Development of a cross-scale and cross-sector adaptation assessment model integrating agriculture and water resources fields: A case study of regional to local scale

MOST 科技部 Ministry of Science and Technology

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AGU 100 ADVANCING EARTH AND SPACE SCIENCE

Purpose

The purpose of this study is to develop an integrated model, **AgriHydro**, and to operate with **Climate Adaptation Algorithm (CAA)** in order to form the pathway and to support decision-making. Therefore, the targets of this study are:

1. **Develop AgriHydro with feedback mechanism (interdisciplinary).**
2. **Demonstrate how AgriHydro operate as a tool with CAA.**
3. **Show the potential future development of AgriHydro.**

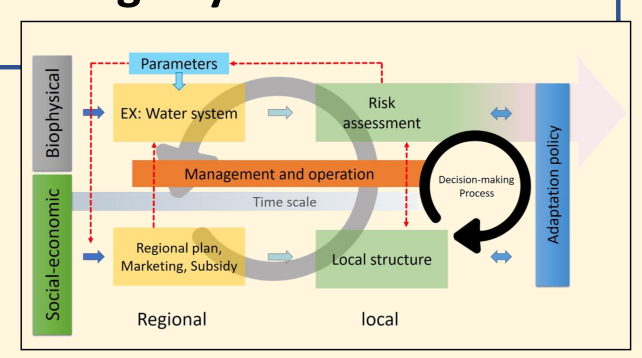

Fig.1 Two main Feedback Cycles.

Method & Sub-model

GWLF

Shimen Reservoir Inflow (RCP85)

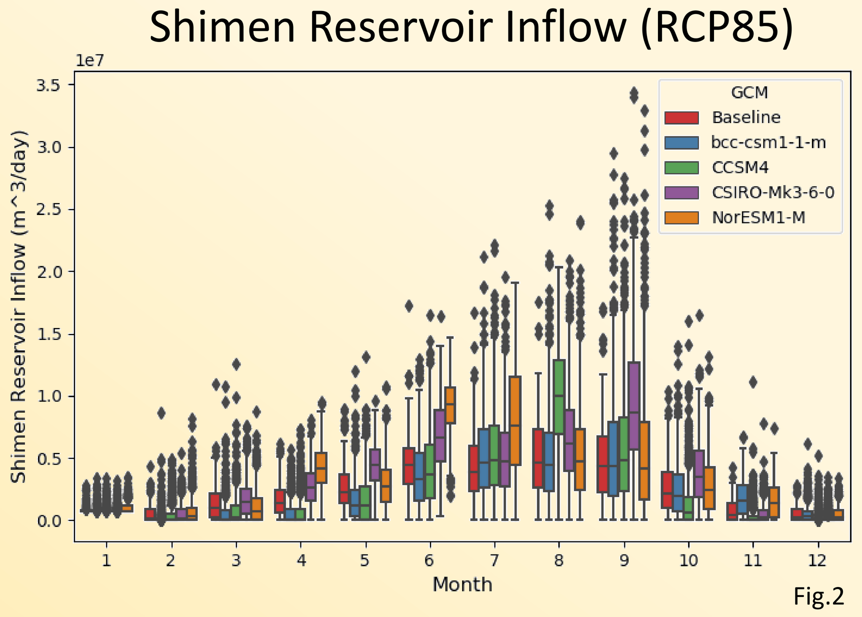

Fig.2

Research Area: Taoyuan City

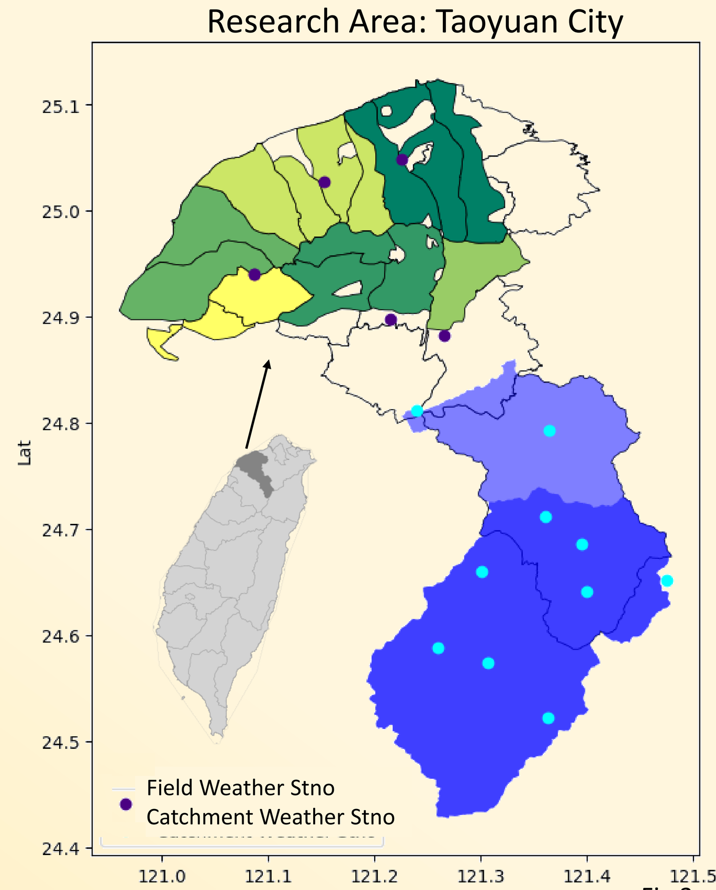

Fig.3

GWLF model shows good performance at tenday scale (RMSE: 21.12 CMS, CE: 0.92, year: 2008-2017). Fig.2 is the monthly trend of RCP85 over 2021-2040, which the inflow increase during summer and decrease in winter.

Multi-site Weather Generator $V = \gamma \times W \times RN + RN$

This study used multi-site weather generator (WG) to downscale the GCM data. We applied Richardson type multi-site WG (Khalili et al. 2009) and added climate scenarios modular into WG. The performance of the 7 weather stations simulation result is shown in fig.4 and fig.5. Overall, it performs well while underestimates the interstation correlation.

Spatial Autocorrelation

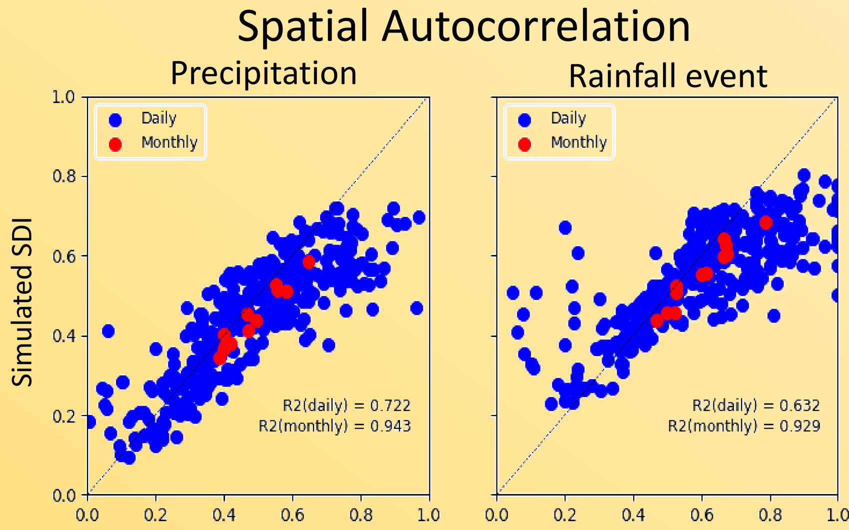

Fig.4

Interstation Correlation

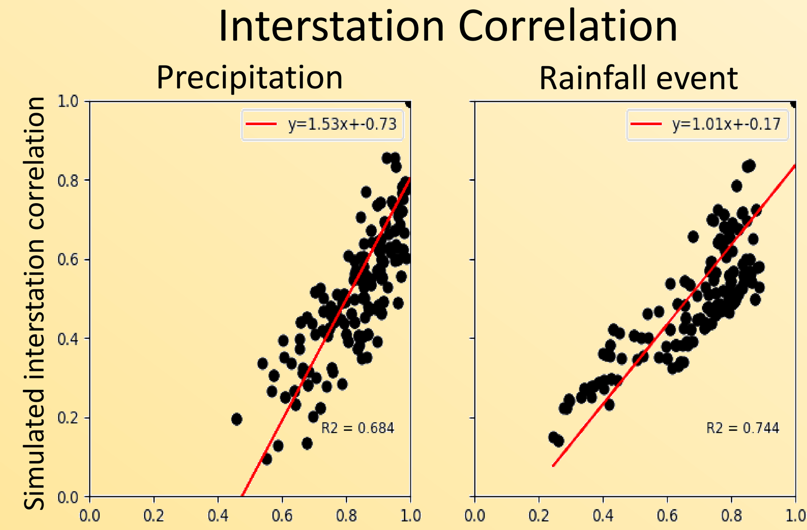

Fig.5

AgriHydro

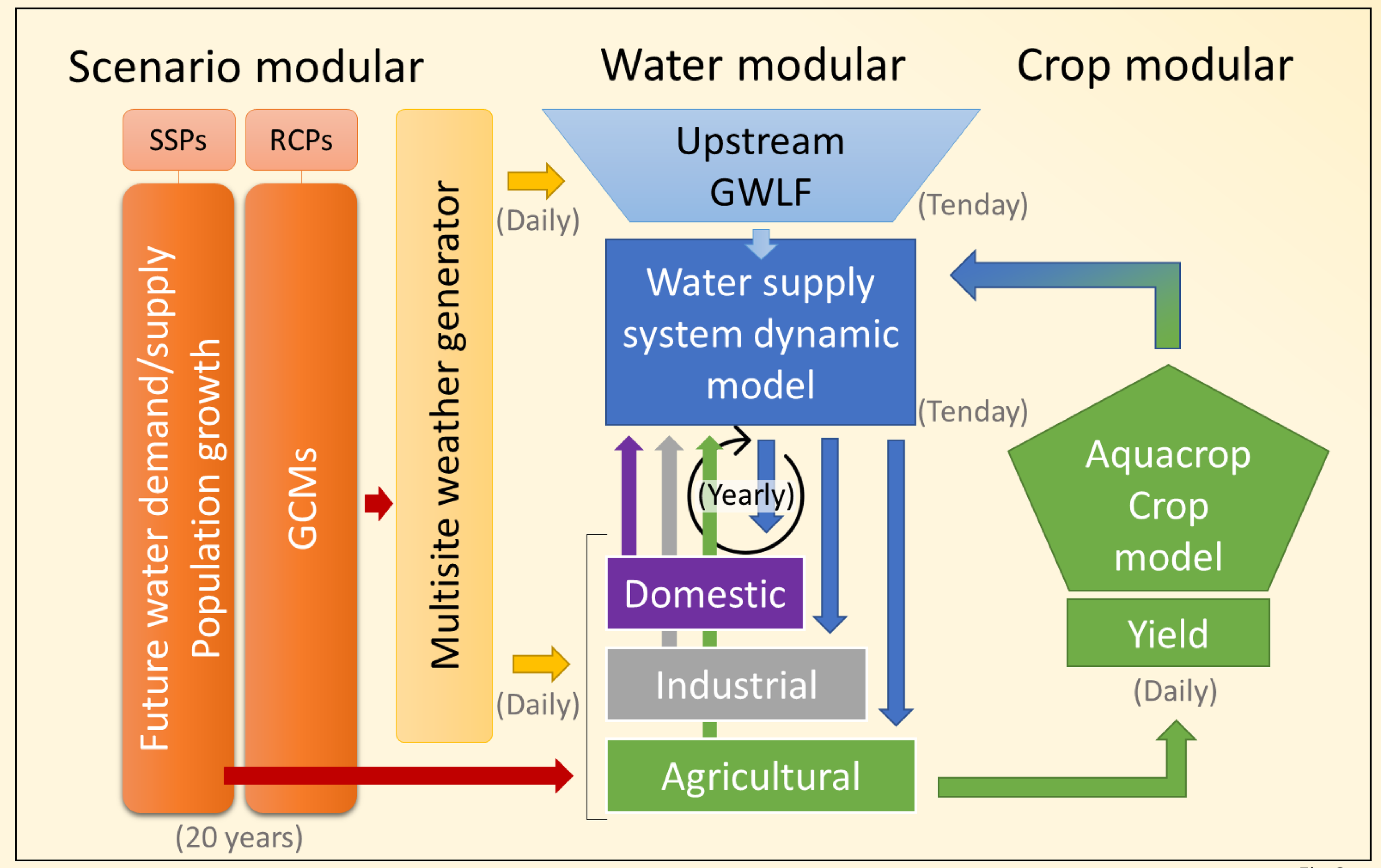

Fig.6

Climate Adaptation Algorithm

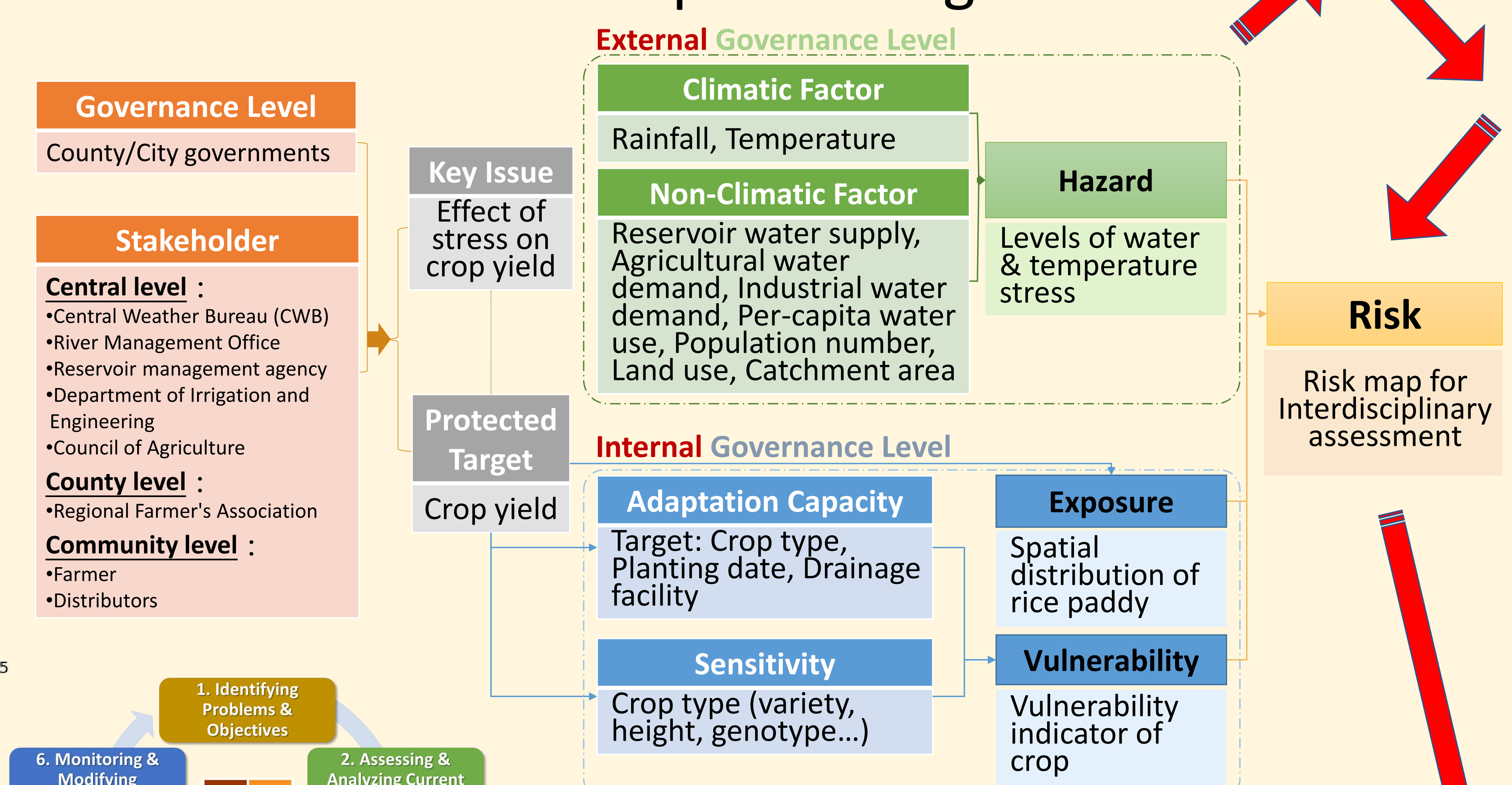

Fig.7 Risk template

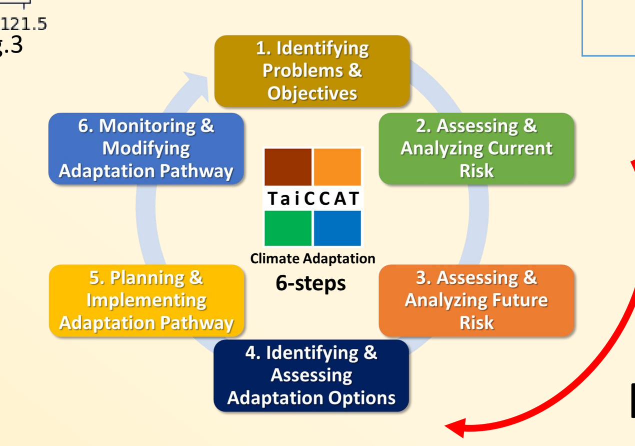

Fig.8 6-steps

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Conclusion & Future work

This study developed integrated model, AgriHydro, and demonstrated how it conducted scenario-based climate adaptation assessment along with CAA. The future vision of this study is to :

1. Include economic model (trade, market).
2. Embed decision-making process (second feedback cycle) which will affect such as land use change and effectiveness of adaptation strategies.
3. Form Dynamic Adaptive Policy Pathways (Haasnoot et al., 2013; Kwakkel et al., 2016).
4. Combine with short-term forecasting model.

AquaCrop

Fig. 9 & 10 show the water demand of 2nd growing period relies more on irrigation, while 1st growing period faces more water shortage in later analysis.

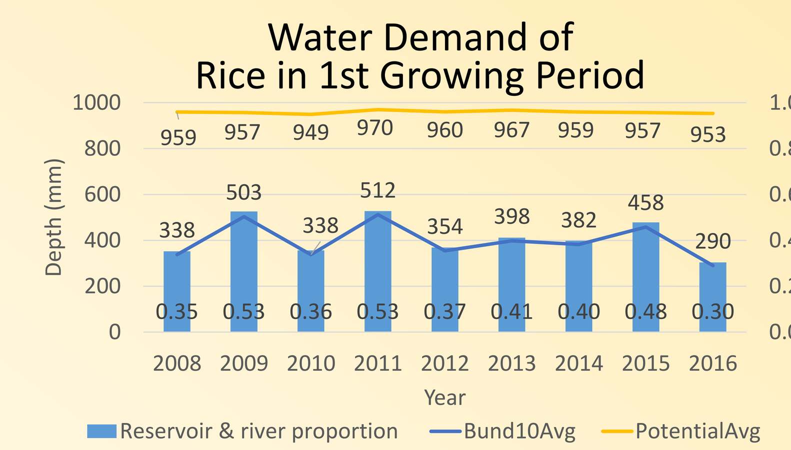

Fig.9

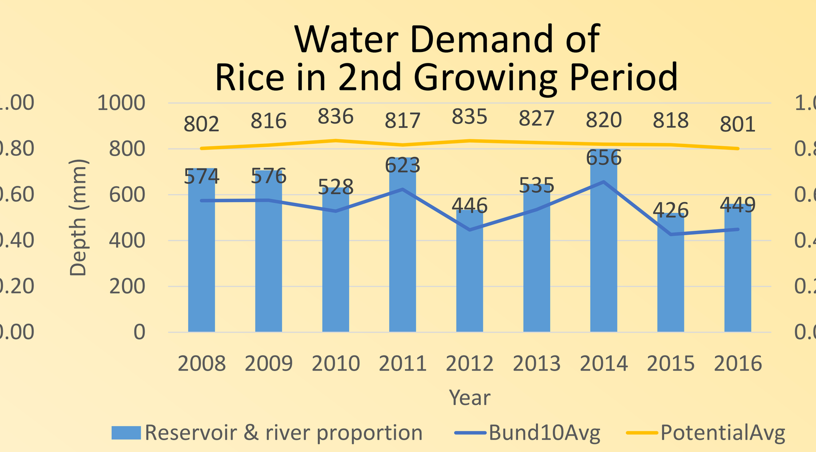

Fig.10

Key Result

Indicators

1. Shortage Index (SI) $= \frac{100}{N_{year}} \sum_{i=1}^{N_{year}} \left(\frac{Deficiency_i}{Demand_i}\right)$

2. Yield Reduction Ratio (YRR) $= \sum_{field,\ crop\ type,\ planting\ date} \left(\frac{Potential - Actual}{Potential}\right)$

1. Future Trends

Risk Map (Baseline)

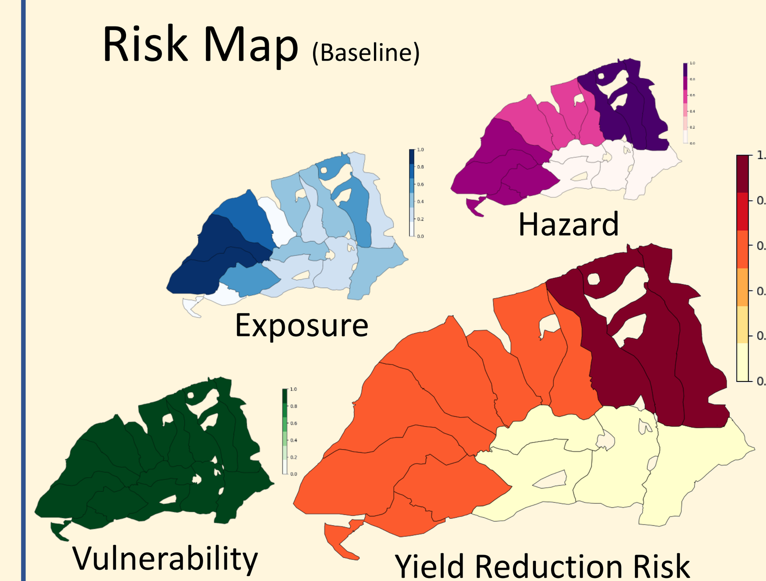

Fig.11

Baseline and Near Future (2021-2040) SI Comparison

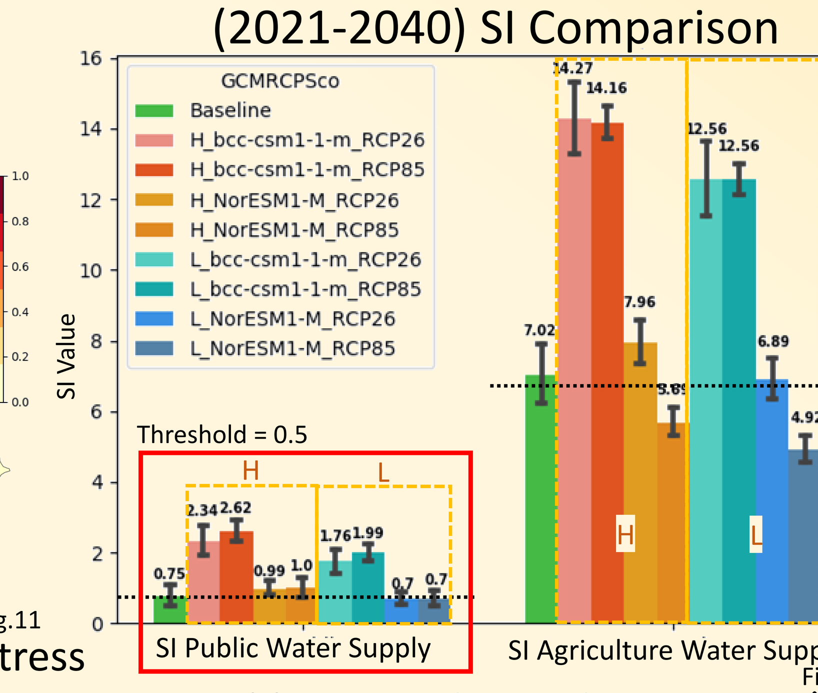

Fig.12

Hazard: Temperature & water stress

Exposure: Planting area

Vulnerability: Crop type (Rice=1, soybean=0.5)

H: Public water demand => 22.74%↑

L : Public water demand => 12.11%↑

2. Effectiveness of Adaptation Options

AgriHydro interdisciplinary model indicates the effectiveness of different adaptation options, either trade-offs or synergies, among different disciplines. The trade-off example of public water SI and agriculture YRR under NorESM1-M_RCP85 (2021-2040) is shown in fig. 13.

Effectiveness of Adaptation Options

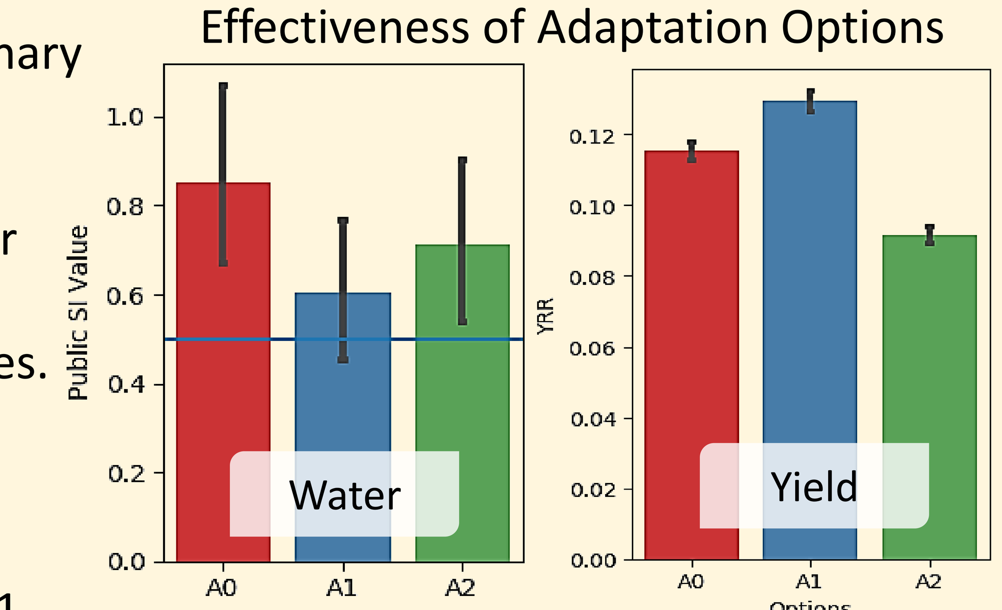

Fig.13

A0: All rice (original status),

A1: 50% soybean in 2nd growing period,

A2: 20% soybean in 1st & 2nd growing period.