

Water Quality Model in the Reservoir of the Chikugo Barrage

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1. Introduction

According to the water quality monitoring in the reservoir of the Chikugo Barrage, three types of phytoplankton (diatoms, green algae and blue-green algae) are observed in the reservoir every year. The cell number of phytoplankton shows that diatoms predominate from winter to spring; green algae are the major group in summer while blue-green algae are highly observed from summer to spring. Recently, the increase in chlorophyll *a* (Chl-*a*) has been monitored in the reservoir of the Chikugo Barrage especially in summer and high ratio of diatoms is frequently observed. This high concentration of Chl-*a* in the discharge from the Chikugo Barrage may lead to water quality problem in the lower reach of the Chikugo River Basin. In this research, the developed completely mixed model is applied in the reservoir of the Chikugo Barrage to study about productivity of algae and its relation with nutrients. The information obtained from the completely mixed model will be useful for water quality management not only in the reservoir itself, but also in the estuary of the Chikugo River and the Ariake Sea.

2. The Chikugo Barrage

The Chikugo Barrage is a moveable weir constructed during 1978 to 1984 at 23 km upstream of the estuary of the Chikugo River. The Chikugo Barrage is operated by the Japan Water Agency (JWA). Main purposes of the Chikugo Barrage are to secure stable water intake for the lower reach of the Chikugo River, flood control and prevention of seawater intrusion from the Ariake Sea¹⁾. Total and effective storage capacity of its reservoir is 5.5 and 0.93 million m³, respectively. A Council consisting of representatives from Kyushu Branch Office of Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Kyushu Branch Office of Ministry of Agriculture, Forestry and Fisheries (MAFF), Fukuoka Prefecture, Saga Prefecture, JWA, specialists and fishermen's union has been established in order to investigate the environmental impact of the Chikugo Barrage since 1977. Environment monitoring is carried out in the Chikugo River at both upstream and downstream of the barrage as well as in its estuary and the Ariake Sea. Location of water quality monitoring stations and intake structures is shown in Fig.1.

3. The Completely mixed Model

In this study, the developed completely mixed model²⁾ is applied in order to simulate water quality in the reservoir of the Chikugo Barrage in 1985-2008. The reservoir of the Chikugo Barrage is considered to be under a completely mixed condition which means water quality is homogeneous in the whole reservoir. Water quantity and quality calculated in this study are average values over a time step of one day. Loading from the main stream and the Houman River is estimated from L-Q equation. In the calculation of chlorophyll *a*, diatoms, green algae and blue-green algae are considered.

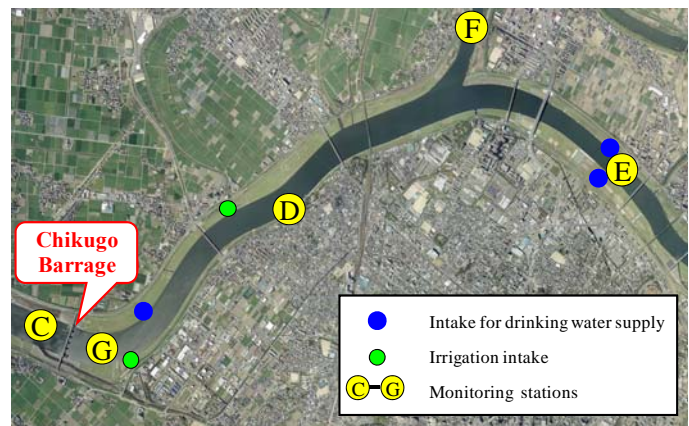


Figure 1 Water quality monitoring stations and intake structures around the Chikugo Barrage

Chikugo Barrage, completely mixed model, chlorophyll *a*, dissolved inorganic nitrogen, orthophosphate

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4. Results and Discussion

Calculated results of chlorophyll *a* (Chl-*a*), dissolved inorganic nitrogen (DIN) and orthophosphate (PO₄-P) are shown in Fig.2. The developed completely mixed model can simulate the growth of algae in the reservoir of the Chikugo Barrage effectively, as the peak of the calculated result occurs mostly in the same period with the observed data. Moreover, the developed model can also represent the high Chl-*a* concentration during the drought summer of 1994 and the low Chl-*a* concentration due to low hydraulic retention time in the reservoir between 2006 and 2008.

In the simulation of nutrients, the calculated results of DIN and PO₄-P show good agreement with the observed data during the dry season except in 1987-1991 when the monitoring data shows a relation between the low level of DIN in the reservoir and the decrease in DIN loading from the upstream. A further study about the contribution of water management in the upper reach of the Chikugo River on water quality in the reservoir of the Chikugo Barrage is necessary.

5. Conclusion

By taking into account the characteristics of each type of phytoplankton, the developed completely mixed model can efficiently simulate chlorophyll *a* in the reservoir of the Chikugo Barrage. The simulated DIN and PO₄-P also have good agreement with the observed data during the dry season. The developed completely mixed model can be used as a tool for water quality management in the reservoir of the Chikugo Barrage during the dry season which is the critical period of water quality.

Acknowledgement

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References

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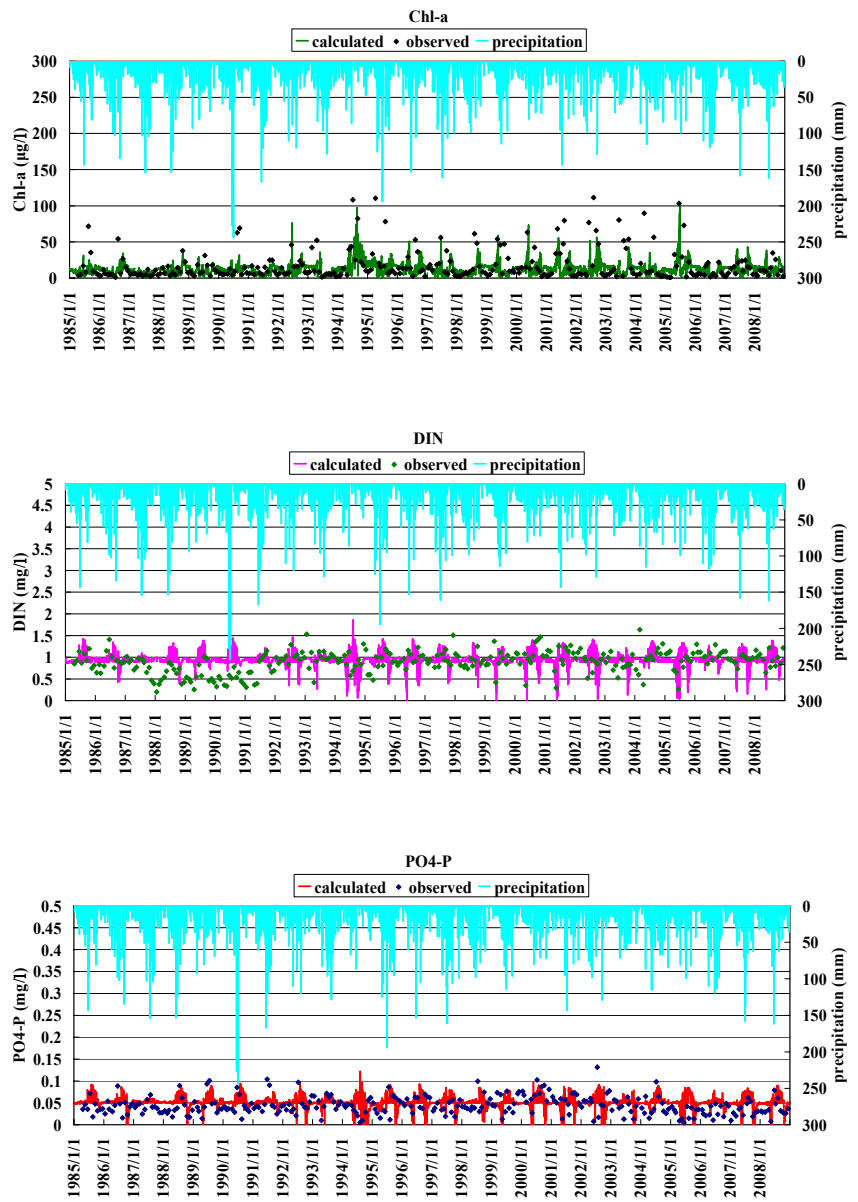


Figure 2 Results obtained from the developed completely mixed model
(upper) Chl-*a*, (middle) DIN, (lower) PO₄-P