# United Nations' view on the state of Antarctica

Resource EP1

1. Antarctic tourism is a growing industry, with the number of sites being visited, as well as the range of types of activity, increasing dramatically. The long-term environmental impacts of tourism activity in Antarctica remain largely unknown, and there are difficulties in distinguishing natural from human-induced change because of the short periods for which environmental impact data have been collected.

2. Current fishing levels are below total allowable catch levels set by CCAMLR, but many fisheries, including krill, are still attracting commercial interest. Problems have been experienced with bird by-catch in longline fisheries, and also with illegal fishing within the CCAMLR area. CCAMLR is attempting to address these problems. It is important to have accurate knowledge of the biology and ecology of the marine ecosystem to allow informed management decisions to be made thus producing a sustainable fishery. This is the focus of the CCAMLR ecosystem approach.

3. Pollutants originating in the industrial and populated areas of the world are transported to Antarctica by atmospheric and oceanic circulation. Levels in Antarctica are still, however, generally extremely low because of the limited human activity there. Antarctica is thus an ideal stage on which to base monitoring activities for long-range pollutants. It is important that this scientific value of Antarctica is not destroyed through local sources of contamination.

Dr I. Everson/BAS

Fisheries in Antarctica are attracting considerable commercial interest

4. A substantial Antarctic ozone 'hole' is expected to occur each austral spring for many more decades. This is because stratospheric chlorine and bromine abundance will only approach the pre-ozone hole levels (late-1970s) very slowly during the next century. The ozone layer is anticipated to be most affected by human-influenced perturbations, as well as being susceptible to natural variations, during the next decade. Peak stratospheric chlorine and bromine abundance are expected to occur in 1998. It is only because of the restrictions in the Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer (which control chlorine and bromine emissions) that the Antarctic ozone hole can be expected to disappear.

5. Sea ice is a very important environmental parameter in the Antarctic, the large seasonal cycle having a significant effect on the exchange of energy, mass and momentum between the ocean and atmosphere. Research using satellite data has shown that the length of the sea-ice season and maximum ice extent have fluctuated throughout the 1970s and 1980s. Evaluations of global ice-cover variations have thus far detected no overall significant change in Antarctic ice cover, although that in the Bellingshausen/Amundsen seas appears to be responding to a regional climate warming. There are, however, insufficient systematic, spatially distributed data sets available to determine the seasonal and regional variability of the ice and snow thickness, distribution and growth processes.

6. The mass balance of the Antarctic ice sheet should be an important variable for global climate models. However, uncertainties in the accumulation and attrition components, as well as spatial variations in ice-sheet characteristics, make estimation of the total mass balance imprecise at present. The principal immediate effect of climate warming on the mass balance of the Antarctic ice sheet is expected to be an increase in precipitation and consequently accumulation. The marine-based West Antarctic ice sheet is considered by many glaciologists to be vulnerable to global warming and sea level rise. However, whether it is currently retreating, in equilibrium or advancing again is not clear. Increasing atmospheric temperature and contemporary ice-shelf retreat on the Antarctic Peninsula over the past 50 years suggests that this region is a sensitive indicator of climate change.

*These are the views of the United Nations as expressed in United Nations (1996) The State of the Environment in Antarctica – Report of the Secretary General. United Nations, New York.*

# The loss of the *Bahia Paraiso*



**At 1100 hrs on 28 January 1989, the Argentine resupply ship *Bahia Paraiso* departed from Arthur Harbour on Anvers Island, Antarctic Peninsula, following a visit to Palmer Station (US). The ship struck an underwater ledge which ripped a 30 m long gash in its hull and diesel fuel began to leak almost immediately. By mid-March 1989, the ship had spilt approximately 600,000 litres of diesel fuel and other fuels, making the spill the largest ever to have occurred in Antarctica.**

### Rescue and evacuation

The *Bahia Paraiso* was carrying 81 tourists and a crew of 235. It had a cargo of diesel, petrol, and aviation fuel totalling more than 1,100,000 litres. The ship ran aground about 2 km away from Palmer Station which organised an immediate rescue operation. The tourists and crew were ferried back to the station using small inflatable boats. Two cruise ships operating in the area evacuated the tourists to a Chilean airstrip on King George Island. A Chilean and a Spanish vessel removed the crew, the last leaving Palmer on 4 February. For several days a station designed for 40 people had to accommodate over 300. This created major problems, including the cancellation of most of the station's scientific programme that summer.

### Clean-up and fate of the wreck

Initially, a 1 $km^2$ fuel slick formed next to the grounded vessel. After four hours, the slick spread east into Arthur Harbour and began to wash up on nearby beaches. Winds, currents and tides then freed the ship and it drifted to DeLaca Island on 31 January. At this location it rolled over and sank, leaving only about 20% of the superstructure above the sea surface. By this time the slick covered about 100 $km^2$ of the sea around Arthur Harbour.

At first only a very limited clean-up was attempted because Palmer Station lacked the necessary equipment. Due to the remote location, a special US spill response team did not reach the wreck until 7 February. This team, with assistance from the Argentine and Chilean navies, skimmed oil off the water, put down containment booms, surveyed and plugged leaks in the hull and removed remaining fuel. A total of 65,000 litres of fuel was collected by the time the salvage team departed in mid-March 1989. Later that year the vessel turned over completely.

In January 1993, Argentina and the Netherlands carried out a second salvage operation on the wreck and removed all the remaining oil and other hazards. The upturned vessel still remains at DeLaca Island where its keel can still be seen.

T. DeLaca (NSF)

The *Bahia Paraiso* grounded near Palmer Station, Antarctic Peninsula

### Environmental impacts

When news of the spill first emerged environmentalists forecast that the oil could damage Antarctic marine ecosystems for a century because it would degrade only very slowly in the cold polar climate. Scientific investigations revealed, however, that the actual pollution effects were limited.

Observed effects were restricted to a few kilometres from the wreck. The coastline was most badly hit, with as much as 50% of the intertidal limpet population being killed within 2 km of DeLaca Island. Within four to six weeks of the spill, limpet populations had recovered, probably by recolonisation from the subtidal population. By 1 February 1989, a number of Adélie penguins and blue-eyed shags were found dead and oiled. About 300 dead birds were collected over a three week period. Actual mortality may have been greater because of the severe weather, and scavenging of dead birds by predators. Eight weeks after the spill there was little or no residue of fuel remaining on birds' feathers. Effects of oil on the breeding success of one bird species was found. Blue-eyed shag chicks died due to oil toxicity and abandonment by their parents. South polar skuas failed to breed, but this may have been due to natural factors rather than the spill. Of greater concern was the desertion of nests by southern giant petrels because of noise from helicopters involved in the clean-up.

Seawater, sediments and marine organisms (e.g. limpets) living within 4 km of the wreck were contaminated to varying degrees for at least a year after the spill. However, no ecological effects on benthic (bottom living) communities were found. The impact of the spill on fish also appears to have been negligible, as it was on seals and whales.

## Conclusions

The loss of the *Bahia Paraiso* was not the catastrophe it was first feared to be. The high volatility of the fuel, the small amount of fuel lost and the high-energy environment all helped to limit environmental effects. The grounding of the vessel so close to Palmer Station meant that there were no injuries or loss of life. However, a similar accident in a remote location in Antarctica could result in a major and very serious disaster.

# The Greenpeace vision of Antarctica as a 'World Park'

Resource EP3


Greenpeace

Greenpeace protesters at the French Dumont d'Urville research station, Pointe Geologie, Terre Adélie in February 1989. The protest was against the construction of a crushed rock airstrip at the station. The airstrip was never completed as in January 1994 it was seriously damaged by a tidal wave and the French government decided not to carry out repairs because of the cost and to prevent disturbance of breeding penguins.

Greenpeace's vision of a World Park is guided by four principles:

- the recognition of the intrinsic value of the continent as the world's last great and near-pristine wilderness;
- the protection of all wildlife and ecological communities based on the precautionary principle, within the area below the Antarctic convergence
- the use of the continent only for high quality scientific activity, emphasising co-operation among scientists from all nations;
- and maintaining the continent as a zone of peace, free of nuclear and other weapons, and of all military activities.

Protection of the Antarctic environment would be the paramount consideration in a World Park when evaluating all human activities. Activities deemed detrimental to the environment would be prohibited. These currently include:

- mineral and oil exploitation;
- military and nuclear activities;
- disposal of radioactive and toxic waste;
- killing or interfering with marine mammals, birds and plant life.

Activities to be carefully monitored and subject to evaluation using the precautionary principle would include:

- scientific research;
- tourism and non-governmental activities;
- commercial exploitation of marine resources (except mammals and birds which should be completely protected);
- the construction and decommissioning of stations and logistical support facilities;
- and the operation of all scientific bases, including fuel use, waste disposal and other logistics.

*Greenpeace vision of Antarctica as a 'World Park' is as expressed in Szabo, M. (1994) State of the Ice: An Overview of Human Impacts in Antarctica. Greenpeace International, Amsterdam*

# Waste management in Antarctica

Resource EP4

### Frozen wastes amid the frozen wastes

One of the most serious environmental issues for the British Antarctic Survey (BAS) is waste disposal. The Environmental Protocol requires Antarctic operators to reduce the amount of wastes they produce in order to minimise damage to the environment. This is not simple, because the low temperatures prevent natural degradation of rubbish, and waste quickly freezes and becomes inert. In the interior of the continent metal does not rust because the air is so dry. This means that the huts and equipment from the earliest expeditions remain almost in the same condition as when they were left almost a century ago. For example, there is an amazingly well-preserved rubbish dump next to the historic hut at Cape Evans, Ross Island, consisting of empty food cans and other items discarded by Scott's British Antarctic Expedition (1910–13) and the Ross Sea party from Shackleton's Imperial Trans-Antarctic Expedition (1914–17).

### Waste management in BAS

BAS policy is that all waste from its operations, other than sewage or food waste, should be removed from Antarctica. The dumping of waste or chemicals on land or at sea, or open burning of rubbish are all prohibited. Instead wastes are separated at source, processed using a range of compacting and shredding equipment, and then removed.

All hazardous wastes (e.g. laboratory chemicals) are returned to the UK for safe disposal. Drink cans, lead-acid batteries, photographic chemicals are recycled in the UK, and empty fuel drums are either re-used in the Falkland Islands or recycled in the UK. Non-hazardous wastes, such as paper and glass, are taken to the Falkland Islands where they are disposed of properly by controlled landfill. The quantity of waste removed each year is substantial. For example, in 1995–96, 2200 litres of chemicals, 600 kg of special waste, 1700 kg of batteries and 2000 litres of photographic chemicals were brought back to the UK, and 2043 $m^3$ of non-hazardous wastes were shipped to the Falkland Islands. As permitted under the Environmental Protocol, sewage and food waste are discharged into the sea at the BAS research stations at Rothera and Signy, and at Halley they are put into ice pits. Such wastes are not removed from Antarctica because of the health risks involved in shipping large quantities over long distances. The installation at Rothera of a biological sewage treatment plant, as used on the BAS research vessels RRS *James Clark Ross* and RRS *Bransfield* is planned.

The Antarctic waste management system is coordinated from the Cambridge headquarters of BAS by the Environmental Officer, working closely with BAS logistics experts, the station Base Commanders, the Masters of the research vessels, and with waste contractors in the Falkland Islands and UK.

### 'Gash' duty

As Antarctica is so remote, waste disposal must be completely self-sufficient. Everyone, from the Director of BAS or a visiting professor, downwards, must take a turn at waste management, or 'gash' duty in BAS slang. This involves clearing away and safely storing all fresh rubbish to await removal. Waste disposal must therefore be quick, practical and easy to understand. Training on this is given to all staff, and detailed guidance is contained in the BAS *Waste Management Handbook*.

### Waste minimisation

Now that an effective waste disposal system is in place, BAS is actively trying to minimise rubbish production, particularly packaging materials which make up about 60% of all non-hazardous waste. This makes a lot of sense as reducing packaging will not only decrease environmental impact, it will also reduce disposal costs. For example, BAS is making much greater use of shipping containers to carry cargo to Antarctica. This minimises the number of wooden crates used, which usually only survive the outward journey. On return from Antarctica the shipping containers carry wastes.

### Abandoned British stations

The Environmental Protocol requires abandoned stations in Antarctica to be 'cleaned up'. This poses considerable difficulties for BAS because of its legacy of old stations and huts, some of which date back to the mid 1940s. A conservation survey of the old British stations was carried out by the UK Antarctic Heritage Trust in 1994. Four stations – Port Lockroy, Argentine Islands, Horseshoe Island and Stonington Island – were designated as Historic Sites under the Antarctic Treaty and are being conserved. A clean-up plan has been established for the five other old stations. Hazardous wastes, fuel and rubbish have been removed already. However, demolition and removal of buildings raises complex management issues. For example, clean-up itself could damage sites of scientific importance adjacent to old stations.

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Port Lockroy in January 1992 before clean-up in 1996. (Compare this picture with the one of the station shown in Resource T3 with Worksheet 15)

# Environmental assessment of the Rothera airstrip

Resource EP5

## Overview

*In September 1989, the British Antarctic Survey (BAS) released a Comprehensive Environmental Evaluation (CEE) of the proposed construction of a crushed rock airstrip at Rothera Point, Adelaide Island, Antarctica. This resource summarises the CEE and outlines the proposal, the scientific benefits of the airstrip, and the predicted environmental impacts and also sets out the final decision made by BAS's parent body the Natural Environment Research Council (NERC).*

## Outline of the Comprehensive Environmental Evaluation of the Rothera airstrip

### *The proposal*

The proposal is to construct a 915 m long crushed rock airstrip with associated aircraft parking area, hangar, fuel storage tanks and wharf at Rothera Point, Adelaide Island. The area to be developed is already in use for support of activities at Rothera Research Station (UK). The crushed rock airstrip will replace the existing ice skiway on the Wormald Ice Piedmont, situated 5 km from the station. The air facilities will be available by agreement to official aircraft of other Antarctic Treaty nations. They will not be open to non-governmental aircraft, except in an emergency.

### *The scientific benefits*

The airstrip will provide a major increase in the support for BAS scientific research especially in climate, glaciology, geology, geophysics, upper atmospheric physics, terrestrial and freshwater biology and airborne remote sensing. The support will be achieved through:

- establishment of air links to Antarctica from the Falkland Islands, and occasionally from South America, for personnel and light cargo
- more efficient transport of scientific parties into the 'deep-field'
- initiation of regular air communication with Halley Research Station.

In addition, the airstrip will also provide significant improvements to the health and safety of BAS aircraft operations and security of aircraft through:

- better weather conditions (wind regime, visibility) at the sea level runway
- provision of a hangar for aircraft and their maintenance
- new and improved fuel storage and bunkering facilities.

### *The environmental impacts*

Rothera Point is a sparsely vegetated gravel and low rock promontory. It does not have breeding penguin or seal colonies. The most abundant breeding birds are skuas, of which there were 16 pairs in 1989. The terrestrial flora and fauna is very restricted in species diversity and abundance compared to other nearby ice-free areas.

Judged on a worst case scenario, the construction and operation of the airstrip at Rothera Point will lead to:

- noise impact on the bird and seal populations in the local area which might conceivably lead to relocation elsewhere
- dust pollution of the isthmus and the ice ramp leading from the station up to the Wormald Ice Piedmont
- destruction of intertidal and benthic communities where construction extends into the sea (though these communities are expected to recolonise impacted areas)
- destruction of flora, mainly lichens, in the small area from which rock is quarried
- the area of the airstrip, servicing facilities and approach roads remaining barren.

It is very unlikely that either the construction or operation of the airstrip will have anything but the most limited impact beyond the area already influenced by Rothera Research Station.

It is concluded that the construction of the airstrip will have a severe impact in the immediate vicinity of Rothera Research Station and that operation of the airstrip will cause a greater impact than the station has had in the past.

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BAS Dash-7 aircraft, with Rothera Research Station and airstrip in the background

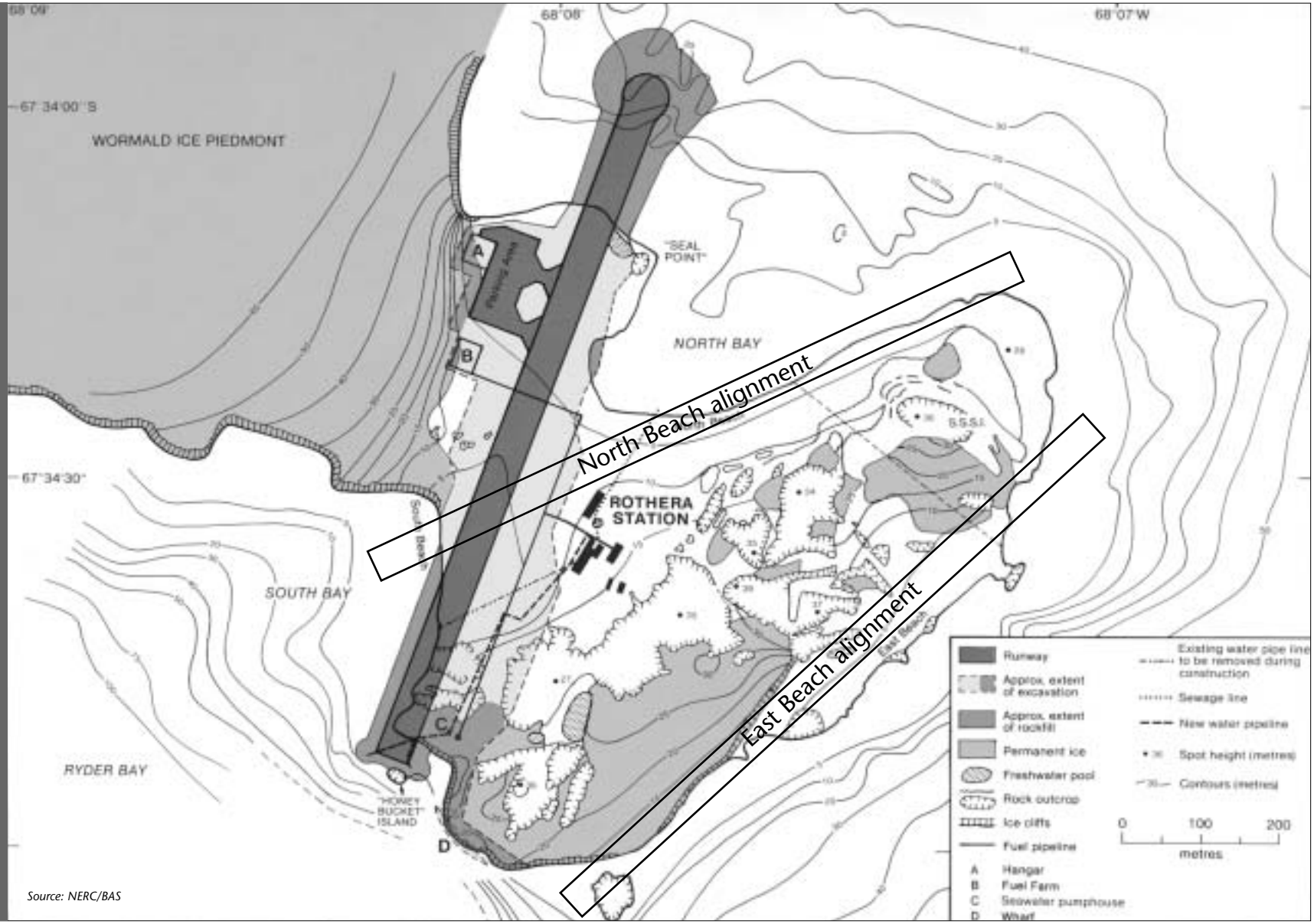
To check the predictions made in this evaluation, environmental monitoring activities at Rothera will be enhanced. Besides the existing programmes of monitoring heavy metals in lichens and the breeding success of the local population of skuas, a further programme of monitoring airborne dust will be carried out during the construction phase. In addition, soils will be monitored for hydrocarbons from any oil spills that might occur. A specially appointed BAS Environmental Officer will be responsible for these programmes.

### *The decision*

NERC has decided, following completion of a detailed assessment of the likely environmental impacts and subject to environmental safeguards and future monitoring, that the construction of the airstrip and associated works at Rothera is justified and necessary. The value of support to global science objectives outweighs the minor and local environmental impacts.

*Source: Summarised from NERC (1989) Comprehensive Environmental Evaluation – Proposed Construction of Airstrip at Rothera Point, Antarctica. NERC, Swindon.*

Map of Rothera Point, showing the crushed rock airstrip and the two alternative runway alignments considered.




*Source: NERC/BAS*

# Environmental protection of Antarctica

Worksheet 14

**Antarctica remains the last great wilderness on Earth. In the past the continent was protected by its remoteness and inaccessibility. Thanks to modern technology this is no longer the case and Antarctica is receiving an increasing number of visitors. International concern over the conservation of the continent led to the Antarctic Treaty nations adopting the Protocol on Environmental Protection to the Antarctic Treaty in 1991, which came into force in 1998. The Environmental Protocol provides for the comprehensive protection of the Antarctic environment, and sets out mandatory regulations governing human activities in the region. This worksheet examines the different types of human impacts affecting Antarctica and explains how the British Antarctic Survey minimises the environmental effects of its operations.**

**Task 1** Look through all the worksheets in the pack and the subjects they cover. List all the references to environmental impact by subject. Are there any that do not raise environmental issues either directly or indirectly? Resource EP1 summarises the views of the United Nations concerning the state of the Antarctic environment. Produce a list of their main findings. Compare it with the list you made in your review of the pack. Identify any differences between the lists.

## What human activities have an impact on Antarctica?

It is important to distinguish between environmental impacts in Antarctica caused by local human activity and those caused by human activity elsewhere on the planet. The ozone hole, for example, is a very significant impact but it is caused by the release, mostly from the industrialised northern hemisphere, of man-made chlorofluorocarbons (CFCs) and other ozone depleting gases (see Worksheet 9 on The Ozone Hole). By contrast, waste from Antarctic research stations is generated directly by people living on the continent.

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Waste being removed from the BAS Signy Research Station

**Task 2** Examine your own list of environmental issues produced in Task 1. Write against each issue whether it is globally, regionally or locally caused. Now rank the issues in order of significance. Consider for each one its geographical scale, damage caused to the environment and the extent to which actions have been taken to solve the problem. You may find it useful to 'brainstorm' this task in small groups or pairs. Present your findings to the class as a summary table. Which issues were the most significant? What does this tell you about the management of environmental issues in Antarctica?

## Major pollution incidents in Antarctica

You may have identified major pollution incidents, such as marine oil spills, as being a serious environmental problem in Antarctica. However, large crude oil tankers, like the *Exxon Valdez*, do not sail near the continent because it is off the major shipping routes. The few ships currently operating south of latitude 60°S are fishing vessels, research vessels, and cruise ships and they transport only light diesel fuels. The largest marine oil spill to have occurred in Antarctica was as a result of the Argentine resupply ship the *Bahia Paraiso* running aground near Palmer Station (US) on the Antarctic Peninsula in 1989. Resource EP2 describes the spill, the subsequent clean-up and the identified environmental impacts.

**Task 3** Read Resource EP2.

- Imagine you are the Base Commander of Palmer Station. Write an urgent report dated 1100 hrs on 29 January 1989 to the US National Science Foundation, who are responsible for the station, telling them about the grounding of the *Bahia Paraiso*. Your report must not exceed 1 page A4. Use bullet points to summarise the key facts.
- Consider the environmental impact of the spill. How did initial forecasts match up with the results of long-term environmental monitoring?
- What lessons can be learnt from the *Bahia Paraiso* oil spill? How could major spills be prevented? If they occur, who do you think should pay for cleaning them up?

## The Environmental Protocol

Some environmentalists have argued that Antarctica should essentially be left entirely alone, except for high quality scientific research into problems of global relevance. For example, Greenpeace has long campaigned for Antarctica to be made a 'World Park' (see Resource EP3). With the entry into force of the Environmental Protocol, Antarctica is now protected by one of the toughest sets of environmental regulations found anywhere in the world. In summary, the Protocol:

• designates Antarctica as a 'natural reserve, devoted to peace and science'
• sets out principles for environmental protection
• bans mineral resource activity (other than scientific research), with a mechanism to review the ban after 50 years, or before if all Treaty nations agree
• requires the Environmental Impact Assessment (EIA) of all activities before they can go ahead.

**Task 4** Read Resource EP3, as well as Resource ATS5 (with Worksheet 5 Antarctic Treaty System).
• Compare the Environmental Protocol with the Greenpeace vision of a 'World Park'. What are the differences between them?
• Imagine you are representing the UK at the annual Antarctic Treaty Consultative Meeting. Prepare a short paper for the meeting (no longer than two pages A4) suggesting improvements that could be made to the Protocol.

### The response of the UK to the Protocol

The UK has enacted domestic legislation to enforce the provisions of the Protocol through the Antarctic Act 1994. The Act introduces a permitting system, administered by the Foreign & Commonwealth Office (FCO), for all British activities in Antarctica. For example, permits are required for all British expeditions to Antarctica, as well as all British-registered aircraft and vessels operating south of latitude 60°S.

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The RRS *Bransfield* requires a permit to operate south of 60°S

As the main British operator in Antarctica, the BAS fully complies with the provisions of the Protocol and the Antarctic Act. It has responded to the Protocol in several ways, such as the:
• appointment of an Antarctic Environmental Officer
• routine removal of all hazardous waste and general rubbish from its stations and ships for proper disposal outside of Antarctica
• environmental assessment of all new scientific and logistic projects.
• clean-up of old British stations

Overall, the policy of BAS is to carry out a programme of first class science in Antarctica with the minimum of environmental impact. This policy is in the Survey's own interests as so many of its scientific projects depend for their success on an unpolluted environment.

### Waste management in BAS

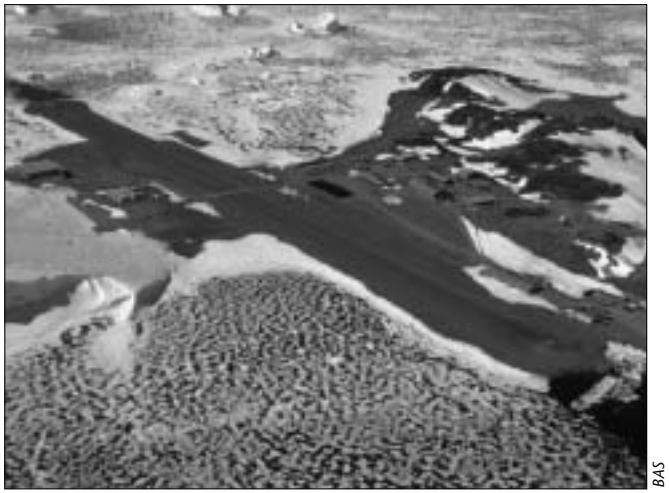
The Resource EP4 summarises a recent article by BAS's Environmental Officer.

**Task 5** Read Resource EP4.
• Draw a flow diagram showing the different types of waste BAS produces and what happens to them. Comment on the adequacy of the waste disposal methods and suggest ways of improving them. Indicate the costs of your suggestions (e.g. a sewage treatment plant is expensive and consumes electricity).
• What would you do with the nine old British stations that BAS is responsible for? Options might be conservation as Historic Monuments, maintenance as visitor centres or emergency refuges, or dismantling and complete removal. Give reasons for your choices.

### Environmental Impact Assessment (EIA)

One of the key requirements of the Environmental Protocol is for new projects in Antarctica to be subject to EIA. This requires operators such as BAS to examine the environmental effects of all new science and logistical projects before allowing them to go ahead. Different countries have interpreted this requirement in different ways. A number of comprehensive EIAs have been carried out for major projects, such as the building of new research stations. In 1989, the BAS carried out a comprehensive evaluation for the construction of the airstrip at Rothera Research Station. Resource EP5 provides a summary of this EIA.

**Task 6** Using the information provided in Resource EP5, as well as Resource LW6 (with Worksheet 3 Living and Working in Antarctica), carry out a cost benefit analysis of the Rothera airstrip project. Provide an annotated map to show the predicted environmental impact of the project at Rothera Point. Weigh up each of the costs and benefits that you identify in your analysis. On the basis of your results do you support the project? Do you think the disturbance to the local environment at Rothera is outweighed by the increase in scientific knowledge that the use of the airstrip will bring?



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Aerial view of the BAS Rothera Research Station and airstrip