Effects of temperature and precipitation on the irrigation water requirements for Terantang irrigation units in Barito Kuala, South Kalimantan, Indonesia under future climate scenarios

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1. Background and Purposes of This Study

The irrigation water requirement (IWR) is the amount of water that must be supplied to a crop via irrigation to achieve optimum crop growth. Global factors such as climate change i.e., increasing temperatures and fluctuations in precipitation are increasing stress on agricultural systems and drive variations in the IWR (Zhang, Wang, & Niu, 2019).

An objective of this study is to conduct an analysis of how the IWR responds to climate change (CC) associated with variations in temperature and the pattern of precipitation under representative concentration pathways RCP 4.5 and 8.5 simulated by Coupled Model Intercomparison Project (CMIP5) in IPCC.

2. Research Methodology

The Penman-Monteith equation and crop coefficient approach recommended by the FAO are used to calculate the IWR. This study applied a standard method of estimating future local paddy IWR. Four Global Circulation Models (GCM) Access1.0, CNRM-CM5, GFDL-CM3 and MRI-CGCM3 are used to predict the future climatology parameter. Scenarios used to produce the simulation are two scenarios, RCP 4.5 and RCP 8.5. The simulations cover period from 1979 to 2005 (historical run) and from 2041 to 2100 with CMIP5 under 2 scenarios. To understand the changing value in temperature and precipitation, the projected changes in both variables are analysed for two periods: the 2050s (2041-2060) and the 2090s (2081-2100) relative to the 1979-2005 climatology historical data.

3. Results and Discussion

Figure 1 shows that observed values of monthly average temperature are higher than simulated values in both scenarios. A historical data shows that a minimum temperature appears in July, but the simulated result shows in August. In the study area, the minimum simulated monthly average temperature in August is observed to be 18.57 °C under RCP 4.5 in 2090s and 20.13 °C under RCP 8.5 in 2090s. In addition, the simulated maximum value is expected to reach 19.55 °C under RCP 4.5 and 21.21°C under RCP 8.5. This condition occurs because the location of Barito Kuala is under the equator line where a gradual decrease in temperature is predicted by the IPCC. Compared to Japan where located upper the line, it was expected that the average values of annual mean temperature would increase with a rate of 1.89°C from current condition to 2090 under RCP 4.5 by MRI CGCM3 model (Kanno, et al., 2019).

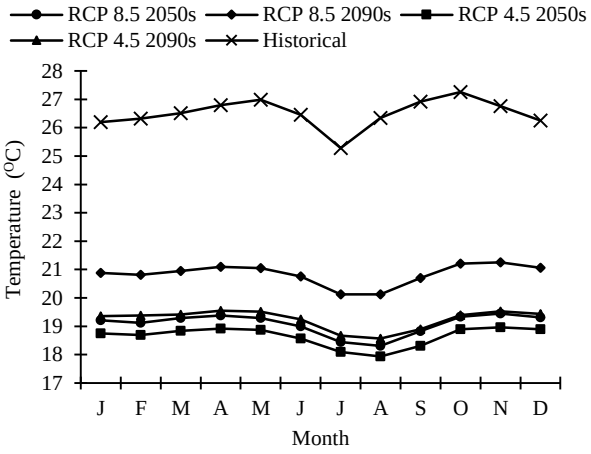

Figure 1. Observed historical value and future simulation of average monthly temperature.

Figure 2 shows the peak observed precipitation in December with the depth of 12.04 mm/day, but the peak simulated precipitation is changing according to the scenarios. In January, it is observed that maximum precipitation depths are 10.15 and 9.76 mm/day in the 2050s and 2090s respectively under RCP 4.5, on the other hand, 10.18 mm/day in the 2050s and 11.20 mm/day in the 2090s under RCP 8.5. Since the climate of Indonesia is entirely tropical, it has two seasons: dry and wet seasons. Dry season usually starts from April to September, being likely to receive increased precipitation in the future with respect to the baseline values. When comparing to the wet season, the historical value for each month is higher than simulated value. This condition will have some impacts on the future IWR.

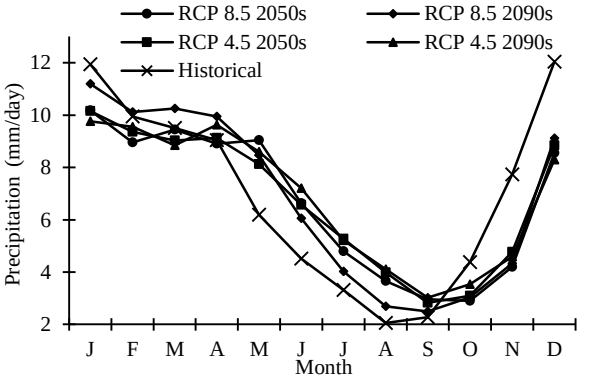

Figure 2. Observed historical value and future simulation of average monthly precipitation.

Future temperature and precipitation simulated under two scenarios results in a slightly different on the pattern as mentioned above. These two parameters are key values to generate an evapotranspiration which is also a dominant parameter of water requirement for irrigation. **Figure 3** shows the same pattern of present IWR compared to 2050s and 2090s under RCP 4.5. In this graph, it is observed that water demand in 2050s is higher than that of 2090s. Moreover, maximum water demand is reached in the first period of September for all three cases.

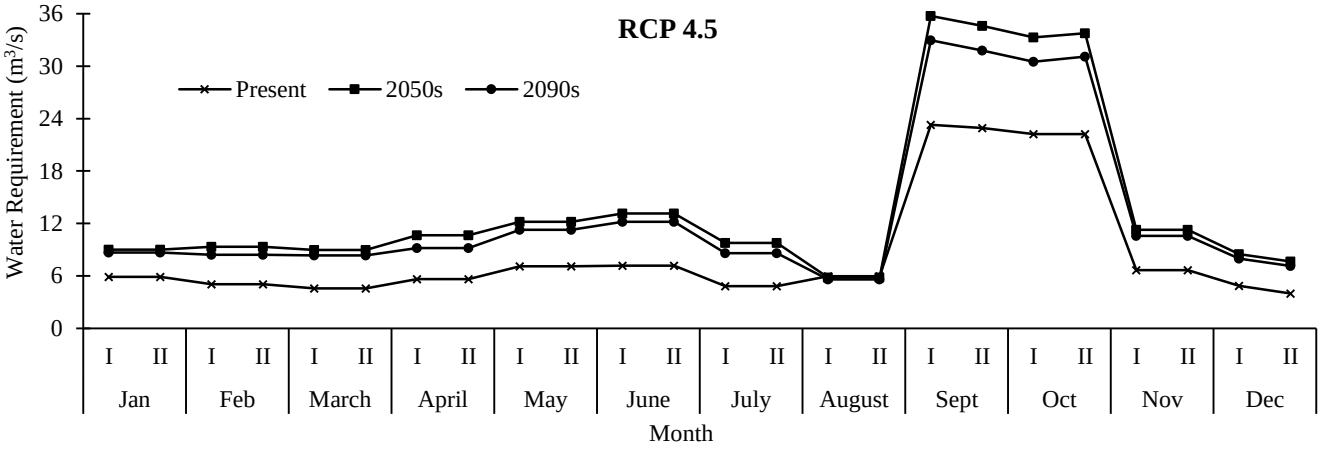

Figure 3. Present and future simulation under RCP 4.5 of irrigation water requirement in Terantang, Barito Kuala.

Figure 4 presents the IWR under RCP 8.5 scenario. In this scenarios, the water requirement pattern is slightly different in May and June where the result of 2090s is higher than 2050s. These differences may appear due to the result that the different pattern of simulated precipitation value under RCP 8.5 in 2090s is lower than 2050s. Therefore, the aforementioned results describe that the effective precipitation in 2090s will be lower than 2050s. This in turn leads to increase in water requirement for May and June in 2090s.

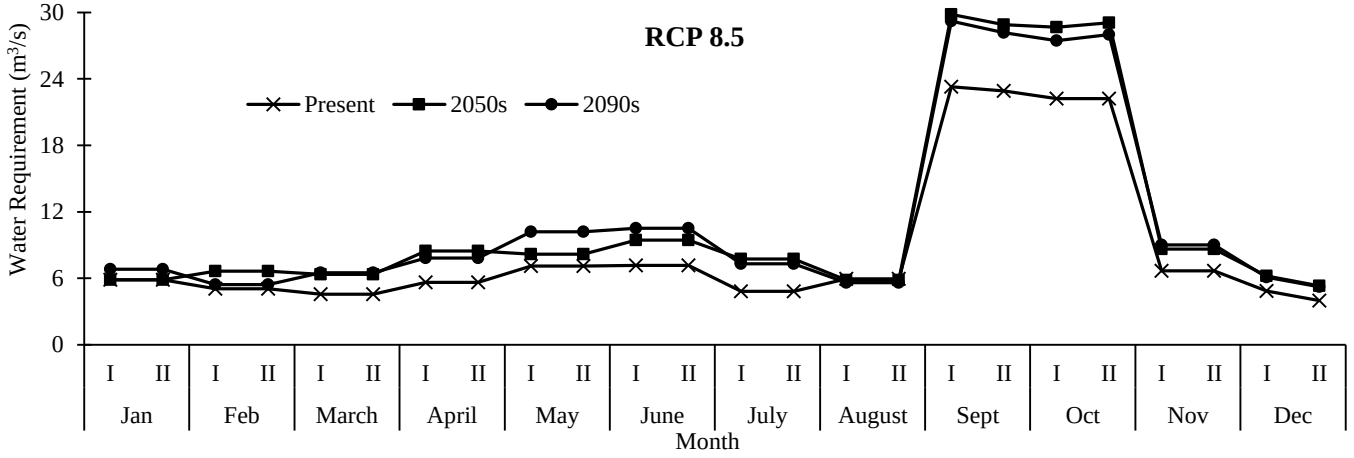

Figure 4. Present and future simulation under RCP 8.5 of irrigation water requirement in Terantang, Barito Kuala.

4. Conclusion

1) The result found that the future average temperature will decrease compared to the present. However, the 2090s temperature is higher than 2050s under RCP 4.5 and RCP 8.5. The average future precipitation is likely to increase in dry season but decrease during wet season in the 2050s and 2090s under both scenarios.
2) Irrigation water requirement is projected to increase in the future for both scenarios, although there is a slight difference between RCP 4.5 and RCP 8.5 due to the precipitation values. The increase requirement for water in May and June under RCP 8.5 is caused by effective amount of precipitation.

5. References

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