Practical evaluation of ICT smart automated sluice gate for paddy fields from the aspect of an additional function of ponding water temperature control

Masaomi Kimura (The University of Tokyo)
Wenpeng Xie (The University of Tokyo)
Katsunori Shimomura (Enowa Co., Ltd.)
Takeshi Tsuchi (Mie University, Tarafuku Rice Farm)
Kishin Kusumata (Dope Japan Co., Ltd.)

Recent trends in Japanese rice farmers (MAFF, Japan)
➢ Decreasing number of successors
➢ Aging of farmers
➢ Aggregation of farmland

Working hours in paddy farming in Japan (per 10 a)

High temperature damage to rice grain ripening
- Reduced farmers' income by degrading rice quality
- Caused by high temperature of air and irrigation water
- Climate change may magnify the damage

ICT devices for smart paddy water management
◆ Monitoring
◆ Remote/Automated operation

High temperature damage to rice grain ripening
- Field experiments focusing on the effect of scheduled water management by utilizing ICT automated gates on mitigating the water temperature rise
Experimental paddy plot A (Toyama pref.)
➢ IoT smart sluice is installed at an inlet.
➢ Accessibility to relatively cool and large amount of water from its mountainous basin

Experimental paddy plot B (Mie pref.)
➢ Lower accessibility to cool and large amount of water
➢ IoT smart sluice is installed at an outlet as well as an inlet.
➢ Scheduled gate operation

Observed results in plot A
◆ Inflow discharge and water depth
◆ Water temperature profile

Inlet IoT smart sluice at plot B
• Inlet gate open: 18:00 to 10:00 (from 13 Jul.)
**Observed results in plot B**

- Inflow discharge and water depth
- Water temperature profile

**Heat balance model in paddy field**

Heat balance model along vertical direction (air – plants – ponding water)

**Verification results (Plot B)**

(Data of rainy days were excluded.)

**Verification results (Contd.)**

Water temperature at outlet of paddy plots

**Scenario simulation results**

- Influence of water depth on water temperature variation
- Efficiency of irrigation for water temperature reduction
Conclusions

➢ Field experiments were performed in two paddy plots in different regions in Japan, where ICT automated gates were installed at each inlet.

➢ Spatio-temporal variation of ponding water temperature was observed.

Observed results:
- Firm reliability of remote scheduled ICT automated gate management
- Effect of scheduled water management by utilizing ICT automated gates on mitigating the rise in water temp.
- Efficiency of deployment of the ICT automated gates strongly depends on the availability of irrigation water at the installed plot.

Simulated results:
- The shallower the ponding water is, the lower the water temperature gets at night.
- Quantitative estimation of effects of irrigation on cooling ponding water temperature

Suggestions

➢ Beneficial paddy area per one ICT gate must be increased.

➢ Aggregation of farmland and development of inlet distributor e.g. Baffle Distributor, which can provide uniform amount of water regardless of water level in branch canal would be necessary in the future.

Conception design of irrigation system

Remote-controllable gate

Inlet

Main canal

Branch drainage canal

Branch canal

Paddy plot

Remote-controllable gate

Paddy plot

Remote-controllable gate

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