Chapter 5

Conclusions and Recommendations

Spatial water productivity for irrigated agricultural systems in Chiang Mai - Lamphun valley was investigated by employing data management, spatial analysis and display capacity of GIS together with a set of customized tools developed in this study that utilize programming objects of GIS.

The geodatabase was designed by using the Unified Modeling Language (UML) to define its data structure of land and water resources and relationships between object classes. The core class of this geodatabase was land mapping unit (LMU), a homogeneous polygon land unit from which land use type, climatic, soil, irrigation, and economic data can be accessed for estimating water balance and water productivity of LMUs, irrigation zones and irrigation projects. The components of irrigation layer were also designed to describe the irrigation project structure.

The customized tools were developed with a user interface in Thai and English language by using ArcObjects modules and Visual Basic programming to facilitate the analysis and displaying the results of water productivity assessment and their components in four large irrigation projects in the study area. These tools were developed as the extension modules that have to run with ArcMap in the ArcGIS system.

Spatial distribution of water requirement in the irrigation projects were estimated for each LMU following the FAO Penman-Monteith equation. The Mae Kuang irrigation project required highest amount of water supply expressed as m^3 due to its extent of the cultivated areas, followed by Mae Ping Kao, Mae Taeng, and Mae Feag-Mae Ngad irrigation project. However, in the dry season, Mae Kuang irrigation project required lowest quantity of irrigation water because most land was used for single crop of rice due to the unfilled reservoir at the time of this study. Although Mae

Ping Kao irrigation project covered smallest irrigated areas but water requirement in the dry season was higher than other projects since longan was extensively planted, they covered about 75 percent of irrigated areas. The Mae Feag-Mae Ngad was another irrigation project that required relatively high yearly water requirement expressed in mm. because of its intensive cropping systems. Water requirement for agriculture was greatly reduced in the central zone of Mae Taeng irrigation project due to conversion of crop land to urban areas.

The results of this study suggest that water productivity on the annual basis of Mae Ping Kao was the highest (3.87 baht/m^3) among four major irrigation projects, partly from high productivity of longan production and better irrigation efficiency, followed by Mae Kuang (2.76 baht/m^3), Mae Taeng (1.31 baht/m^3), and Mae Feag-Mae Ngad (1.23 baht/m^3) irrigation projects. Relatively high water productivity in Mae Kuang irrigation project was also contributed by the net return from orchard particularly mango and longan. Relatively low water productivity in Mae Taeng irrigation project was caused by the unproductive vacant land in the middle part of the project and low irrigation water efficiency. Although Mae Feag-Mae Ngad irrigation project generated higher net return from cropping activities than Mae Taeng irrigation project but during the study period the project overly supplied irrigation water hence reducing its water productivity.

The comparison of water productivity for rice growing areas in the rainy season among different irrigation projects suggested that Mae Kuang irrigation project had highest water productivity (2.50 baht/m^3) followed by Mae Ping Kao (2.01 baht/m^3) because of higher irrigation efficiency in both irrigation projects consequently low water consumption. Although Mae Taeng and Mae Feag-Mae Ngad irrigation projects generated higher average net return per area but irrigation water was over supplied resulting in water productivity of about 1.01 and 0.97 baht/m^3. Water productivity assessment in rice cropping areas in the dry season revealed that most irrigation projects yielded higher water productivity than that of the rainy period as the consequence of increasing yield and net return, couple with effective water use. Water productivity for this condition in Mae Ping Kao, Mae Taeng, Mae Kuang, and

Mae Feag-Mae Ngad irrigation projects were 2.31, 1.88, 1.66, and 1.03 baht/m^3 respectively. When comparing water productivity of longan cropping system across all irrigation projects, it was found that water productivity of Mae Ping Kao irrigation project was the highest (4.11 baht/m^3) due to high irrigation efficiency and high crop productivity followed by Mae Kuang (2.16 baht/m^3) Mae Taeng (1.56 baht/m^3) and Mae Feag-Mae Ngad (1.33 baht/m^3).

A simple scenario analysis can be achieved using a customized tool developed in this study. The tool facilitates the user to change some key factors such as land use pattern, water supply, production costs and prices, apart from water allocation strategies. These tools will be useful to develop a guideline for planning and improving the water productivity in irrigation project.

This study attempted to assess only one component of the water productivity indicator, crop production (bath) per water consumed (m^3). However, many irrigation efficiency indicators such as depleted fraction (amount of water depleted divide by gross inflow) and beneficial utilization (amount of water depleted by all beneficial processes to the amount of water available) are also helpful to assess the irrigation project. The environmental and socioeconomic assessment such as chemical pollution, employment and adaptation to climate change in these irrigation projects are also necessary to expand the scope of the study for the emerging issue.

Further study is needed to provide more detailed data on water delivery and irrigation efficiency along the lateral canals. Water scheduling and distribution of crop varieties are required to evaluate water productivity for each irrigation zone in order to accurately identify areas within the irrigation project where improvement in irrigation water distribution and maintenance are necessary. Research on land allocation is needed to improve land productivity in irrigated areas of these projects to achieve the optimum water productivity in the future.