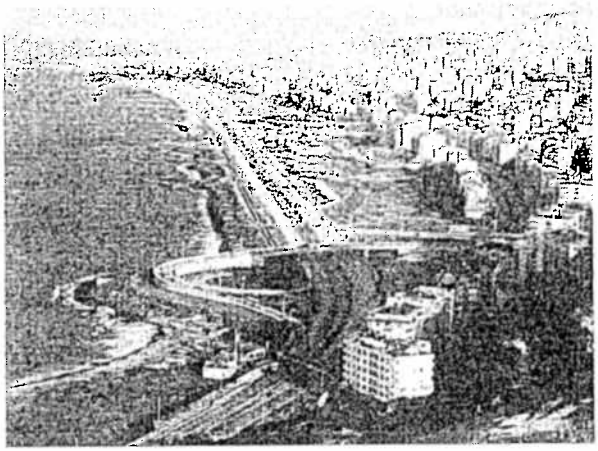



**Fig. 3.** Overall plans and illustrations of the landfill areas for each city.

The daily amount of household waste generated in the city is about 250 ton/day. To this must be added 800 ton/month from neighboring municipalities and 25 ton/month from peripheral villages. Street sweepers also collect 200 ton/day of wastes. All these wastes are collected regularly by the municipal authority and transported to the site. Industrial wastes are also collected and transported to the site by their various organizations.

(a)



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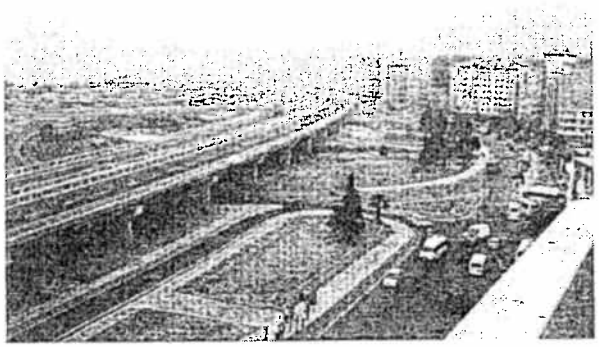

**Fig. 4.** (a) Showing new road development at Trabzon, (b) Showing new road development at Rize.

Waste can then be stored, piled up or just dumped on the sea shore (Figure 8(a,b)).

There are almost 40,000 dwellings in Trabzon that produce household wastes daily. Waste produced per capita varies between 1.31 kg/person/day and 1.44 kg/pp/day depending on the season. Average per capita waste production is 1.39 kg/pp/day [5,6].

## Classification of Wastes

Wastes are generally classified as household, commercial, industrial, and purification plant wastes. The composition of household waste varies depending on geographical conditions, living habits, living standards and household heating systems.

*Waste Components*

The components of municipal waste are mainly influenced by the geographic conditions, living habits, standards, and domestic fuel structure. While the municipal waste quantity is increasing rapidly, the components in the waste are also changing. The organic and easy-burning

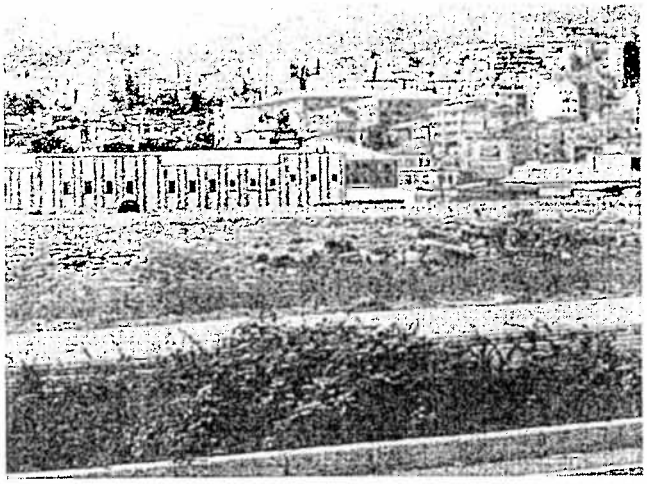

**Fig. 5.** Newly reclaimed land in front of the fish market.

materials are also increasing. There is obvious distinction between the waste in large cities and small/medium ones. The organic compounds in the domestic waste in large cities account the most of the waste. Waste characteristics of the region are as follows (Table 3):

At the time of writing most of the wastes are still piled up together, in the open air. Household wastes are not pretreated before being transferred to the waste filling site. Sorting the waste is done by waste pickers who have worked on the site for 18 years on a contract (Figure 9). Waste pickers sort and collect reusable and recyclable materials depending on the market demand and market values of the materials regained by sorting which amounts 20% of the total wastes.

*Re-use of Wastes*

Re-use of wastes enables the use of a product or material more than once for the same or different purpose. Re-use avoids the more costly re-processing required to recycle a product for another use. Repairing a product, donating or selling a product to another user are examples of reuse. In this region re-usable wastes are estimated at 1500 tons/year [7,8].

*Recycling of Wastes and the Problems*

Recycling refers to practices and technology that recover materials from the waste stream for recovery and re-use. Materials include paper and paperboard (cardboard), magazines, glass, aluminum, plastics, tin cans. Recycling may be limited by unstable markets and prices that fluctuate, causing problems for recycling. Waste may be sorted, but has to wait until the market is favorable (Figure 10(a,b)).

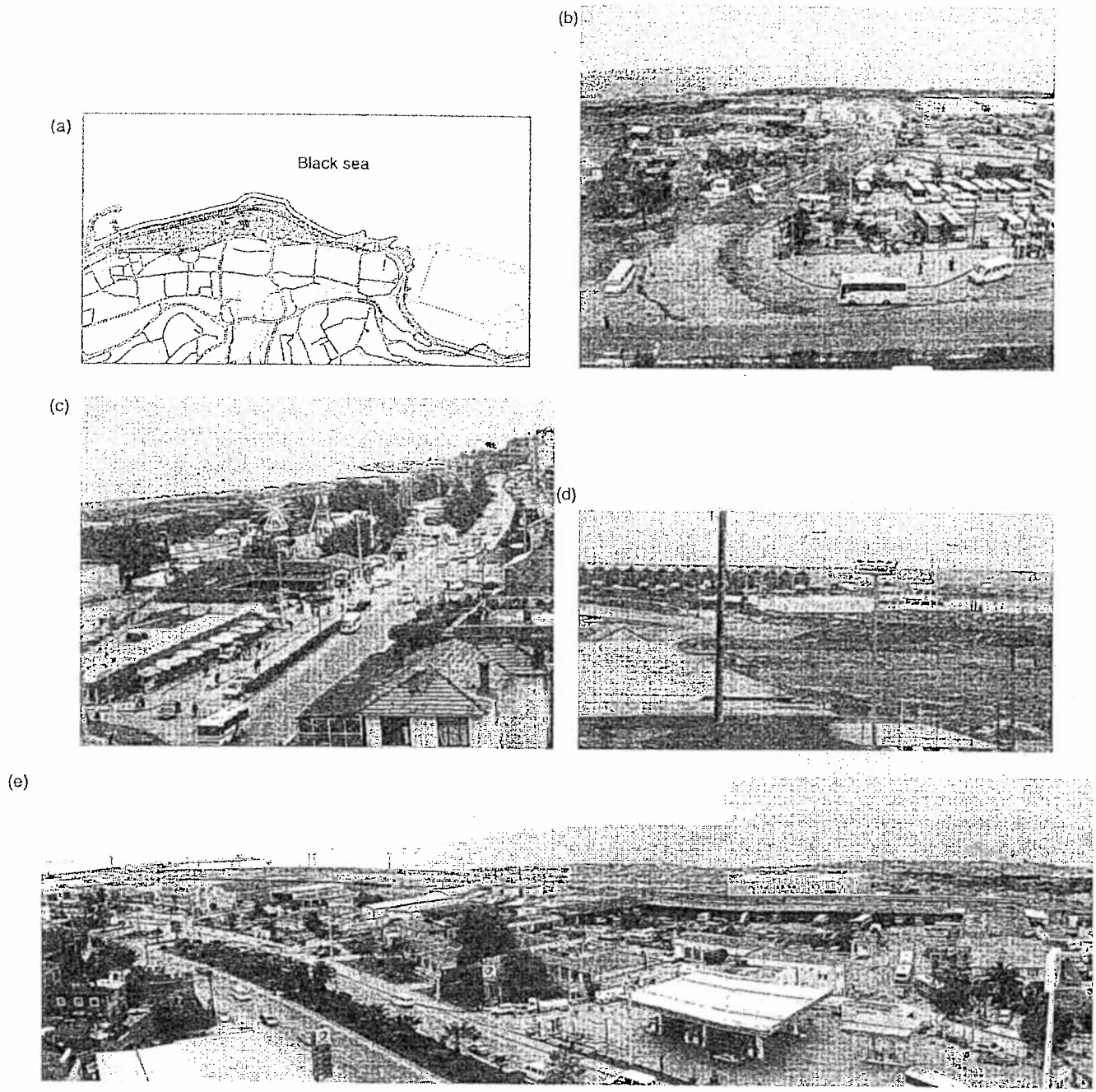


**Fig. 6.** Subsequent recreational use of land-filled area in Trabzon: (a) Plan of infilled waterfront area in Trabzon, (b) Development of land filled area with land filling still in progress by the sea shore in the distance. Showing minibus terminal, semi-open bazaar and municipal services, (c) Use of infilled area: Fruit and fish market and Luna Park, (d) View looking seawards and fishermen's boarding house, (e) Use of infilled area: Football Federation's Regional Office, playing field, fire station municipal services and petrol station.

## Environmental Impacts of Waste Filling

Several environmental effects may occur from piling, dumping, and infilling of household wastes and biomedical wastes such as smelly odour, pathogenic microbes, release of ammonia, and sulfur compounds, dirtiness, methane leakage, visual pollution, contagious diseases carried by mice, birds, flies and mosquitoes, and contamination of soil and waste.

Waste filling sites are dangerous for human for many reasons, not least because of the possibility of a methane gas explosion unless necessary precaution are taken.

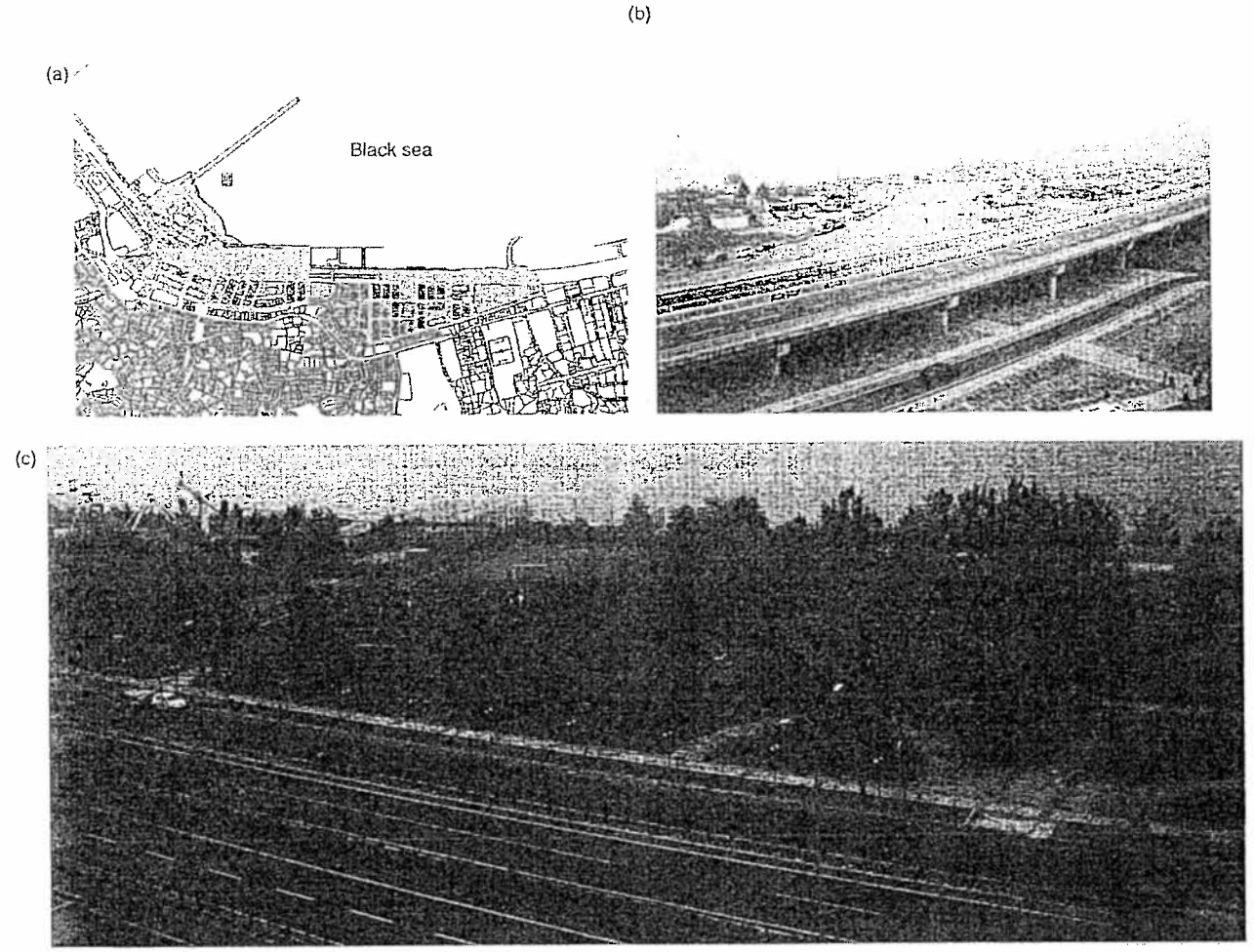


**Fig. 7.** Subsequent recreational use of land-filled area in Rize: (a) Plan of infilled waterfront area in Rize, (b) Use of infilled area: road construction and open food market, (c) Use of infilled area: recreational use.

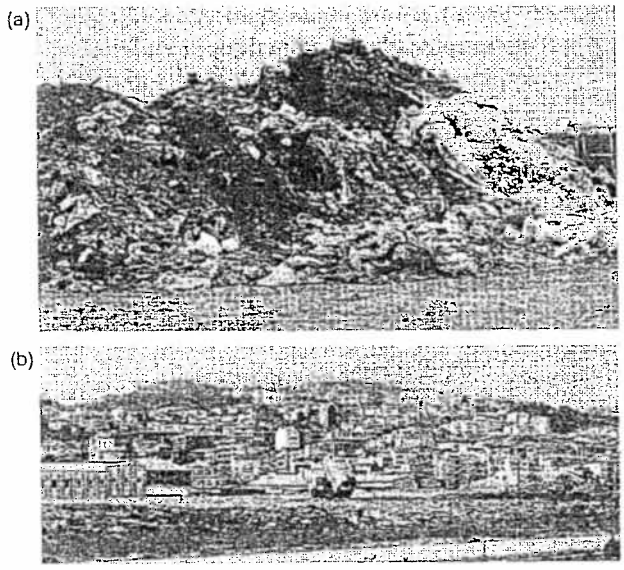


**Fig. 8.** (a) Pile of rubbish, (b) Waste dumped on the sea shore.

**Table 3.** Waste composition in the case cities

| | Trabzon | Rize | Giresun | Ordu |
|---|---|---|---|---|
| organics | 57.8 | 61.9 | – | 64 |
| paper | 4.45 | 3.8 | – | 5.1 |
| plastics | 10.7 | 4.6 | – | 7.3 |
| metals | 1.65 | 2.9 | – | 0.9 |
| iron | – | – | – | 3.3 |
| glass | 0.7 | 1.8 | – | 2.8 |
| textiles | – | – | – | 0.9 |
| ash - rubbish | 10.0 | – | – | 12.7 |
| other | 17.9 | – | – | 3.4 |

Piling up waste can generate large amount of acid, alkaline or organic pollutants one effect of which is to dissolve heavy metals in the waste. Leachate can completely destroy marine ecology. Another problem with waste is that they may contain pathogenic microbes, A study [9] has been made along the Trabzon coast

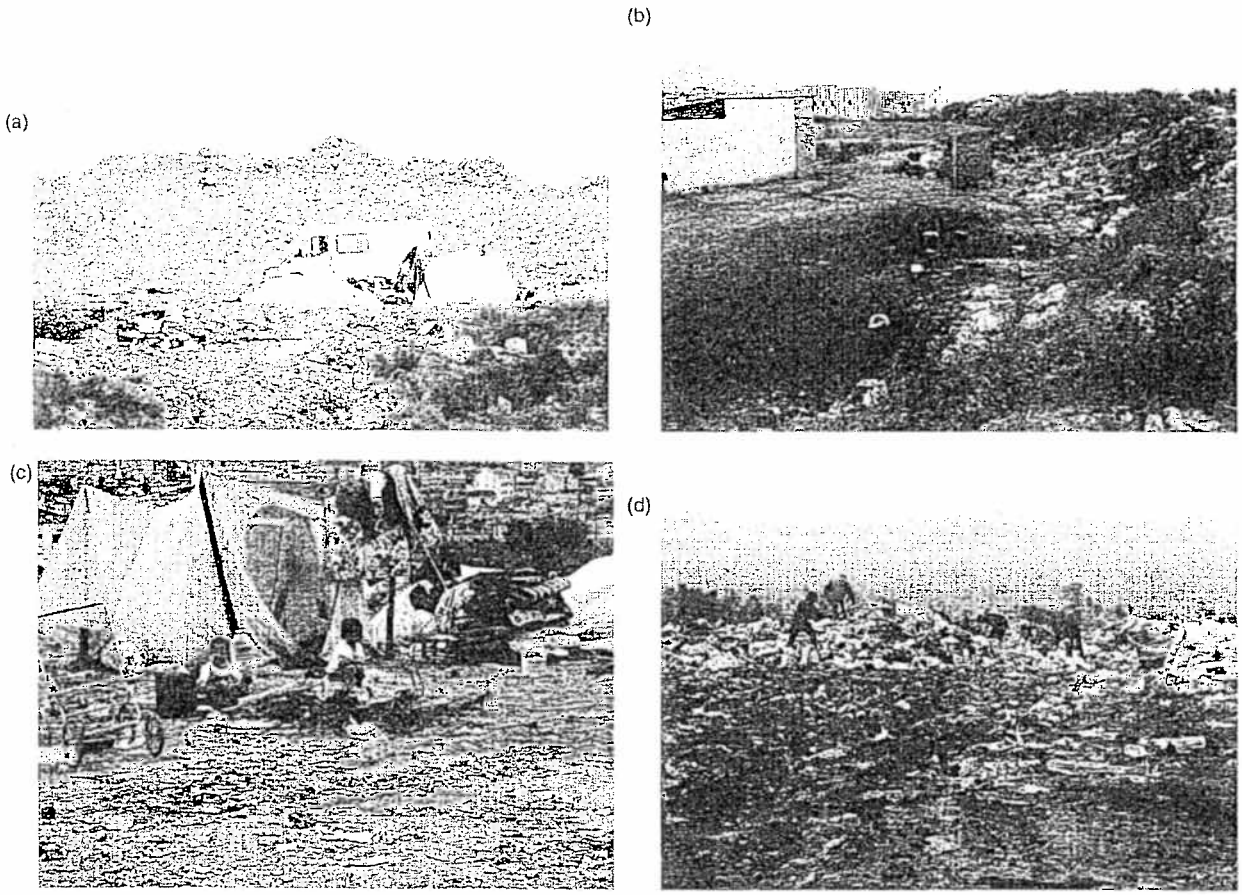


**Fig. 9.** Waste pickers/sorters.

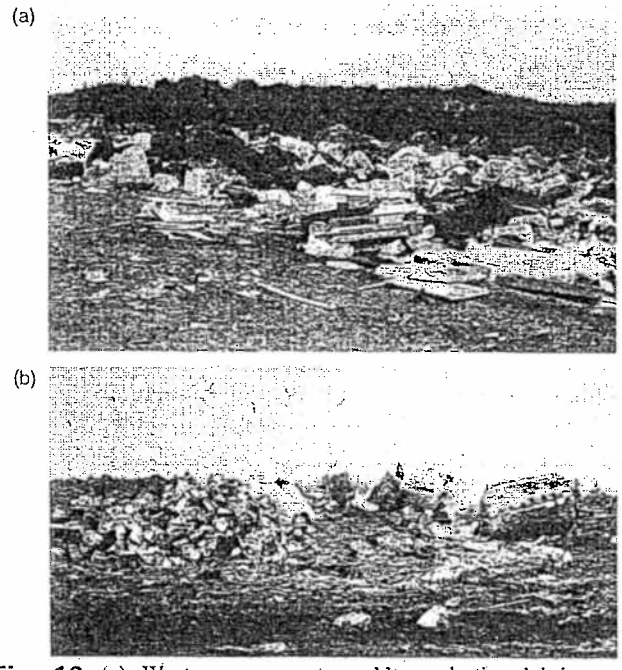


**Fig. 10.** (a) Waste components: rubber, plastic, debris, etc., (b) Sorted waste awaiting favourable conditions before selling.

sampling at 11 points including the waste dumping site Faroz. Specimens taken from those points showed that ammonium nitrogen, phenol and coliform bacterias (1100 cells/100 mL.) were found higher than the prescribed limits. This may result from leachate and leakage from dumping as illustrated in Figure 11(a,b).

*Effects on Human Health: Likely Consequences of Waste Infilling*

Landfill where organic material is exposed or near the surface become home to legions of insects. The house fly and any local species of blow flies are the most common insects at urban landfills around the world. In these situations they may breed continuously through the year, although in decreased numbers in the colder months. Crickets and cock-roaches, including the German cockroach, can become established, depending on local conditions. Infestations of cockroaches can result from household refuse that came to the landfill infested. Pest bird species vary according to location, but the most common are gulls (Figure 12(a,b)), crows,

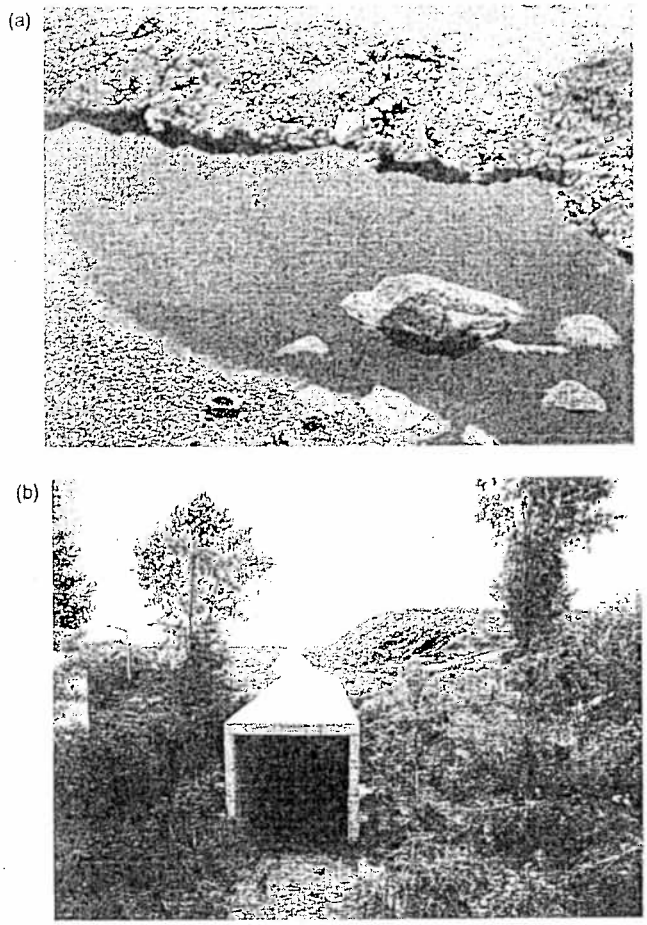

**Fig. 11.** (a) Toxic waste leachate from waste dumping which drains to the sea, (b) Discharge box.

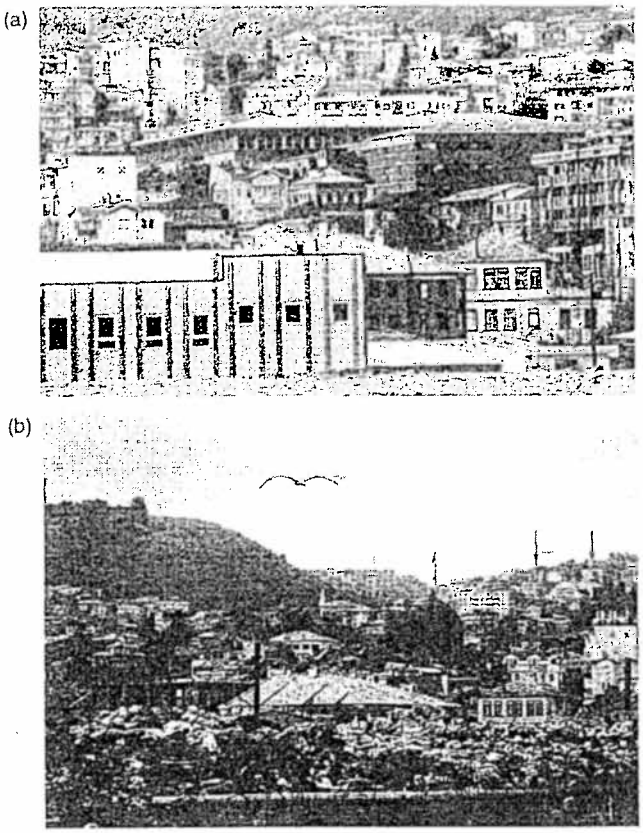

**Fig. 12.** (a) Waste filling into the sea disturbing sea gulls' habitat so that they move to nearby buildings' roofs, (b) Waste filling into the sea disturbing sea gulls habitat.

starlings, and kites. They rarely nest at the sites, but usually include the landfill within their foraging territory. The brown rat is common in landfills around the world and large vertebrates, such as foxes, feral dogs, and goats are also regularly found. Even domesticated animals such as cows may be found (Figure 13).

Sudden disturbance of house fly, cricket, and cockroach populations can result in the dispersal of large numbers to areas surrounding the landfill. House flies and blow flies are capable of travelling 1–3 km from infested sites, and cockroaches can move across a varied landscape to building perimeters. Large numbers of seagulls at landfills can disrupt the operation of compaction and earth-moving equipment and spread disease. Faeces from gulls at landfill sites have been shown to contain human pathogenic bacteria, such as *Escherichia coli* O157. Landfill gulls have the potential to transport such bacteria to farms and urban sites [4].

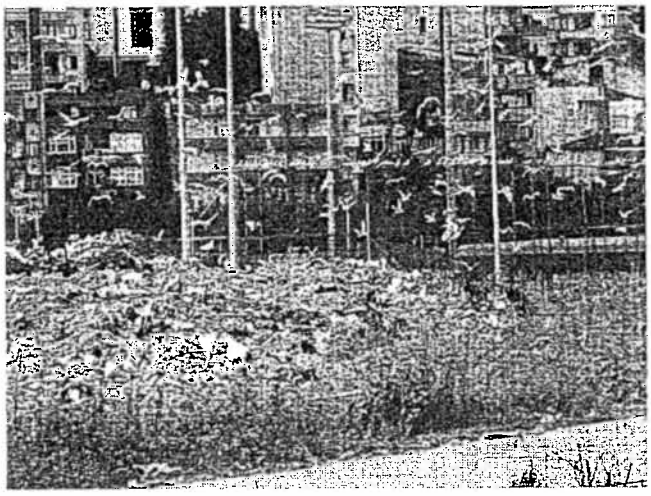

**Fig. 13.** Herring gulls (*Larus* sp) can be vectors for Salmonella and Shigella.

A study on the waste infill sites in Trabzon, Giresun and Ordu showed that herring gulls carried a wide range of potentially dangerous bacteria including Salmonella, which can be pathogenic to man and domestic animals [10] (Figure 14).

**Fig. 14.** Domestic animals can also carry Salmonella and Shigella introduced by gulls.

Finally, smell from waste dumps is a serious matter especially during the warm days of the summer and when it is carried by the prevailing winds towards the city.

## The Future

The way in which waste of all sorts is dealt with by a number of Eastern Black Sea Coastal towns and the impact of this waste on local ecology and on the population has been examined. It is accepted that the current situation is far from ideal and decisions have been taken for the following policies to be implemented:

- Minimize the amount of waste at the source (at premises and work places)
- Minimize household waste by encouraging, consumers and producers to use recyclable packaging materials (nonplastic materials)
- Undertake research and development on disposal technologies that aim to facilitate industrial waste treatment including the promotion of making good quality compost, work to improve landfill technologies, develop and adopt the appropriate equipment and materials.
- Set up the technology and equipment for incineration.
- Strengthen the publicity and education, raise the public environmental awareness.
- Use better burning coal for heating houses and work places.
- Promote households to use waste disposal units (grinders) fixed to kitchen sinks to grind vegetable and fruit residue instead of collecting them in bins or containers.
- Ensure proper land filling is implemented with regard to location, design, construction of new land fills and their operation, closure and aftercare phases [11,2].

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