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Water quality

Tsukabaru Dam, Japan

Kyushu Electric Power Co., Inc. developed a novel system for controlling red tide algal blooms at the Tsukabaru Dam in Japan using ship borne ultraviolet irradiation.

Overview

The Tsukabaru Dam is a concrete gravity hydro electric dam on the Mimi River, Japan. At completion in 1938, Tsukabaru was the highest gravity type dam in Japan, standing at 87m high. It was also the first completed using mechanical technology.

The dam design has received acclaim and recognition, with patterned bridge railing situated at the top of the dam reminiscent of the Great Wall of China and turrets at both ends similar medieval European Castles. The dam structure was nominated for Early-Modern Civil Engineering heritage status in 2001.

Tsukabaru Dam has a total storage capacity of 34,326×103 m^3. Upstream of the dam, the river basin is more than 95% mountain forests and wilderness, with cultivated land amounting to less than 1% of the catchment area.

Details

The appearance of ‘Red Tides’ (blooms of single celled planktonic algae, in this case Peredinium bipes) in the Tsukabaru reservoir was first confirmed in the 1970’s. Blooms intensified steadily until the 1990’s, creating unsightly discolouration of the surface water, along with foul odours.

Studies to determine the cause of the blooms included investigations of the optimum temperature range for growth of P. bipes, nutrient limitation experiments, lake circulation assessments, analysis of the distribution of germinated cysts/plankton, and water quality parameters. The studies concluded that in this instance eutrophication (nutrient enrichment) was not the cause of the blooms, but rather:

- Circulation currents deposit cysts of P bipes at the upper end of the lake, creating an algal cyst accumulation and nursery area;
- Algal cells accumulate in the surface layers due to phototaxis

- These factors constitute a continuous cultivation system for Peridinium bipes at the upstream end of the reservoir.

Ultraviolet irradiation was investigated as a management strategy for red tide blooms in view of its economic efficiency, treatment capacity and novelty. Field and laboratory experiments undertaken over a 4-year period indicated that UV irradiation was effective, killing all cells within two days of initial treatment.

The treatment process involves pumping surface water through irradiation chambers on a specially fitted boat. Gross organic material (e.g. leaf litter) is removed and the water is exposed to UV irradiation similar to the disinfection systems now commonly used in potable water treatment facilities. The equipment is fitted with a flow-through turbidimeter for continuous estimation of bloom density, and automatically slows pump rates during dense blooms, increasing UV exposure time.

The ship is able to treat the entire lake within a 5-hour period, destroying 99% of the red tide cells present. This has proven more cost effective than other strategies for managing red tide blooms and has the advantage of leaving no chemical residuals.

Further information

Source: Hydropower Good Practices Workshop, Annex VIII - Examples for Good Practice Report, Villach, Austria, October 2005. International Energy Agency.

http://www1.kyuden.co.jp/en_index

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