Economic Value of Water Functioning System of Paddy Field in Sri Lanka

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Abstract

Paddy farming in Sri Lanka can be divided in to tree schemes according to the source of water availability for farming. In addition scale of cultivation depends on the schemes. Naturally paddy field acts as a multifunctional surface due to its structure. Then paddy field helps to mitigating flood, recharging groundwater and purifying water which was determined previous studies. Then, the study focused on estimating economic value of those non-market benefits and find out how does the magnitude effects of those benefits vary within the cultivation schemes in Sri Lanka based on non-market evaluation methods of Replacement Cost Method (RCM) and Contingent Valuation Method (CVM). Primary data was collected by using structured interview method and experiment method. Further one-way ANOVA was utilized to achieve the objective of the study. Further the result shows that the Economic Water Functioning system of Paddy Field is vary within the cultivation schemes and allocated as 172421.8LKR, 63320.7LKR and 32996.66 in major irrigated scheme, minor irrigated scheme and rain-fed scheme respectively per acre.

Keywords: Paddy farming, Economic value, Non-market evaluation, Replacement Cost Method, Contingent Valuation Method, External benefits, water management

1.Introduction

Paddy cultivation areas in Sri Lanka are divided into three Schemes according to the water availability namely, major irrigated, minor irrigated and rain-fed. The major irrigation scheme contains the paddy cultivation areas which are irrigated by irrigation systems with more than 80 ha command areas. The Minor irrigated scheme covered the paddy cultivation areas which are provided the water from the irrigation systems where the command area is lesser than 80 ha including both tanks and anicuts (Nishantha, 2014, DOASl, 2006).One of the intrinsical feature of paddy cultivation is that the fields are usually filled with water. The water percolates through soil; part of them return to the downstream river, stabilizing base stream flow in rivers; parts seep into the ground providing valuable water source during drought seasons which is mainly used for living and industrial purposes. , during rainy period paddy field acts as an artificial wetland to control flood and as a major source of ground water recharge (Tsai, 1993).Ridges surrounding the paddy field helps to prevent or mitigate the damage of flooding (Yoshida,2001). Flood mitigation, fostering water resources, preventing soil erosion, purifying water, cooling air temperature, refreshing atmosphere, Soil erosion and recreation are some positive external effects that are generated by paddy production process (Chiueh, 2008; Huang *et al.,* 2006;Matsuno*et al*., 2005; Yoshida, 2001 and Tsai, 1993).In the context of Sri Lanka, flood mitigation, recharge groundwater level and purification of water can be identified as main social benefits sources of water functioning system of paddyfield. Therefore the study analyzed the economic value of those benefits and how does it vary within the cultivation schemes.

2. Literature Review

Huang *et al.* (2006) have studied on multi-functionality of paddy field in Taiwan that provides information regarding the potential magnitude and monetary value of seven functions of paddy fields including flood mitigation, fostering water, preventing soil erosion, purifying water, cooling air temperature, refreshing atmosphere and recreation. But they did not concentrate on external cost of paddy farming functions. Matsuno *et al.* (2005) and Kim *et al.* (2006) also pointed out positive effects of paddy farming such as flood alleviation, groundwater recharge, water purification, soil erosion control, air purification and climate change mitigation, biodiversity conservation and recreation. The study of Yoshida (2001) under the topic of " An economic evaluation of the multifunctional roles of agriculture and rural areas in Japan "reveals that some positive functions of paddy farming known as flood prevention, conserving water resources, preventing soil erosion and landslides, organic waste disposal, air purification, climate mitigation, and preserving amenities for recreation and relaxation. According to Kim *et al.* (2006) on the impoundable water capacity by land type, measured at 270 mm in the consolidated paddy land (300 mm in bund height, 30 mm in pond depth), 70 mm in the unconsolidated paddy land, 60 mm in the upland and 10 mm in the grassland in Korea. Yoshida (2001) mentioned that due to ridges which surrounding the paddy field helps to prevent or mitigate the damage of flooding and estimated monetary value of water retention function of paddy field was US$ 24.73 billion in flatland, US$ 9.61 billion in hilly and mountain area, and in upland US$ 1.88 billion in Japan.

According to the study of Huang *et al.* (2006) potential monetary value of flood controlled due to paddy farming in Taiwan was estimated at US$ 389 million. One of the most important features of paddy cultivation is that the fields are usually filled with water. The water percolates through soil; part of them return to the downstream river, stabilizing base stream flow in rivers; parts seep into the ground providing valuable water source during drought seasons which is mainly used for living and industrial purposes. A flooded paddy field can also be considered as an artificial wetland and as a major   source of ground water recharge (Tsai, 1993). Korean Institute of Construction and Technology (KICT) (1999) mentioned that 55 Percentage of outflow water returns to the river and helps to improve the river flow and the other 45 Percentage contributes to groundwater recharge. Yoshida (2001) also pointed out that water drawn from rivers to irrigated paddy fields penetrates into the soil, and eventually drains away and returns to the river. Some of this water contributes to the stabilization of flow regimes, while some of the rest penetrates deep into the ground and becomes a part of the groundwater reserves, and has confirmed the above comments through evidence that was obtained from estimating monetary values of this function as contribution of stabilization river flow, volume of groundwater conserved and volume of groundwater recharge by paddy fields were US$ 12.07 billion, US$ 0.658 billion and US$ 0.159 billion consecutively. According to the water balance analysis of paddy fields in the 30 year observation data in the *Yadang* irrigation reservoir, estimated amount of recharged groundwater for the entire paddy field area reached roughly as 8-9 billion m^3. (Kim *et al.*, 2006).

The role of an irrigated paddy field as sources or sinks of pollutants has been assessed in terms of the net outflow load[1]. The paddy fields may be beneficial for water quality, showing negative net outflow load of nutrients (Yoon *et al.* 2003; Kim *et al.* 2005). Kim *et al.* (2005) investigated a 50.1 ha watershed including paddy field as sinks or sources of nutrients during irrigation periods from 1999 to 2003 in Korea. The paddy field during irrigated period acted as sinks of nutrient despite a large amount of fertilization, except during very wet years, due to uptake of nutrients by rice crops, nitrification, and phosphorus adsorption by paddy soils. A paddy field is filled shallowly during the growing season, overlapped with the rainy season and this could help reduce the export associated with soil erosion due to buffer function against the rainfall impact and thereby helping to control eutrophication of the downstream water (Kim *et al.,* 2006a) Soil erosion will be high due to higher amount of rainfall in the rainy season and topography is precipitous. A paddy field has the ability to minimize soil erosion due to flat topography, flooding condition and vegetation. According to Huang *et al.* (2006) the soil erosion prevention function of paddy fields in Taiwan amounted to US$ 433 million. Yoshida (2001) has also emphasized that paddy land helps to prevent soil erosion comparing with other crops and estimated monetary value of soil erosion prevention by paddy land in Japan as US$ 2.851 billion. Not only the above, the researcher has mentioned that continuous paddy cultivation can prevent landslides in high land area through the evidence obtained from Japan. Accordingly the monetary value of prevention of landslide by paddy cultivation was US$ 1.428 billion in Japan.

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[1]Net outflow load = outflow load – inflow load

In the process of paddy growing, air is purified through photosynthesis as it releases O_2 and absorbs CO_2, SO_2, NO_2 etc.(Yoshida, 2001). According to the market price of Oxygen, Yoshida (2001) calculated the monetary value of pollutant air absorbed by paddy fields in Japan as US\$ 0.099 billion. When water evaporates from the surface of paddy fields, it absorbs heat from the surrounding air, lowering the air temperature (Yoshida, 2001). Tan (2004) was able to find a 7.81^0C temperature difference between paddy fields and urban land cover by using the thermal band of Land sat seven satellite images. As said by Yoshida (2001), the monetary value of drop temperature surrounding the paddy field area in Japan was US\$ 0.10446 billion. There were a few researches was carried out on external benefits of paddy farming in Sri Lanka. They have shown some external benefits which have arisen by the process of paddy production. The study carried out in *KirindiOya* irrigation reservoir in the dry Zone by Renault *et al.* (2000), showed that inland fishermen operate 318 days per year, on the average. The fish catch per boat trip averaged about 35 Kg and 1.4 Kg was retained for home consumption. Panabokke *et al.* (2006) revealed positive impacts of irrigation development on groundwater by studying Mau Ara (a stream of Walawe river) diversion project area. According to the results of the study, groundwater levels deplete after May under normal circumstances and irrigation water diversions help to maintain high water levels until dry season. There are many researches in the world arena which could find out, Economic value of water functioning system of paddy field as external benefits which have arisen throughout the paddy farming process. In addition some studies were focused on to estimate the monetary value of water functioning system of paddy field. However, it is hard to find the studies which compare those effects between different farming schemes.

3. Methodology

The quantitative research approach was applied the study by using both primary data and secondary data. Primary data were collected from paddy farmersand experiments. Secondary data were collected from annual reports of Central Bank of Sri Lanka, National Water Supply & Drainage Board Sri Lanka, reports of Department of Census and Statistics in Sri Lanka, Irrigation Department of Sri Lanka, and selected research papers and reports. Experiments of obtaining average depth of standing water in particular paddy field during the raining period and different harvesting stages were conducted in selected measurement points in the particular paddy fields which are located in the *Grama Niladari* Divisions of *Sandhagalathenna, Kithalawa* and *Baddegama* representing major, minor and rain-fed cultivation schemes respectively. The measurement points were selected by dividing paddy fields into three clusters according to the surface elevation. Then ten Points were randomly selected from each cluster. The reduction of water depth in the paddy fields per day is necessary to calculate the water infiltrated rate during the cultivation period. Hence, the water level of the selected point is measured in three different stages of paddy cultivation during irrigation periods and the day after rain to calculate the average water reduction within 24 hours during cultivation period. Under the assumption of water level of the paddy field is not reduced during rainy days, these measurements are taken in sunny days. *Figure 01* shows that how water level are measured during cultivation periods.

According to the *figure 01*, L1, L2 and L3 represent the separated cluster in the paddy field and those clusters are separated according to the inclination of the paddy field surface. Then L1, L2 and L3 are begin part (beginning from the tank band), middle part and end part in the paddy field respectively. In general, the surface of the paddy field in most areas in Sri Lanka is prepared with some inclination for flowing irrigated water and for distributing irrigated water from beginning to the end in the paddy fields. Therefore it is most appropriate to collect data from three divisions separately. Then the first reading (M1) of water depth was taken at 6.00 a.m. in a specific day and the second reading was taken also at 6.00 a.m. the next day. However, the second reading (M2) could be taken, if there wasn't rain within 24 hours after the first reading was taken. Then the difference between M1 and M2 is considered as the total reduction of water depth per day. This process was continued same for the different three stages of cultivation process which are mentioned above.*Figure 02* shows the process of obtaining the water depth of paddy field during the raining period. According to this process three readings of water level were taken from the thirty randomly selected points of the three clusters in the three consecutive rainy days with over 100 mm rainfall. To determine the WTP for water of individuals 150 individuals were interviewed. The interview is scheduled based on the contingent valuation method (CVM). Sample unites were selected using two stage stratified sampling from three cultivation schemes namely major irrigated , minor irrigated and rain fed.

3.1 Evaluating Monetary Values

The benefit evaluation was done using the household production model which was first employed by Freeman (1993), who established this model through theory on benefit evaluation for non-market goods. Chiueh (2008) evaluated the social value of the environmental multi functionality of paddy fields in Taiwan. This study used the CVM to evaluate the value of environmental multi functionality of paddy fields from the purposefully selected poll of samples in Taiwan. Paddy field operates as a reservoir during the rainy period in terms of flood mitigation. Thus, the potential monetary value of flood mitigation function of paddy field should be reasonable for replacing the cost of storing water in a dam or reservoir. Therefore monetary value of flood mitigation function can be calculated by using following formula, which was formularized according to the non-market valuation method of replacement cost.

$$FM_{mv} = W_{pf} \times C_d$$

Where,

FM_{mv} = Monetary value of flood mitigation function of paddy fields

W_{pf} = The potential amount of water (m^3) collected in the Individual paddy fields by rain during Maha season.

C_d = Annual mainatance cost of storing one m^3 of water in the tank or reservoir

C_d is replaced to annual expenditure of collecting one m^3 of rain water in the year 2011 which is 2.26 LKR[2] . Then W_{pf} is calculated by multiplying Grand mean of standing water depth ($\overline{\overline{D}}_{wl}$) that are calculated by using experiment data, the area of the paddy fields and number of rainy days (RD$_i$) which indicated more than 25 mm/day [3]. Since W_{pf} presents a form of m^3, A_{pl} is multiplied by 10000 in order to convert area (hectare) of individual paddy land (A_{pl}) into square meters.

$$W_{pf} = \overline{\overline{D}}_{wl} \times A_{pl} (10000)(RD_s)$$

The general situation in paddy fields, average water depth of those clusters can be indicated some considerable differences due to the inclination of land surface. Since geometric mean can eliminate the impact of the smallest value or the largest value, the average depth of standing water in paddy field during rainy period($\overline{\overline{D}}_{wl}$) is geometric mean of average water depth in day of separated three clusters.

$$\overline{\overline{D}}_{wl} = \sqrt[3]{\overline{D}_{wl1} \times \overline{D}_{wl2} \times \overline{D}_{wl3}}$$

Then the following formula used to calculate the average depth of standing water in a cluster. Since ten readings were taken in a cluster, sum of R (Readings) divided by ten to compute average depth of standing water in a day. Further, since the reading of water depth is taken in the three consecutive raining days with over 100 mm rainfall, the numerator of the following formula is divided by 3 to compute the average depth of standing water in a cluster.

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[2]The irrigation system has enabled the country to collect 43,000 Million Cubic Meters (MCM) out of the total rainfall all of 118,000 MCM received at present. And total investment (expenditure) for irrigation sector development in 2011 amounted to 19 Billion LKR (Ministry of Finance and Planning, 2012)

[3]The Department of Meteorology of Sri Lanka has categorized daily rainfall into six categories as 0-12.5 mm light rain, 12.5mm-25mm light to moderate rain, 25 mm – 50 mm moderate rain, 50mm-100mm fairly heavy rain, 100mm-150mm heavy rain and up to 150mm very heavy rain (Perera, 2012).

$$\overline{D}_{wl_i} = \frac{\sum_{j=1}^{3}\left[\dfrac{\left(\sum_{i=1}^{10} R_i\right)}{10}\right]}{3}$$

Where; i = number of measurement points in a cluster, j = number of measurements in a point, R= Reading of water depthIn general a paddy field is filled with water from rain and irrigational methods. Many researchers have discovered that water in the paddy field is evacuated by evaporation, transpiration and infiltration (Weerasinghe and Katulanda, 1988). As mentioned by the researchers, water in the paddy field is polluted by chemicals and other human activities. However, the paddy field performs as a water purifying machine because the soil structure of the paddy field helps to purify the polluted water while infiltration. Since the assumption of all the infiltrated water of the paddy field is totally purified, cost of purifying water (one m^3) of National Water Supply & Drainage Board (NWSDB), Sri Lanka in the year of 2011[4] was applied to calculate the monetary value of water purifying function of paddy fields. Hence, the following formula was constructed to compute the monetary value of water purification function of paddy fields based on RCM.

$$WP_{mv} = \lfloor WI_Q \rfloor \lfloor PC_w \rfloor$$

Where,

WP_{mv} = Monetary value of water purification function of paddy fields

WI_Q = Amount of water infiltrated during cultivating period

PC_w = Cost of water purification (m^3)

Then WI_Q is calculated by multiplying area (hectare) of individual paddy land (A_{pl}), IR_D and WF_D. Since WI_Q presents a form of m^3, A_{pl} is multiplied by 10000 in order to convert it into square meters. Hence, WI_Q is computed by using the following formula.

$$WI_Q = (IR_D)[Apl\ (10000\ )](WF_D)$$

Where,

IR_D = Infiltration rate per day

WF_D = Water filled days during cultivating period

In the computation of obtaining IR_D, ER_D is equaled to 3.5 mm in dry zone [5] (major irrigated scheme and minor irrigated scheme) and 3.84 mm in wet zone [6](rain-fed scheme) and divided by 1000 for converting millimeter into meter. WD_R was calculated using the data, taken from the experiment. Assuming that the other factors are constant, total water reduction within 24 hours is equal to evapotranspiration and infiltration, IR_D can be obtained by subtracting ER_D from WD_R. IR_D can be computed by using following formula.

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[4]Cost per one cubic meter of water purification is 14.86 LKR of <u>National *Water* Supply & Drainage *Board*(NWSDB)</u>
      Sri Lanka in 2011 (Ministry of Finance and Planning, 2011)

[5]Average rate of evaporation in a sunny day in the Dry Zone during "Maha" is about 3.5 mm and during "Yala" is about 6 mm (Department of Agriculture Sri Lanka, 2006)

[6]Werasinghe and Katulanda (1988) stated that the total evapotranspiration demand per day was 3.76 mm, 3.74 mm and 4.01 mm for 2.5 cm, 5cm and 10 cm submergence levels respectively in Yala season. According to that average evapotranspiration demand per day was 3.84 mm.

$$IR_D = (WD_R) - \left(\frac{ER_D}{1000}\right)$$

Where,

WD_R = Average Reduction of water depth (m) with in 24 hours in the paddy field

ER_D = Evapotranspiration rate mm/day

Considering the water level of peripheral highland wells to the paddy fields are higher than other wells that are located out of peripheral areas because the amount of groundwater is recharged by infiltration (Kim et al., 2006). However, the amount of recharged water has been consumed for human needs (drinking, cooking, washing etc.) without paying. Similarly, directly or indirectly the urban people and some rural people in the dry zone have to pay for water. Then willingness to pay for 1m³ of water (WTP_w) is applied to estimate the monetary value of groundwater recharge function of paddy fields (GR_{mv}).   Willingness to pay for 1m³ of water of respondents was taken from interview based on contingent valuation method (CVM).

$$GR_{mv} = \lfloor WI_Q \rfloor \lfloor WTP_w \rfloor$$

Where,

WI_Q = infiltrated water quantity in individual paddy lands
WTP_w = Willingness to pay for water (1 m³)

4. Functioning of Water in Paddy Fields

A paddy field performs as multifunctional land surface due to its ability for ponding water. During the cultivation period, paddy field is filled with water usually within the period of land preparation stage to grain filling stage by irrigation or rain water. Ponded water in the paddy field is reduced mainly through evaporation, transpiration and infiltration. Infiltration water helps to increase the standing water level in the wells nearby paddy fields and fulfill the water requirement of high land crops nearby paddy fields. Besides, during the raining period, paddy fields act as a reservoir in mitigating floods. The magnitude of reducing surface water in the paddy fields depends on climate and soil structure which vary within the cultivation schemes. In addition to the above, it varies within stages of cultivation. According to the DOASL (2006), Water reduction of paddy fields varies with the method of land preparation, method of crop establishment and duration of the rice crop(s). It also varies with the soil, environmental conditions and the management of the subsequent rice crop.   According to the experiment, reduction of standing water depth varies with the cultivation stage and cultivation schemes. In the experiment in the paddy fields, the maximum level of standing water reduction was recorded during the land preparation in any scheme and minimum level of water reduction was recorded in the vegetative stage. According to the experiment, average reductions of water per day during land preparation were 0.0241m, 0.0177m and 0.0087m in major irrigation scheme, minor irrigation scheme and rain-fed scheme respectively. In the vegetative stage, average values of standing water depth reduction per day were 0.0145m in major   irrigation scheme, 0.0086m in minor irrigation scheme and 0.0045m in rain-fed scheme.

Due to the gradual slope in the paddy fields, depth of standing water also varies with the different locations and the magnitude of water reduction is also vary within different levels of paddy fields. It is observed that in the major irrigation scheme, average level of standing water in level one is higher than in the other two levels. However, the same in level three is higher than in level two. Considering minor irrigation scheme and rain fed scheme, the values of average standing water depth have reduced gradually from level one to level three. This practice on the paddy field surface has influenced on reduction of standing water depth. Further, average values of standing water depth reduction per day were 0.181m in major   irrigation scheme, 0.144m in minor irrigation scheme and 0.0063m in rain-fed scheme. As explain in above standing water depth varies within the different levels of paddy field surface due to inclination. Rainfall may vary within schemes. Therefore, it is important to identify the variation of standing water depth in paddy field during raining days. According to data obtained by the experiment, the average standing water depth in level three was higher than the other two levels and the level two was higher than the level one in all three cultivation schemes.

Considering the overall values, average values of standing water depth of paddy fields during raining period were 0.1154m in major   irrigation scheme, 0.1076m in minor irrigation scheme and 0.1073 in rain-fed scheme.

5. *Flood Mitigation*

To identify the magnitude difference of flood mitigation as a positive effect of paddy farming, it is important to examine the amount of raining water ponding in paddy field in separate three cultivation schemes during considered time period for experiment in Maha Season. Then *Table 01* contains the average amount of raining water ponded in individual lands as per head and per acre in separate schemes. The data reveals *(see Table 01)* that amount of rain water filled in the paddy fields in the major irrigation scheme is higher than in other two schemes. However considerable amount of rain water is collected in the paddy fields in minor irrigation scheme and rain-fed scheme as well. The major   reasons for these differences are relatively higher rainfalls in major irrigation scheme during Maha Season in 2011 and land size of individual farmer. The interesting thing is that the above trend can be identified in the average amount of rain water per acre as well. The identified reason for that trend is rainfall differences within the cultivation schemes. Further, one-way ANOVA on the variable of collected rain water in the individual paddy land revealed that mean difference between each and every couples of cultivating schemes are statistically significant($F_{(2,147)}$= 120.69, $P<0.001$ and Gabriel post-hoc test, $P<0.001$).

6.Recharge Groundwater and Purification of Water

Since it is assumed that the groundwater level is recharged by infiltrated water and the infiltrated water is purified by paddy field, magnitude effect on both groundwater recharge and water purification function are identified by considering the amount of water infiltrated through paddy land surface. Then *Table 02* contains the average amount of infiltrated water from individual paddy lands as per head and per acre during cultivation season (Maha Season) in three cultivation schemes separately. The analysis reveals*(see Table 02)* that the amount of infiltrated water through paddy field surface in the major   irrigation scheme is higher than other two schemes. However, a considerable amount of water is infiltrated in the minor irrigation scheme and the rain-fed scheme too. The interesting thing is that the above trend can be identified in the average amount of water infiltrated per acre as well. The identified reason for that trend is the differences of water availability in paddy filed within cultivation schemes. The result of one-way ANOVA of average amount of water infiltrated in individual paddy land determines that the mean different of water infiltrated amount of the individual paddy land within each and every couple of cultivating schemes are significant ($F_{(2,147)}$=108.335, $P<0.001$ and Gabriel post-hoc test, $P<0.001$).These results suggested that people's utility of consuming ground water is in the major   irrigation scheme greater than in minor irrigation scheme and rain-fed scheme.

7.Monetary Value of External Benefits of Paddy Farming

The monetary values of external benefits of paddy farming including flood mitigation function, purifying water and recharge groundwater level are given in *Table 03*. The given information reveals that how those positive effects differ within each cultivation scheme. It is observed in *Table 03* that the estimated total monetary value of external positive effects of paddy farming per farmer is 392259.67 LKR in major   irrigation scheme, 73135.43 LKR in minor irrigated scheme and 39101.02 LKR in rain-fed scheme on average. When considering those benefits separately for each category, it can be identified that every paddy farmer in major   irrigated scheme has released 74435.44 LKR as benefits to the society through the flood mitigation function of their paddy farming. These values in minor irrigation and rain-fed schemes are 9093.16 LKR and 19785.85LKR respectively. Further, the society is benefited by water purification function from the values of 140710.65 LKR in major irrigation scheme. This value in minor irrigation and rain-fed schemes are 35006.91 LKR from and 8414.64 LKR respectively. In addition to that the monetary value of recharge groundwater per farmer is 175746.28LKR in major   irrigation scheme, 26102.05LKR in minor irrigation scheme and 10900.53 LKR in rain-fed scheme. These results shows that monetary value of the benefits of both recharge groundwater and water purification function in major   irrigation scheme greater than the values produced by minor irrigation scheme. The rain-fed scheme produces the least benefits comparing with irrigated schemes because in practice, water availability of the paddy field during cultivating period in irrigated schemes is greater than Rain-fed scheme relatively.

8. Conclusion

According to above mentioned result it can be concluded that the multi-functionality of water in paddy fields is the main cause for generating external benefits of paddy farming. As positive externalities of paddy farming, food mitigation, recharging groundwater and purification of water could be assessed. Further, the amount of rain water filled in the paddy fields in the major irrigation scheme is higher than in the other two schemes. However, a considerable amount of rain water was collected in the paddy fields in minor irrigation scheme and rain-fed scheme as well. Further, it is suggested that people's utility of consuming groundwater is in the major irrigation scheme greater than in the minor irrigation scheme and in the rain-fed scheme. Thus, it is concluded that economic value of water functionality of paddy production varies within schemes of cultivation.

Figure 01: Experiment Procedure of Obtaining Level of Water Depth Reduction
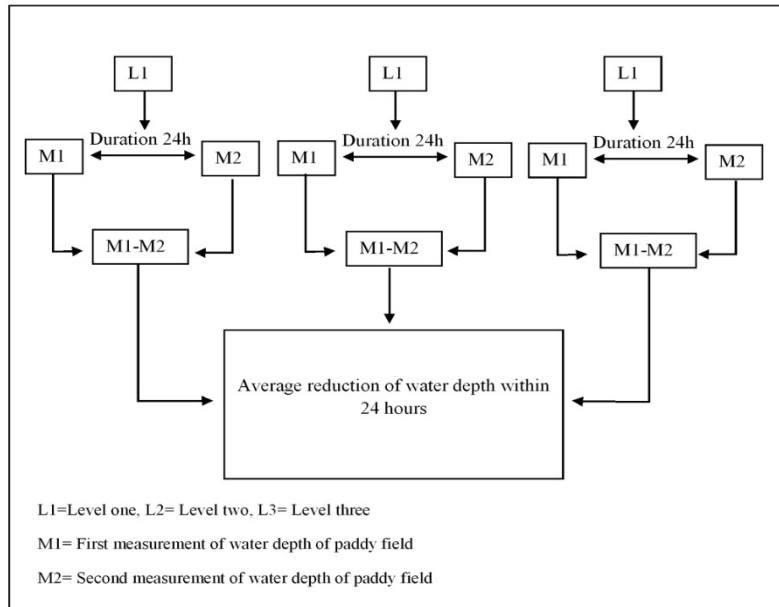
Figure 02: Experiment Procedure of Obtaining Level of Water during Raining Period
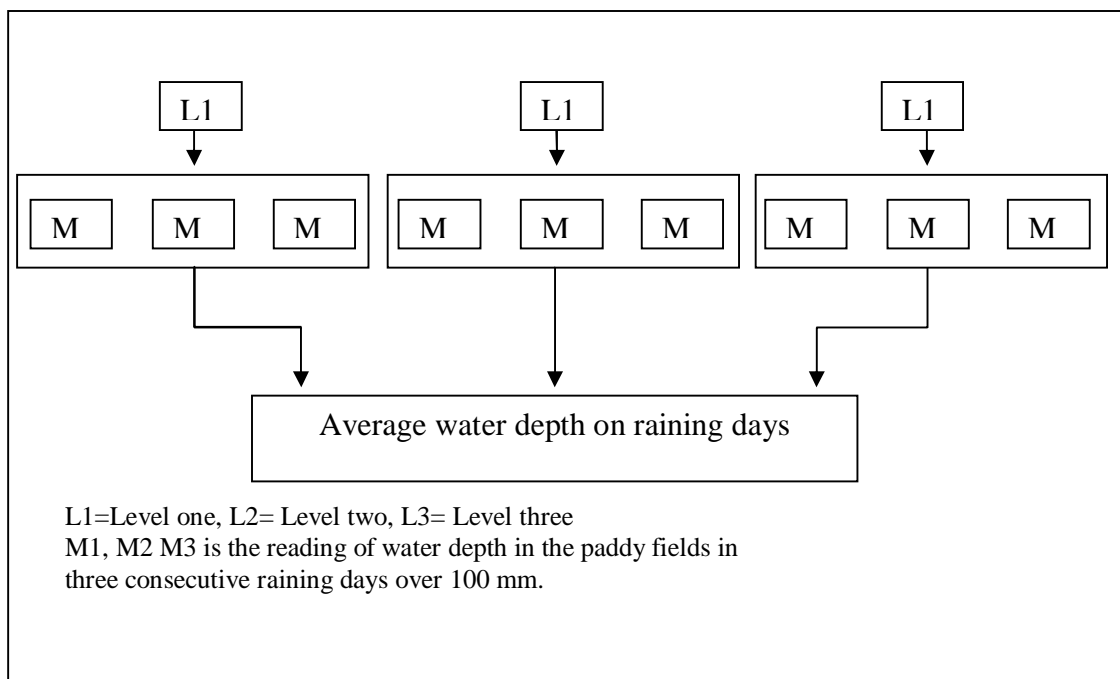
Table 01: Potential Amount of Rain Water Filled in the Paddy Fields during Maha Season

Scheme	Amount of rain water ponding (m^3)	
	Per farmer	Per acre
Major	32936.034	14477.3801
Minor	4023.53	3483.5715
Rain-fed	8754.80	7388.0206

Source: Source: Calculated Data from Experiment, 2014

Table 02: Average Amount of Water Infiltrated from Paddy Field Surface

Scheme	.Average amount of water infiltrated in m^3	
	Per farmer	Per acre
Major	9469.09	4162.24
Minor	2355.78	2039.64
Rain-fed	566.26	477.86

Source: Calculated Data from Experiment, 2014

Table 03: Monetary Values of External Benefits of Paddy Farming (LKR)

Scheme	Category of external benefits	Per head (per farmer)			Per acre
		Minimum	Maximum	Mean	
Major irrigated	Flood mitigation	16359.44	179953.83	74435.44	32718.8
	Purifying water	30925.42	340179.60	140710.6	61850.8
	Recharge groundwater	38625.56	424881.12	175746.2	77251.1
	Total	**85910.42**	**945014.55**	**390892.24**	**171820.7**
Minor irrigated	Flood mitigation	1968.22	31491.49	9093.16	7872.9
	Purifying water	7577.25	121236.06	35006.91	30309
	Recharge groundwater	5649.80	90396.74	26102.05	22599.2
	Total	**15195.27**	**243124.29**	**70202.12**	**60781.1**
Rain-fed	Flood mitigation	3339.39	66787.71	19785.85	16696.9
	Purifying water	1420.19	28403.88	8414.64	7100.97
	Recharge groundwater	1839.75	36795.06	10900.53	9198.76
	Total	**6599.33**	**131986.65**	**39101.02**	**32996.66**

Source: Calculated Data from Sample survey and Experiment, 2014

References

Chiueh, Y.W. and Chen, M.C. (2008) Environmental multifunctionality of paddy field in Taiwan, paddy water environ, no 6, pp 229-236

DOASL (2006) Water stress effects, water management systems & irrigation requirements for rice in Sri Lanka (WWW), DOASL, Retrieved from
http://www.agridept.gov.lk/index.php/en/crop-recommendations/905(Accessed 01/3/2011)

Freeman, A.M. (1993) The Measurement of Environmental and Resource Values, Resources for the Future, Washington, DC.

Huang, C.C., Tsai, M.H., Lin, W.T., Ho, Y.F. (2006) Multi-functionality of paddy field in Taiwan, paddy water environ, no 4,pp 199-204

Kim, T.C, Gim, U.S., Kim J.S., and Kim, S.K. (2006) The multi-functionality of paddy farming in Korea, paddy and water Environment, Vol 4, No. 4, pp 169-179

Kim, J.S., Oh, S.Y., Oh, K.Y. (2005) Nutrient Behaviour in a Korean Paddy Field Watershed During Irrigation Season, In Proceedings of 2005 American Society of Limnology and Oceanography Summer meeting, P 80

Kim, J.S., Oh, S.Y., Oh, K.Y. (2006a) Nutrient Runoff from Korean Rice Paddy Watershed During Multiple Storm events in the Growing season, Journal of Hydrology, Vol 327, pp 128-139

Korean Institute of Construction and Technology (KICT) (1999) Survey report on the Irrigation Return Flow in the Korean Watersheds.

Nishantha, B.M.N (2014) Influence of Paddy Farming Behavior on Human Health in Sri Lanka, International Journal of Multidisciplinary Thought 04: 02. 267-275.

Matsuno, Y., Nakamura,K., Masumoto., T., Matsui, H., Kato, T., Sato, Y. (2005) Multi-functionality of Paddy Rice Cultivation, Review and Future Prospects for Japan and Other Monsoon Asian Countries, In Proceedings of PAWEES Conference in Tokyo

Ministry of Planning and Finance (2011) Annual Report 2011, (WWW), Ministry of Planning and Finance, Retrieved from http://www.treasury.gov.lk/reports/annualreport/annualreport2011-eng.pdf , accessed 4th of April 2012

Panabokke, C.R., Seneviratne, A.A.A.K.K., Ariyaratna, B. R. (2006) Groundwater study in Malala Basin, IWMI. Sri Lanka

Perera, A. (2012) Rainfall categories based on daily rainfall,. Interviewed by Namal Nishantha [in person] Department of Meteorology in Sri Lanka, Colombo,-11.03.2012.

Renault D. and Hemakumara Molden (2000) Importance of water consumption by perennial vegetation in irrigated areas of the humid tropics: evidence from Sri Lanka. Agricultural Water Management. Vol 46 Issue 3, January: 201-213.

Tan C.H. (2004) Quantification and Valuation of Climate Mitigation Function of Paddy Field, In: Proceedings of workshop on Determining Paddy Irrigation Multi-Functionality, Taipei, Taiwan, May 11-13, pp 71-81.

Tsai (1993) The Public Benefit Externality of Taiwanese Paddy Rice, COA Report, Taipei, Taiwan.

Werasinghe and Katulanda (1988) Evapotranspiration requirement of rice at Mapalana in the wet zone of southern Sri Lanka (WWW), Journal of the National Science Foundation, Retrieved from http://nslrc.nsf.ac.lk/JNSF_online/16_1.htm , accessed 5th of July 2013

Yoon, C.G., Ham, J.H., Jeon, J.H. (2003) Mass Balance Analysis in Korean Paddy Rice Culture, Paddy Water Environ, Val 1, No 2, pp 99-106.

Yoshida, K. (2001) An Economic Evaluation of the Multifunctional Roles of Agriculture and Rural Areas in Japan (WWW) FFTC Publication, Retrieved from http://www.agnet.org/library/tb/154/ (Accessed 12/10/ 2013)