# EVALUATION OF MULTI-FUNCTIONALITY OF IRRIGATION AND DRAINAGE SYSTEMS IN KOREA USING AHP

## ÉVALUATION DE LA MULTI-FONCTIONNALITE DES SYSTEMES D'IRRIGATION ET DE DRAINAGE EN COREE EN UTILISANT LA METHODE AHP

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**ABSTRACT**

Multi-functionality of agricultural water and irrigation and drainage systems of Korea was identified by AHP method with surveying expert opinions. Major functions identified were 'agricultural water supply', 'multipurpose water supply', 'environmental conservation', 'fostering social culture' and, 'disaster prevention and energy'. The function as agricultural water supply showed significantly higher weight value than the others. Rational share of operating and management cost for irrigation and drainage facilities is current issue in Korea. Relative benefit of each function of irrigation and drainage system to the beneficiaries was calculated and summed up. Based on this calculation, the rational ratio of cost sharing for management of the system by beneficiaries is proposed as follow (100% in total) ; people (nation) 40, region (municipalities) 25, local (village) residents 15, farmers 10, and other users 10%.

**RÉSUMÉ**

La multifonctionnalité de l'eau agricole et des systèmes d'irrigation et de drainage en Corée a été identifié par la méthode AHP en complément avec des avis d'experts. Les fonctions majeures identifiées sont la fourniture d'eau pour l'agriculture, l'approvisionnement en eau à usages multiples, la conservation de l'environnement, la dynamisation sociale et la prévention des catastrophes et la fourniture d'énergie. La fonction d'approvisionnement en eau pour l'agriculture se révèle avoir un poids nettement plus élevé que les autres. Le partage rationnel des coûts d'exploitation et de gestion des installations d'irrigation et de drainage est une question actuelle en Corée. Les bénéfices relatifs de chacune des fonctions des systèmes d'irrigation et de drainage pour les bénéficiaires ont été calculés. D'après ce calcul, le rapport rationnel de partage des coûts pour la gestion du système par les bénéficiaires est proposée comme suit (100% au total) : la population (la nation) 40% ; la région (communes) 25% ; résidents locaux 15% ; agriculteurs 10% et autres utilisateurs 10%.

**Keywords:** Irrigation, Drainage, Multi-function, AHP, Beneficiary, Korea

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## 1. Introduction

In Korea which belongs to the Asian Monsoon climate zone, the rice farming has been the backbone of the agriculture for a long time, and agriculture was virtually whole national industry and farmers were identified as citizens in the pre-industry period. Agricultural water management, construction and maintenance of irrigation facilities, which is essential to increase productivity of the rice farming directly related to the national survival and prosperity were the duty of the country. Under this circumstance, cost sharing for agricultural water management or any social conflict about it did not exist. Recently, the status of agriculture has been in sharp decline due to rapid industrialization and the countryside has changed to space of farming and non-farming population by the increase of rural society's heterogeneity and urban sprawl. Therefore, the direct/indirect beneficiaries are becoming more and more varied according to these changes, the necessity for social discussion about the cost sharing for maintenance and management of agricultural water and its related facilities is rising.

Agricultural water is a basic input for agricultural production activities and the farmer is the biggest beneficiary. But agricultural water and irrigation and drainage facilities can be considered as public goods by assimilating into the waterside ecosystem of rural space. Therefore, responsibility for its sustaining should be shared socially. Now, beyond the agricultural economic perspective that the area would be the agricultural production base, the social awareness of the multi-functionality of the rural area that the area is the space to preserve and develop our culture, tradition, and morals is being spread out (Kim et al., 2006). In this respect, this study considers agricultural water as a component of countryside capital and the concept of 'Countryside Water' is re-defined comprehensively by including multi-function of agricultural water which is necessary for environment, recreation and service industry in rural space.

Korean farmers who have been serviced irrigation from facilities managed by local governments continue to pay maintenance costs, but other farmers who have been serviced irrigation from facilities managed by Korea Rural Community Corporation(KRC) run by government are exempted from water fee and maintenance cost. Due to this circumstances, OECD and other international organizations are regarding this government's share as subsidies and requiring compliance of benefit principle. However, there have been no discussions to solve this problem between nation-municipalities-community-farmers.

The objectives of this study are identification of multi-functionality of agricultural water, irrigation and drainage systems and assessment of beneficiaries' reasonable cost sharing for irrigation and drainage facilities management in Korea based on analysis of benefit using AHP method with surveying expert opinions.

## 2. Research method

Total 11 experts, whose expertise were water resources, irrigation drainage, rural planning, and agricultural economics participated the survey of this study. Fourteen functions addressed in previous study (KRC, 2006) were reviewed by experts group and important functions were selected. By conducting the second experts group survey using pairwise comparison about multi-functions of irrigation and drainage system and AHP (Analytic Hierarchy Process) analysis method, relative importance weight on each function was elicited. And the beneficiaries of agricultural water were decided as people (nation), region (municipalities), local (village) residents, farmers, and other users. Share of benefit among beneficiaries were also determined by survey and AHP analysis.

## 3. Results and Discussion

The detail functions of irrigation and drainage systems were investigated and classified as 5 groups – 17 functions through the first experts' group survey. Those are agricultural water supply (food security), multipurpose water supply (river maintenance, domestic and industrial water supply, aquaculture), environmental conservation (landscape, tourism/recreation, ground water recharge, ecosystem conservation, water purification, climate change mitigation), fostering social culture (balanced development of land, folk

culture preservation, fostering emotion, place of environmental education), disaster prevention and energy (flood control, firefighting water, small scale hydropower generation)**.**
The relative weight of each function after analysis (total 1.000) is as follows; 'agricultural water supply' is 0.466, 'multipurpose water supply' 0.269, 'environmental conservation' 0.136, 'fostering social culture' 0.070, 'disaster prevention and energy' 0.059. So the function as agricultural water supply shows significantly higher weight than the others and this function is proved as the most important one.

<Table> Functionality of agricultural water and irrigation and drainage systems and its relative weight

| class | | subclass | | class | | subclass | |
|---|---|---|---|---|---|---|---|
| function | weight | function | weight | function | weight | function | weight |
| Agricultural water supply | 0.466 | Food security | 1.000 | Fostering social culture | 0.070 | Balanced development of land | 0.170 |
| Multipurpose water supply | 0.269 | River maintenance water supply | 0.298 | | | Folk culture preservation | 0.345 |
| | | Domestic and industrial water supply | 0.608 | | | Fostering emotion | 0.305 |
| | | Aquaculture | 0.094 | | | Place of environmental education | 0.179 |
| Environmental conservation | 0.136 | Landscape | 0.197 | Disaster prevention and Energy | 0.059 | Flood control | 0.673 |
| | | Tourism/ recreation | 0.104 | | | Firefighting water | 0.128 |
| | | Ground water recharge | 0.205 | | | Small scale hydro power generation | 0.199 |
| | | Ecosystem conservation | 0.285 | | | | |
| | | Water purification | 0.146 | | | | |
| | | Climate change mitigation | 0.063 | | | | |

Numerous empirical studies on the multi-functionality of paddy farming have been explored since the 1990s in Korea. The joint production issue has been investigated frequently, however, the other issues of multi-functionality proposed by OECD have been investigated seldom. It is strongly needed to explore various solid empirical evidences in the Korean agriculture to answer the three questions posed by OECD: the existence of jointness between rice production and the multifunctional attributes, the existence of market failures, and non-governmental options for providing multi-functional attributes (Kim et al., 2006)

In Korea, several studies on the multi-functionality of paddy farming have been performed with positive and negative viewpoints. Those were flood alleviation, water storage, Improvement of water quality, soil erosion control, waste disposal, atmosphere purification, reduction of temperature, maintenance of nature scenery (Kim et al, 2006). There are some empirical works which value rural amenity as an individual multi-functional

attribute of rice farming by using either TCM or CVM: Yoon (1996), Lee (1996), RDA (2000), and KREI (2001). Positive externalities of paddy farming in Korea were evaluated in the range of 3,220–15,922 billion Korean Won (W) (USD $3,390–16,730 million as of 2005) depending on the inclusion of multi-functional attributes of paddy farming.

The social benefit of agricultural water and irrigation and drainage facilities was calculated as 29.2 trillion Korean won in this study. And the benefit by beneficiaries was calculated as follows; people (nation) is 12.3 trillion won, region (municipalities) 7.5 trillion won, local (village) residents 3.9 trillion won, farmers 3.4 trillion won, and other users 2 trillion won

Since water fee was exempted operation & maintenance (O&M) cost was provided government and KRC. The cost increase from US$214 to US$339 million at the year of 2000 and 2013. Government sharing of O&M cost was 30% in 2000 and increased up to 57.9% in 2008 and decrease again to 36.6% in 2013. KRC is asking more government budget for O&M cost. In previous study, fair cost sharing of O&M was questioned for farmers, government officials, members of KRC and about 90% of those questioned were in favor of allocating national budget on irrigation and drainage facilities since those are very important infrastructure of the nation. Favored maintenance cost share among central government: local government: KRC: Farmer was 4:3:2:1.

This study revealed that benefit share of agricultural water by beneficiaries (total 1.000) shows as follows; people(nation) is 0.422, region(municipalities) 0.259, local(village) residents 0.133, farmers 0.117, and other users 0.072. By modifying the calculated apportioning ratio, the rational ratio of cost sharing for management of irrigation and drainage systems by beneficiaries is proposed as follows(100% in total); people(nation) is 40, region(municipalities)25, local(village) residents 15, farmers 10, and other users 10. The sharing ratio of farmers 10% could verify that it is the prevailing opinion almost commonly proposed from previous studies.

## 4. Conclusions

The multifunctionality of irrigation and drainage systems was analysed and result(total 1.000) is as follows; ‘Agricultural Water Supply’ is 0.466, ‘Multipurpose Water Supply’ 0.269, ‘Environmental Conservation' 0.136, ‘Social Culture Cultivation’ 0.070, ‘Emergency and Energy’ 0.059. So the function as agricultural water supply shows significantly higher weight value than the others. Relative benefit of each function of agricultural water to the beneficiaries was calculated and summed up. Based on this calculation, the rational ratio of cost sharing for management of countryside water by beneficiaries is proposed as follows(100% in total); people(nation) 40, region(municipalities) 25, local(village) residents 15, farmers 10, and other users 10. The sharing ratio for farmers up to 10% of total cost matched with survey results from previous studies. As this study do not aim to precisely calculate the value of multi-functionality of countryside water, monetary value results of this study should be considered as a probable and tentative one. In addition, this study applied the cost sharing principle that is setting up the single unit in whole nation due to limited study conditions, so additional researches considering more accurate regional variations would be needed.

## REFERENCES

Kim Tai-Cheol, Gim, Uhn-Soon, Kim Jin-Soo, Kim, Dae-Sik 2006. The multi-functionality of paddy farming in Korea paddy water environment. Paddy Water Environ 4:169–179

Korean Rural Corporation. 2006. A study on the multi-functionality of rural water resources (in Korean)

Korean Rural Economics Institute 2001. Valuation of multifunctionality of agriculture. KREI report (in Korean)

Park, S.W., Chung, H.W., 2003. Reconsideration on public functions of paddy and the policy implication. Special report. J KSAE 45(5):17–24 (in Korean)

Rural Development Administration 2000. Research status on multifunctionality of agriculture (in Korean)

Eom K.C., Yun S.H., Hwang S.W., Yun S.G., Kim D.S. 1993. Public benefit from paddy soil. Korean Soc Soil Sci Fertil 26(4):314–333 (in Korean)

Yoon, Y.C. 1996. The evaluation of agricultural functions for environmental conservation and public benefits. Research report of Seoul National University (in Korean)