The Kansai International Airport Project and Environmental Impact Assessment

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Kansai International Airport is under construction in Osaka Bay, 5 km off the coast of Senshu. The construction of seawalls in the airport island commenced in January, 1987. With the opening of the airport scheduled for the spring of 1993, the construction of aboveground facilities will soon begin.
Construction of this airport, designed as a key international airport in Japan, is being carried out as a national project. In Osaka Bay, land reclamation is strictly controlled by provisions in the Special Law for Environmental Conservation in the Seto Inland Sea. Accordingly, special emphasis has been placed on preventing environmental pollution in and around Osaka Bay, and conserving the natural environment in preparing the airport plan, as well as in assessing environmental impact prior to construction.
This paper outlines the environmental impact assessment regarding construction of Kansai International Airport and environmental monitoring during construction, focusing on the impact on water quality.

1. Environmental Impact Assessment

The outline of the airport project is shown in the attached Table. The environmental impact assessment was conducted in accordance with provisions in the Osaka Prefectural Government's Ordinance and Techincal Guidelines for environmental assessments. The scope of the prediction and assessment covered the impact of the construction, location and operation of the airport on the environment in and around Osaka Bay. The latest scientific findings were utilized for prediction. The assessment was conducted by comparing predicted results with the previously established targets for environmental conservation.

1.1 Environmental Impact Assessment of Airport Location and Operation

The concentration of COD in drainage from the airport is very small (0.003 ppm) at a location approximately 500 m from the airport, causing minimum change in COD concentration pattern in the sea area. As well, loads are small for other items affecting water quality. Accordingly, drainage from the airport will not have significant adverse effects vis-a-vis keeping down the concentration of pollutants in the sea area around the airport to meet environmental standards. As well, studies were made to predict the impact of the airport on the flow of seawater, waves and living things in the sea area. Predicted results showed that the impact on each of these factors is limited to the vicinity of the airport island.
Other factors whose impacts were predicted and assessed through comparison with targets for environmental conservation include aircraft noise and pollutants emitted into the air.

Basic Concept

- Paying due and full regard to pollution control and environmental protection in Osaka Bay and its surrounding areas;
- Serving as a hub for domestic and international air transport;
- Being open to traffic 24 hours a day; and
- Affording passengers and cargo ready access to the mainland for maximum convenience.

Planning of the Airport (Phase 1)

Location: Five kilometers offshore from the Senshu area in the southeastern part of Osaka Bay.

Scale: One main runway 3,500 meters long in a total area of 5.11 million square meters

Capacity: Approximately 160,000 takeoffs and landings per year

Access bridge: 3.75 kilometers long providing both road and railway transportation

Target date of airport opening: End of March, 1993

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1.2 Environmental Impact Assessment of Airport Construction

In the course of airport island construction, soil improvement, seawall construction, land reclamation and aboveground facility construction will be carried out, in this order. Concurrently, the access bridge and railway will be constructed.

Careful consideration has been given to preventing the adverse environmental effects of the airport project, with the goal of creating an airport free from environmental problems, that prospers with the local community. According to the plan, an area of 511 ha (approximately 166 million m3 of soil) will be reclaimed in a sea area with an average depth of 18m, on thick alluvial and diluvial clay layers. This large area will be reclaimed within only six years. Accordingly, it is important to minimize the impact of the construction on water quality, especially the increase in turbidity, in the surrounding sea area.

Potential Air Transport Volume

Classification			Based on 160,000 Take-offs and Landings per Year
Potential Air Trnasport Volume	Passengers	International	19.9 million
		Domestic	10.8 million
		Total	30.7 million
	Cargo (tons)	International	1,170,000
		Domestic	220,000
		Total	1,390,000
	No. of Takeoffs and Landings Per Day	International	356 (74)*
		Domestic	98
		Total	454

* No of take-offs and landings per day for cargo aircraft.

Potential Volume of People and Cargo Entering and Exiting the Airport per Day

Classification			Based on 160,000 Take-offs and Landings Per Year
Potential Volume of People and Cargo Entering and Exiting the Airport per Day	People per Day	International Passengers	44,200
		Domestic Passengers	23,800
		Total No. of Passengers	68,000
		Well-Wishers	51,500
		Airport Employees	58,700
		Sight Seer	3,800
		Visitors on Business	5,800
		Total Volume of People	187,800
	Cargo (tons per day)	International	2,400
		Domestic	600
		Total Volume of Cargo	3,000

NOTE Transit passengers and cargo are excluded

The prediction and assessment of the impact of airport construction on turbidity was conducted using a three-layer model, which simulates conditions during seawall construction, land reclamation and access bridge construction, each at its most active stage. During seawall construction, land sand is laid on the sea bottom in an 18 m depth sea area, to improve the foundation prior to building seawalls with rubble-stones. While sand is laid in an area surrounded by roughly completed seawalls during reclamation, dumping of sand from barges is conducted without an enclosing structure during seawall construction, thus making the increase of turbidity in a wide area more probable. Accordingly, thorough studies were made to determine the volume of impurities in the water, their rate of settlement and other factors, prior to construction.

Simulation results showed that the increase of turbidity in areas around the airport caused by construction of the airport island and the access bridge will be greater in the lower layer than in the middle layer, and greater in the middle layer than in the upper layer; that the maximum instantaneous concentration of additional impurities (SS) will reach 2 mg/l in areas at a distance of up to approximately 1 km from the construction site; and that the maximum instantaneous concentration will reach 10 mg/l only in areas in the immediate vicinity of the construction site. These findings lead to the conclusion that the impact of airport construction is small, and does not bring about significant changes in water quality in sea areas around the site.

1.3 Measures for Environmental Conservation

To prevent noise pollution, the airport island is located 5 km off the coast. As well, the following measures for environmental conservation have been taken or are planned:

(a) Measures to be implemented after airport completion include :
Secondary treatment of drainage prior to discharge; utilization of part of the recycled water as flushing water after drainage treatment; and adoption of a wave absorption structure for part of the seawalls, to reduce the effect of seawall on waves.

(b) Measures to be taken during construction include :
The installation of covers to prevent the diffusion of impurities, if necessary, during dredging and reclamation for access bridge construction; the dumping of soil after the rough completion of seawall, to control the increase of turbidity; the continuous or periodic monitoring of the diffusion of impurities and other environmental factors during construction, and the execution of necessary adjustments (in the timing of sand dumping etc.) if measurements exceed the previously established target values for turbidity control.

2. Environmental Monitoring

Items to be monitored include noise, ambient air quality and weather, water quality, bottom materials, life in sea area and marine phenomena. The monitoring period is categorized into the construction stage and the operation stage.

2.1 Monitoring of Turbidity Increment Resulting from Construction

Monitoring points were located on a 1-km radius circle, with the construction site as the center, based on the results of the environmental impact assessment. Turbidity measured at a monitoring point is comprised of that attributable to natural factors and turbidity resulting from airport construction. Accordingly, it is important to distinguish between these two types of turbidity in monitoring. To this end, background turbidity was measured at a location typical of this sea area with regard to turbidity-related conditions; this background turbidity is subtracted from turbidities measured at monitoring points. A location of 4 km from the airport island was chosen for measurement of background turbidity, so as to preclude the influence of airport construction.

Measurement was conducted at a 1 m point under the sea surface to determine turbidity in the upper layer; at a 2 m point on the sea bottom to determine turbidity in the lower layer; and at a point midway between these two to determine turbidity in the middle layer. For monitoring, the light transmission method was adopted. The determination of turbidity from measurement of SS (inorganic suspension),though more accurate, was rejected as too time-consuming, as it involves the analysis of collected water, and therefore is subject to difficulties in obtaining results quickly for effective adjustment of the construction process. As well, the light transmission method is advantageous in that it is simple enough to allow frequent measurements during construction extending over several years. For on-the-spot measurement, multipurpose submersible instruments are used to measure not only turbidity, but water temperature, pH, salinity and DO, and thus obtain information on the general properties of the seawater. Measurements have also been conducted to determine other factors affecting water quality: Transparency, red tide and oil film. In addition to monitoring via on-the-spot measurement, regular monitoring of SS and VSS via collected water analysis has been conducted to determine the properties of suspension.

The levels of suspension in the sea area varies widely with tidal and other natural and artificial factors. Accordingly, suspension must be monitored constantly for timely adjustment of the construction process, to prevent adverse effects of suspension on the surrounding sea area. To this end, on-the-spot monitoring is conductd daily using a special ship for water quality inspection.

The results of monitoring were evaluated through the previously established targets in water quality control. According to these targets, adjustment of the construction process will be made if the defference between the SS concentraion at a monitoring point and the background SS concentration exceeds 10 mg/l in a single measurement, or 2 mg/l over three consecutive days. The basis for this is that, according to the results of water quality inspection prior to construction, the difference between the SS concentration at a given location and that at another location rarely exceeds 10 mg/l in a single measurement, or 2 mg/l for three consecutive days. The SS concentration is determined by multiplying the turbidity obtained via on-the-spot measurement by a coefficient of 1.3. This coefficient was determined as an average value, based on the relationship between turbidity and SS concentration obtained through water quality inspection prior to construction.

2.2 Results of Turbidity Monitoring during Construction

Some results of turbidity monitoring during construction are presented. These results were obtained from monitoring over two years from January 1987, when construction commenced, to December 1988, when the airport island seawall was roughly completed, and were obtained by monitoring 14 points 317 times (days) at each point in 1987, 325 times in 1988.

In 1987, abnormal values (values which exceeded the background concentration by more than 2 mg/l) were registered most middle frequently (217 times) for the upper layer, 84 times for the middle layer and 170 times for the lower layer. In 1988, the frequency for the upper layer decreased sharply to 84 times; that for the middle layer was 61 times, and that for the lower layer was 171 times. The frequency for the lower layer was the highest among the frequencies for the three layers in 1988, remaining almost unchanged from the previous year. All of the five monitoring points, at which a sharp decrease in the frequency was registered in 1988, were located in an area near the access bridge construction site on the land side of the airport island. It is assumed that the large decrease in frequency in 1988 was due to the difference between the red tide condition in 1987 and that in 1988. While the red tide in this sea area tended toward high concentration in a narrow area near the coast in 1987, it developed over a wider area in 1988. As the point at which the background concentration was measured was located on the periphery of the subject area for water quality monitoring, it is assumed that red tide, which formed in a narrow area along the coast, caused the abnormal values almost over the whole area.

Frequencies of abnormal values for each cause of registration determined via daily monitoring, were 252 times for red tide, 124 times for dragnets, 78 times for tidal influence, and 84 times for effluence of turbid water from the construction site. Criteria for determining the major causes of abnormal turbidity levels are outlined in the following, though these causes, with diverse contributing factors interacting in a complicated way, can be determined only on the basis of general judgements founded on empirical evidence.

The existence of red tide in the upper layer is inferred from the characteristic change in water color, conspicuous DO supersaturation, high pH and other factors. For the middle layer, DO and pH values as high as those in the upper layer, in which red tide is observed, are used as indices of red tide. Results of previous research on red tide have also been used in establishing criteria.

As for the roiling of the sea bottom by dragnets,it has been empirically established that, due to such roiling,turbidity in a relatively small layer on the sea bottom, up to several meters high, increases to an extremely high level, and that, in this layer,turbidity fluctuates widely during measurement. At on-the-spot measurements, data on dragnet fishery and tidal direction have also been used in determining the influence of such fishery.

Data from May 2, 1988 serve as an example of the establishment of tidal influence. As a result of the weekly inspection, abnormal values were registered, in SS analysis for the lower layers at monitoring points A-8 and 17. At the time of inspection at A-8 and 17, the southward current was gaining speed, while dragnet fishery , which causes a large increase of turbidity in the lower layer, was not conducted in the vicinity of the monioring points. Based on these facts, the cause of the abnormal SS concentration was determined to be roiling of the sea bottom by tidal currents.

Data from April 18 and 19, 1987 serve to illustrate the effect of effluence of turbid water from the construction site. On these days, abnormal values were registered at monitoring point A-9, and change in water color was observed in an area extending from a large sand dumping operation in the sixth Seawall Construction Division to the vicinity of A-9. In this and similar cases, in which water color change was observed in an area extending from the construction site to a monitoring point at which abnormal values were registered, the cause was determined to be the effluence of turbid water from the construction site.

2.3 Adjustment of Construction Process

Tidal current is a major factor related to the increase in turbidity resulting from sand dumping. Accordingly, adjustment of the construction process in response to tidal flow conditions is an effective and realistic measure for preventing increased turbiditurbidity due to airport construction. The adjustment was made mainly by modifying the timing of sand dumping.That is,time required for the settlement and scattering of dumped sand (defined as a condition in which sand concentration has decreased to 2 mg/l) has been determined based on actual data. Sand dumping is suspended in a construction division during times in which tidal flow in the division is so rapid that time allowed for the settlement of sand may fall short of the requirement.

Conclusion

The Seto Inland Sea is one of the typical enclosed coastal seas of Japan. In part of this Inland Sea off the coast of Senshu, the construction of an airport on an artificial island has been carried out at a rapid pace on a scale yet unseen in the world. This project represents a prime subject of discussion regarding development and its impact on the environment, and regarding the appropriate utilization of enclosed coastal seas, as it involves various types of prior environmental studies, environmental assessment based on the results of such studies, and environmental monitoring and verification of the assessment during airport construction and operation.

The above is only an outline of environmental assessment related to this project, and part of the results of monitoring on turbidity. The author hopes to report on the details of other environmentally related aspects of the project, including verification of environmental assessment.

This paper is based on the results of the author's collaboration with many individuals concerned, particularly employees of Kansai International Airport Co.,Ltd.in charge of environmental affairs.