Progress of Irrigation Sub-group of the ICCAP in FY2004

Irrigation and Drainage Sub-group

1. Introduction

We summarize each activity of the ICCAP irrigation sub-group in section 2. Details of each activity could also be obtained from personal reports. In this report, we will show our latest progress towards integration of activities by preliminary off-line simulation, using pseudo warming data.

2. Summary of activities and main outcomes in FY2004

2.1 Monitoring of tertiary canals in the LSIP

1) We initiated monitoring of two tertiary canals in the LSIP.
2) Reference water budget of two canals were obtained.
3) We were not successful in quantifying irrigation amount of each land use.
4) Transport loss was estimated to be 35-45% of irrigation amount.
5) Field application efficiencies for major crops were obtained by Dr. Önder and his group.

2.2 Development of GIS for the LSIP

1) Soil maps and shallow groundwater observation points were super imposed.
2) Topographic information is being purchased.
3) Canal and drainage networks are not yet fully input.

2.3 Monitoring of Salinity prone area in the LSIP

1) Based on GIS above, we carried out field survey to assess present state of salinity problem in the LSIP.
2) We set up two transects for continuous monitoring and set up twelve observation wells.
3) We tried measurement of soil salinity with two devices i.e. TDR and EM38.

2.4 Development of Irrigation Management Performance Assessment Model

1) Modules for canal networks, crop water use and groundwater balance were developed. Drainage module is under development. Dr. Hoshikawa is modifying and updating the model continuously.

2.5 Analysis of Efficiency of WUA

1) Addressed the relative efficiency of WUA management by suggesting alternative composite efficiency index.
2) Applied data envelopment analysis to compare efficiency levels with management-, engineering- and welfare-focused models. The analysis revealed that some WUAs are suffering from unfavorable management practices and there is a scope for major reorganization.

2.6 Generation of Future scenario

Although this point was mentioned in the activity plan, no substantial progress was obtained.

3. Preliminary off-line simulation

3.1 Basic concept of evaluation

Irrigation can be viewed as a system which maintains balance between i) water resource, ii) crop response and iii) land use which would be influenced by social change and climate change (see Fig.1.) Adaptation capacity of the irrigation system can be thought as flexibility of the system to maintain balance between these factors. We can represent social influence in land use pattern and various efficiencies related to management. The virtue of the IMPAM, being developed by Dr. Hoshikawa, is that it is not only flexible enough to simulate effect of climate changes, but also capable of expressing mixed land use and specific management losses, and their synthesized effect on water budget as a district. Therefore we have a freedom of testing many scenarios of land use and technological advance to evaluate substantial flexibility of the present system.

3.2 Methodology of the simulation

3.2.1 Tested area and situation of irrigation

To have realistic simulation, we needed to calibrate the IMPAM to the irrigation district with detailed water budget known. For this reason, we have chosen tertiary canal YS 7-1-1 on the left bank.

3.2.2 Land use and condition of irrigation in the command area of YS 7-1-1

Of the 80.6ha of command are of YS7-1-1, citrus gardens and seedling garden dominates (35.6ha and 11.5ha, respectively) followed by maize field (25.6ha). There are one plot each of melon field (5.1ha) and vegetable field (1.9ha). From the monitoring, we have found that substantial amount of water used for irrigation (irrigation intake − tail water) was three times the amount of irrigation recommended by DSI irrigation book. Unit irrigation amount and interval days shown in Table 1 were derived from DSI irrigation book. Transport and application loss rates were assumed to be two times of actual field application intake. In case of improved efficiency, we assumed that loss quantity would become half.

3.2.3 Conditions for simulation by the IMPAM

Calibration and simulations were carried out in the following order.

1) Calibrate IMPAM to present land and water use condition of the monitored tertiary canal in 2004.
2) Run the model on regionally downscaled reanalysis data of 1999.
3) Run the model under pseudo warming climate of the 2070's with present irrigation scheme and efficiency.
4) Run the model under pseudo warming climate of the 2070's with present irrigation scheme and improved efficiency.

3.2.4 Handling of canal and drainage in the Model

Since we did not have enough time to precisely determine canal density and drainage density in the command area, we gave virtual values. For irrigation canal, we gave 0.02m m-2 for grids where canals were actually passing. For drainage, we gave 0.02m m-2 to all grids. But it turned out that drainage density was excessive.

3.3 Results and discussion

3.3.1 Conceptualization by the model

Figure 2 shows how actual plots were conceptualized to grids. Calculation was carried out for each grid of 50x50m.

3.3.2 Given climatic data and calculated PE

Figure 3 shows potential evaporation calculated by climatic parameters used in the simulation. Compared to PE calculated using observed meteorological data of 1999, PE (reanalysis) tended to give larger values throughout the season with greater fluctuation. PE (pseudo warming) was generally greater than PE (reanalysis). The difference is shown in Fig. 4.

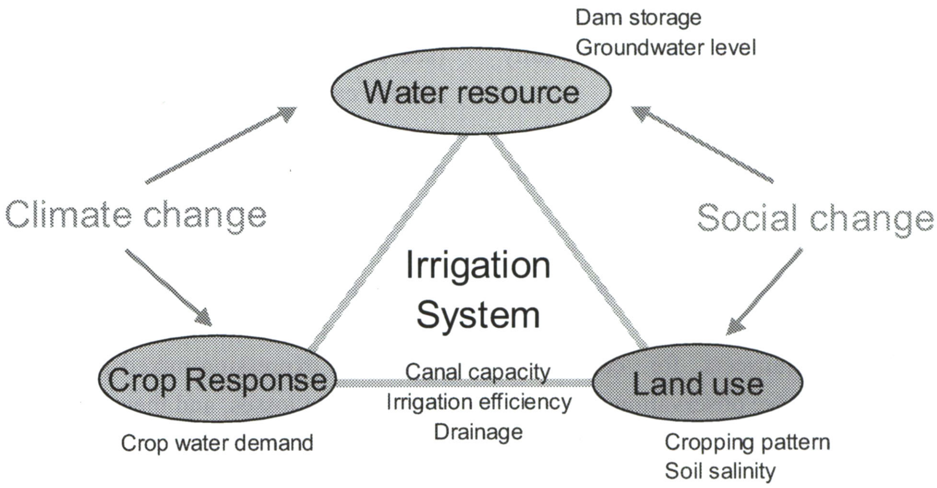

Fig.1 Irrigation as a balancing system

Table 1 Assumed irrigation amount for each crop

Crop Name	Sowing date	Harvest date	Growing days	No. of irrigation (times)	Interval (days)	Unit irrigation (mm)
Citrus garden	13-Feb	31-Dec	321	6	22	110
Seedling	13-Feb	31-Dec	321	6	22	88
Maize	15-Apr	31-Aug	138	5	14	114
Water melon	15-Mar	31-Jul	138	5	12	62

Table 2 Results of simulation by the IMPAM

Condition	2004 Observed	1999 Reanalysis	2070's P.W.	2070's P.W.
Irrigation	455.8	455.8	455.8	455.8
Precipitation	572.9	276.8	236.2	236.2
Seepage	918.2	918.2	918.2	459.1
Total In	1946.9	1650.8	1610.2	1151.1
Actual E	262.2	289.4	297.5	296.4
Actual T	530.9	644.0	696.8	697.4
Drainage	1011.7	994.4	988.1	547.5
Total Out	1804.8	1927.8	1982.4	1541.3

3.3.3 Simulation results

Table 2 shows simulation result. Since drainage density was assumed too high, residence time of infiltrated water was too short. During simulation period, groundwater level continued to lower instead of showing two peaks in the actual situation. Excess drainage also it resulted in inconsistence of total input and output of the system. This point needs to be improved. There was a substantial increase in transpiration in the 2070's. However, soil evaporation did not increase. In comparison of two different seepage cases in pseudo warming, evapotranspiration did not show any difference. This suggests that soil is enough wet with even half amount of actual seepage. It seems that there is just too much water applied at present.

As a result of assuming same land use pattern in the future, the increase in irrigation water demand due to climate change seems to be within range of adaptation, if irrigation management would be improved.

Figure 5 shows T and ET from two representative land uses which are maize and citrus garden. There is a big decrease in ET in May which was probably attributed to cut down in water supply after the end of rainy season when irrigation was not yet started. This big decrease would probably be modified if drainage density were more realistic. Figure 5 also illustrates the feature of the IMPAM very well. The IMPAM is capable of calculating realistic evaporation from non-cultivated plots, affected by groundwater fluctuation of the district. Effect of mixed land use was otherwise difficult to evaluate by the previous models.

4. Conclusion

This preliminary off-line simulation proved that the IMPAM is capable of representing change in cropping pattern and management efficiency reflecting socio- economical aspect of the agricultural system. It was also proved that the model is capable of calculating, lumped effect of different land use and water budget with given climatic data.

5. Future works

After calibrating the model for better representation of the water budget, we will try to up scale the model to cover the whole LSIP. We have very detailed and accurate records of shallow groundwater fluctuation provided by DSI. If the IMPAM can represent this change, upstream-downstream relation can be analyzed. This is the specialty of Dr. Umetsu. We also aim to incorporate salt movement module into the IMPAM so that we would be able to consider problems in development of coastal areas of the LSIP.

We now need a number of realistic scenarios for future trend of land-use and irrigation technology. With these scenarios, climate change data and reservoir water availability, we can carry out variety of sensitivity analysis to find out true adaptation capacity of the LSIP.

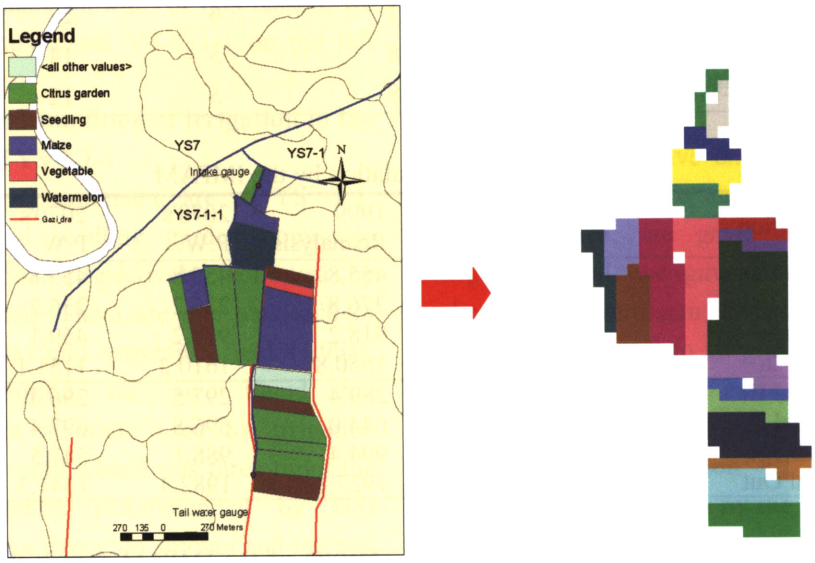

Fig. 2 Conceptualization of the real system into grids of 50x50m

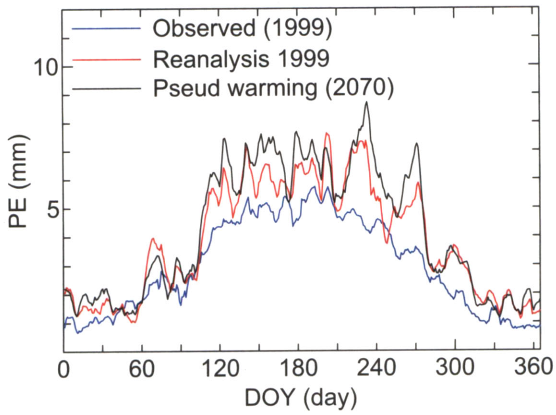

Fig.3 Comparison of daily PE

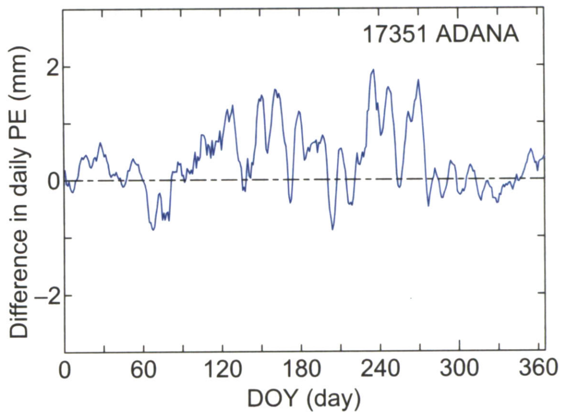

Fig. 4 Difference in daily PE
(P.W. 2070's-reanalysis 1999)

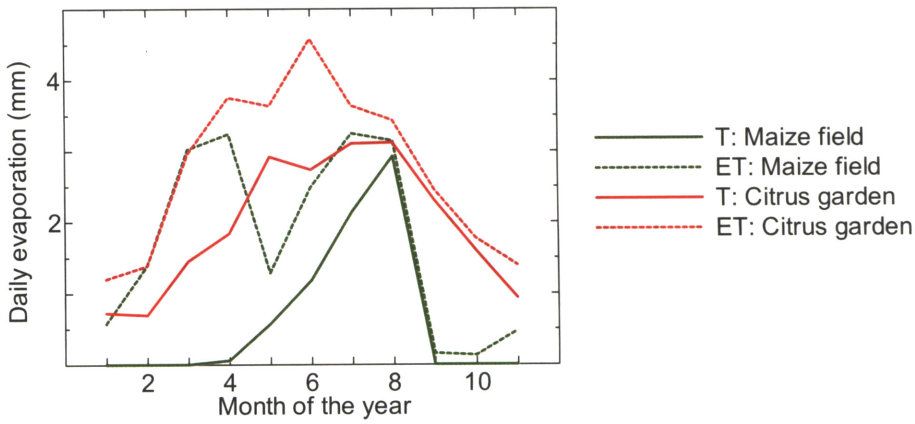

Fig. 5 Calculated T and ET of major land use in YS7-1-1