in seabirds and birds of prey signaled the increasing ecosystem pollution by DDT, and eventually led to new laws, such as the Endangered Species Act, to protect wildlife populations. Other examples of coastal pollution, such as disposal of plastics into coastal oceans have led to international agreements on disposal of plastics at sea, and have reduced injury to albatrosses and their chicks.

Wildlife injury to both fish and birds resulted in the public demand to clean up the U.S. Great Lakes, to make fish safe to eat, and to allow recovery of the contaminated birds. Strict laws on disposal of PCBs, other industrial chemicals, and pesticides into rivers and lakes have allowed recovery of these areas, and recovery of fish and wildlife populations. Disasters such as the Exxon Valdez oil spill led to changes in safety procedures and better monitoring to safeguard seabirds and marine mammals.

Endocrine disrupting chemicals have been discovered in rivers and lakes in the US and Europe, causing reproductive injury to fish, birds and alligators, and signaling possible dangers to human populations. Each of these examples has shown that monitoring of fish and wildlife can identify pollution problems, and lead to improved regulations to keep the environment clean. Fish and wildlife are indicators which must be watched carefully to insure ecosystem problems will not impact human populations.

Atmospheric transport of anthropogenic substances to the surrounding marine environment: A view from biogeochemical cycles

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The East Asian continental rim region is characterized by anthropogenic emissions that are already high in many locals and that are rapidly growing throughout much of the region. Within two decades, emission from eastern Asia could account for roughly half of the sulfur and nitrogen and a third of the carbon emitted from all anthropogenic sources worldwide. The Asia/western Pacific region has a unique mixture of aerosols and trace gases because of these distinctive patterns of emissions in combination with the particular meteorological conditions affecting the region. Anthropogenic materials in the atmosphere can also influence regional and global climate by altering the Earth's radiative balance. Continental outflow affects biogeochmical cycles of the North Pacific, and associated effects on marine biology and chemistry could also have climate implications. The following goals and tasks are the focus of our future research:

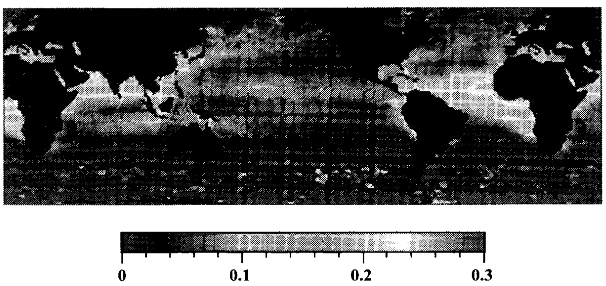

Figure. Annual composite image of aerosol optical thickness in 1993 obtained by NOAA AVHRR sensor. High aerosol concentration was observed along east coast of the Asian continent. However, satellite images cannot tell us the chemical composition of aerosols. It is possible to identify the aerosols are emitted from natural or anthropogenic sources and its transport pattern by chemical analysis.

Table. Source strength, atmospheric burden and residence time of various types of aerosol particles.

Source	Flux ($10^{12}\,g\,yr^{-1}$)	Global mean Column burden ($10^{-3}\,g\,m^{-2}$)	Residence time (day)
Natural			
Primary			
Soil dust (mineral aerosol)	1500	32.2	4.0
Sea salt	1300	7.0	1.0
Volcanic dust	33	0.7	3.9
Biological debris	50	1.1	4.1
Secondary			
Sulphates from natural precursors, as $(NH_4)_2SO_4$	102	2.8	5.1
Organic matter from biogenic VOC	55	2.1	7.1
Nitrates from NO_x	22	0.5	4.2
Anthropogenic			
Primary			
Industrial dust, etc.	100	2.1	3.9
Soot (elemental carbon) from fossil fuels	8	0.2	4.7
Soot from biomass combustion	5	0.1	3.7
Secondary			
Sulphates fropm SO_2 as $(NH_4)_2SO_4$	140	3.8	5.1
Biomass burning	80	3.4	7.9
Nitrates from NO_x	36	0.8	4.1

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Goals:

- To assess transport and chemical transformations of air pollutants over the East Asian continent and the western North Pacific
- To determine the deposition of primary and secondary pollutants in the East Asian region
- To estimate the effects of climate and atmospheric processes on marine biogeochemistry

Tasks:

- Emission inventory
- Intensive field programs
- Ground-surface monitoring network
- Shipboard measurements

Evaluation of carrying capacity in coastal waters

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The 20th century has been the age of the throwaway principle and competition. Consumption has been encouraged in pursuit of material wealth, and this has been supported by our increasing ability to produce industrially anything we want including food. This leads to an escalating demand of materials and energy for further production. On the contrary, little attention has been paid to thrown-away materials. Until quite recently, we did not recognize the cost for managing the waste product. By this, we have exerted huge impacts on the natural environment and its material cycling through extracting things from nature and depositing waste materials far beyond nature's renewing ability. Competition for profits at various levels accelerates this tendency. Now, we are in serious trilemma in many environmental issues among environments, population and resources viz., deterioration in environments, explosion in human population and exhaustion of resources. Recently, it became widely recognized that a proper environment is essential to sustain renewable resources, and that there are practical and moral reasons for placing values on the environment, including utilitarian, aesthetics, the rights of nonhuman life and our obligations to future generations. Moreover, benefits of natural environments are evaluated in terms of 1) goods such as food production, 2) ecosystem services such as material cycling and purging function, and 3) amenity.

Coastal waters have been utilized in various ways, and food production is the most important function. Coastal areas are nurseries for marine biota of which conservation is crucial for sustainability of fish stock. Changes in coastal environments due to reclamation, pollution and heavy eutrophication directly affect the fishery stock through reduced reproduction of organisms. Coastal waters are also intensively utilized for sea farming and aquaculture of fish, shellfish and macroalgae. Since cultured organisms are incorporated into natural material cycling within the coastal ecosystems, excessive aquaculture can lead to disturbance in the material cycling and marine life. In addition, various environmental issues are raised, being associated with habitat modification, wild seedstock reduction, biological pollution and formation of anoxic zone. Sustainable utilization of coastal waters including continued expansion of aquaculture requires healthy ecosystems because of dependence of fish production on natural ecosystems. Then, how much food production can we expect in a coastal area? To answer this question we have to evaluate the carrying capacity of the area through understandings of *in situ* material cycling. A research project on the carrying capacity of coastal waters is currently in progress in Sanriku area in northern Japan in order to establish adequate aquaculture potential for shellfish and macroalgae. Recent progress made in these areas will be reviewed.

Coastal ecology and marine pollution

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Humankind had regarded capacity of the hydrosphere as unlimited at the beginning of the 20th century because of its huge surface (two third of surface of the earth). During the 20th century, agriculture, fisheries, forestry, mining and industry are making rapid progress with accompanying pollution. The world population is expected to increase from 5.9 billion in 1998 to 8.0 billion by 2025. It is estimated that 75% of the global population lives on the coast or within 60 km of the coast by the year 2000 and the percentage is increasing. These population have direct or indirect impacts on environments of