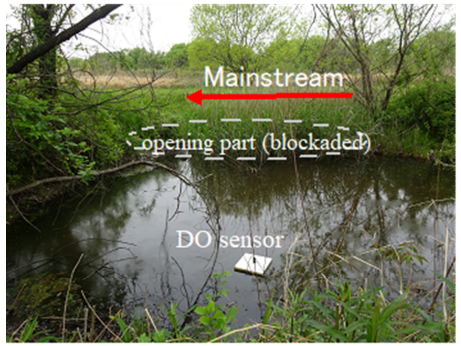
DO recovery process in a square embayment connected to an open-channel flow

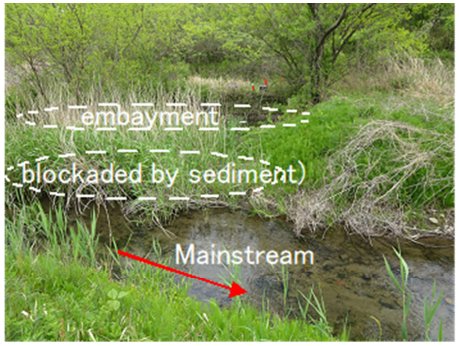
M. Sanjou & T. Okamoto Dept. of Civil Eng., Kyoto university E-mail address: michio.sanjou@water.kuciv.kyoto-u.ac.jp

This study highlights a DO recovery process in embayment connected to a straight main-channel. Our field survey results in that the DO is larger in opened condition to the mainstream than that closed condition without no mass / momentum exchanges with the mainstream. Hence, the mass exchange between the mainstream and the embayment is decided by the embayment opening.

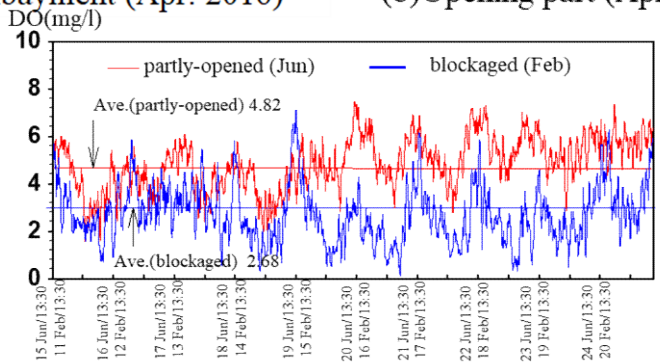
To reveal the relation between DO recovery and embayment opening, we conducted laboratory experiments to measure time-variation of the DO value and horizontal velocity vectors in the model embayment. Finally, we proposed a prediction formula of the recovery time related to reaeration through free-surface and DO supply from main-channel.



(a)Embayment (Apr. 2016)



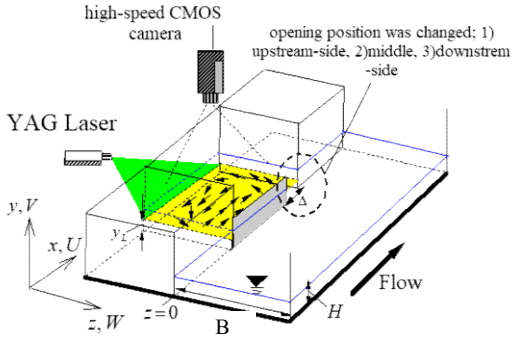
(b)Opening part (Apr. 2016)

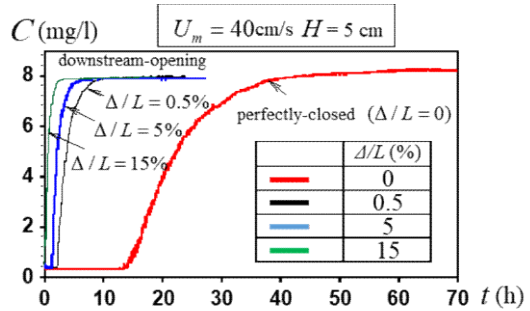


We conducted field observations in a natural embayment zone. The target field is situated in the national Aqua Restoration Research Center (NARRC) in Japan, where the embayment is connected to a 2 m-wide small river.

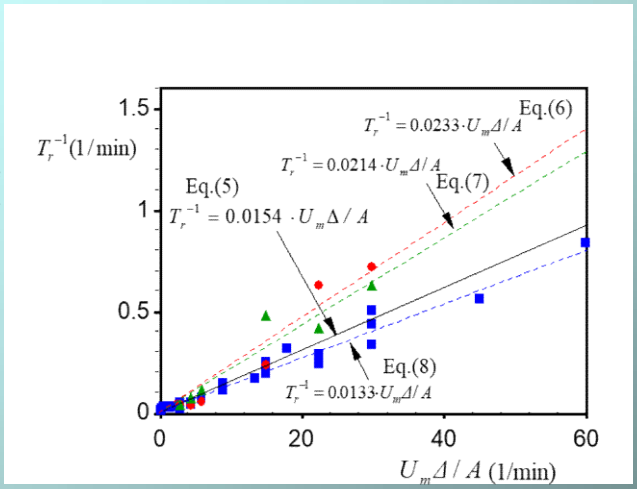
Figure shows an example of the time variation of DO within the natural embayment in the partially open case (June) and in the blocked (closed) case (February). The results indicate that a daily oxygen cycle exists irrespective of the opening condition. During nighttime, the respiration of aquatic plants, fish, etc., significantly reduces the DO because of the lack of photosynthesis.

By contrast, photosynthesis and interfacial transfer from the air increase the DO during the daytime, with the result that the DO recovers, reaching a maximum around 1:00 pm to 2:00 pm. The mean DO value is much smaller in the closed case than in the partially open one. The saturated DO value also is generally larger in colder water. Thus, larger DO values are expected during the winter season, which corresponds to the closed case. However, the lack of mass exchange with the mainstream and the very slow circulation actually induce a hypoxic environment in the embayment.





We conducted laboratory experiments in a 16m-long, 40cm-wide, 50cm-high, circulating, tank-type channel. A sketch of this model embayment is shown in which B = 20 cm is the main-channel width, and Δ is the length of the opening. The embayment zone, which is a square L = 20 cm on a side, was situated 10 m downstream from the inlet honeycomb. Mass and momentum exchanges occur through an opening on the downstream side of the mainstream/embayment boundary. We varied the opening length systematically by using a 3 mm-thick acrylic plate from Δ = 1 to 100 mm (Δ/L = 0.5% to 50%).



Analyzing the DO recovery rate, this study could obtain experimental formulae for the different opening positions.

Please see the detailed information in the following article.

M. Sanjou, T. Okamoto and I. Nezu, Dissolved oxygen transfer into a square embayment connected to an open-channel flow, *Int. J. Heat and Mass Transfer*, 125, 1169-1180, 2018.